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Cartographic sources as a base of knowledge about land use in selected areas in the north-western Poland

Abstract. The aim of the research was to analyse land use changes and to develop a coherent base on the basis of available cartographic source materials – archival and contemporary topographic maps and spatial databases. The presented research is a continuation of works related to the cartographic visualization of changes in the distribution of the settlement network in the Noteć Forest – one of the largest forest complexes in Poland. The analysis was performed for nine villages together with their immediate surroundings, located in this area. The total surface area of lands covered by the study was 32,468 km^2. Cartographic source materials were collected for selected areas. The archival maps were georeferenced and then digitized. In this way, the data has been transformed into a homogeneous system enabling further comparisons and analyses in an automated manner. Geodetic software (C-Geo), GIS (MapInfo, QGIS) and GNSS technology were used in the work. Cartographic sources can be successfully used for spatial analyses and environmental studies, providing reliable and available quantitative data. This type of research is important because it shows the changes taking place in the natural environment and can be used in works related to spatial planning, landscape ecology and social research.

Keywords: topographic map, archival maps, cartographic analysis, land use, Poland

1. Introduction

The objective of the research consisted in tracing changes in land use within villages and other settlements located within one of the largest forest complexes in Poland, commonly known as the Noteć Forest (fig. 1). The region where the research area is located is called Wielkopolska (Greater Poland). The analysis of changes was carried out on the basis of numerous available archival and contemporary cartographic sources and spatial databases.

Changes in the usage of lands were the result of the introduction of settlement based on 'olęderskie law'. In Greater Poland, this commenced in the 17th century and lasted throughout the 17th and 18th centuries (Rusiński, 1947). Initially, the term 'Olęders' was used towards settlers from the Netherlands, Flanders and Frisia, who emigrated to Poland due to difficult living conditions and religious persecution (Klassen Pater, 2002; Targowski, 2016). In later years, it was applied to immigrants of various ethnic nationalities (Przewoźny & Przewoźny, 2009; Szałygin, 2002). The settlements were established on lands that were uninhabited and difficult to till, they were set up in order to clear the forests and reclaim wastelands.

In Greater Poland, the 'olęder' colonization was completely agricultural in nature, and formally ceased to exist as such in 1823. Chodyła (2001) informs that approximately 700 settlements were established in the region on the basis on this law. Today, traces of this colonization type are visible in rural architecture and the spatial arrangement of villages (Kusiak, 2013). The territories of Poland where the research area is located in the years 1793–1918 were under the Prussian occupation, in the

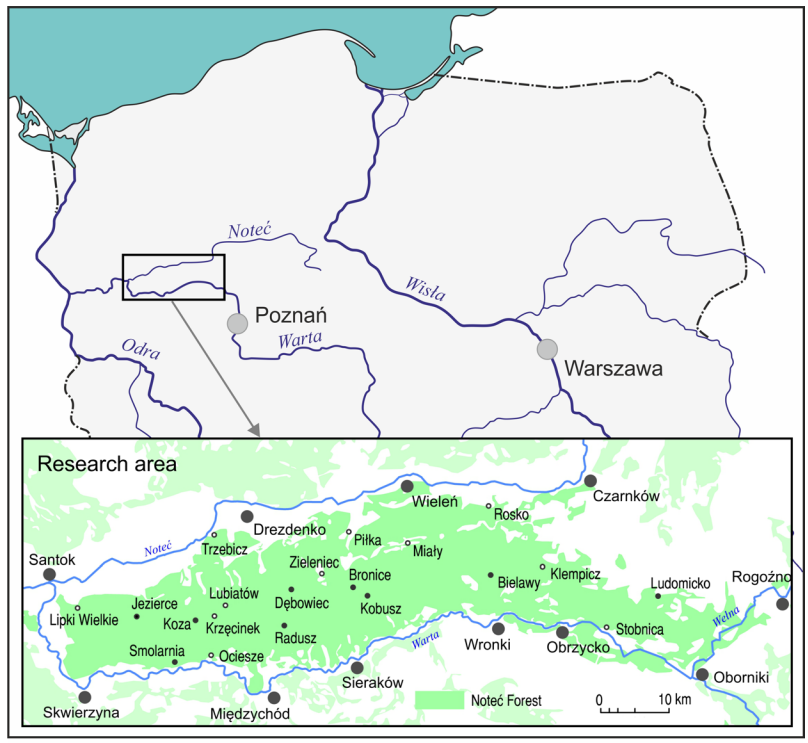


Fig. 1. Location of the research area. Prepared on the basis of the Geographical Objects Database (GUGiK, 2017)

years 1918–1939 this area was divided by the state border between Poland and Germany. Since 1945, the entire area has been within the borders of Poland.

A study of the spatial distribution of colonization and the methods of land use methods is made possible by, among others, archival cartographic sources (Plit, 2006; Szady, 2018) and contemporary topographic and thematic maps. Changes in the area of the Noteć Forest, determined on the basis of cartographic sources, have already been the subject of research. The structure of built-up areas (Ławniczak & Kubiak, 2021) and the geometric features of lakes (Ławniczak & Kubiak, 2016) were analysed.

2. Research area

The research area is a vast wooded forest complex which occupies approximately 1,372 km^2 (Lasy Państwowe, 2022). This area stretches latitudinally more than 100 km from Santok and Skwierzyna in the west to Oborniki and Rogoźno in the east, and Czarnków in the north-east. The analysis was performed for nine villages together with their immediate surroundings: Jezierce (52°41′19″ N, 15°33′35″ E), Smolarnia (52°38′36″ N, 15°40′47″ E), Koza (52°41′49″ N, 15°43′57″ E), Radusz (52°41′49″ N, 15°33′11″ E), Dębowiec (52°44′57″ N, 15°57′33″ E), Bronice (52°56′16″ N, 16°03′25″ E), Kobusz (52°44′50″ N, 16°05′06″ E), Bielawy (52°46′19″ N, 16°22′37″ E), and Ludomicko (52°45′06″ N; 16°43′40'' E). Due to the fact that only scant material traces of these settlements have survived in the field, we have provided approximate geographical coordinates describing their locations in brackets.

Unfortunately, the unavailability of archival register maps for the above-mentioned settlements does not allow to precisely define their boundaries. In addition, these areas have now been incorporated into other administrative units. For this reason, individual ranges are determined by buildings and agricultural land.

The total surface area of lands covered by the study was 32,468 km^2.

The research area is currently one of the least populated regions of Poland, the area is overgrown mainly with pine stands, sporadically interspersed with birch stands, which occupy the poor sandy habitats located on outwashes and inland dunes. In the 1920s, the forests on the research area fell victim to a natural disaster, 'panolis flammea' outbreak. It resulted in the death of 70,000 hectares of pine stands. Soon after the pest was controlled, the forest areas were recultivated. The modern pine stands in the Noteć Forest are about 90 years old (Kusiak & Dymek-Kusiak, 2002).

3. Source materials

For the areas covered by the research, there are very rich cartographic sources, including the time period from 1832 to 2021. In the years 1793–1918, the lands of this part of Poland lay in the Prussian partition zone. Therefore, the oldest maps of a topographic nature are the studies by Urmesstichblatt von Preussen at the scale of 1:25,000. Publication of these maps began in 1822. The work lasted 50 years, and the result was the development of 2,000 sheets (Czerny, 2015). The maps were based on a plane table surveying method and triangulation network, they are one of the first maps of this type in Europe (Engelmann, 1968; Lorek, 2017). These maps, however, are not a fully cartometric, this is confirmed by the research conducted by Lorek and Medyńska-Gulij (2020). In the case of older topographic maps, there is a problem with their georeferences and transformation to modern coordinate systems (Czerny, 2015). Urmesstischblatter maps does not show any precise boundaries between the types of land use, and borders between arable land and meadows and pastures. Maps showing the research area come from the years 1832 and 1833, are valuable archival material, but due to their shortcomings, they were not used to conduct quantitative spatial analyses. Figure 2 presents parts of the analysed areas.

The analysis of changes in the land usage was based on archival and contemporary cartographic sources and topographic databases. These included the following materials:

• Messtischblatter at the scale of 1:25,000. This term is used to describe maps that were published periodically in the years 1875–1931. In total, 3,065 sheets of the Prussian area were prepared. During their implementation, plane table surveying method was used (Czerny, 2015). These maps, due to their high value, are often used as source material in research in various fields. Kubiak-Wójcicka et al. (2021) used them in the analysis of changes in the surface of lakes, Ławniczak and Kubiak (2016) in studies of changes in the course of the lakes' shoreline. Molewski (2021) reconstructed the morphology of the area in Toruń on the basis of maps, Jancewicz et al. (2021) analysed landform changes in the urban landscape as a result of industrial activities, while Lieskovský et al. (2018) changes in land use in the Carpathian region. For the research area, these are the first maps that meet the criteria of topographic maps, and the first version is from 1893. The sheets used in the research were published in the years 1918–1935 and are the result of updating previous studies. From them, data was obtained for the areas that remained outside Poland in the years 1918–1939.

• Maps of the Military Geographical Institute (WIG) at the scale of 1:25,000, were, with a few exceptions, reprints of the partition maps of Messtischblatter (Kuna, 2018). This also applies to maps covering the research area. The materials used are an updated version of the Messtischblatter Prussian maps at the scale of 1: 25,000. Data were obtained from them for areas that after 1918 were within the Polish borders. The Military Geographical Institute was also the publisher of topographic maps at the scale of 1:100,000. These were tactical maps intended for the needs of the army, but due to the richness of their content, they were also used for economic and social purposes (Stankiewicz, 2013). They were developed on the basis of the updated detailed topographic maps of the WIG at the scale of 1:25,000. WIG maps were made in the Roussilhe quasi-stereographic projection. The main point of the projection is located at the intersection of meridian 22° with a parallel 52°. This location corresponds to approximately the geometric middle of Poland from the interwar period. The map sheets used in the work were published in 1934. This edition of maps presents a high cartographic level, as noted by Nita and Myga-Piątek (2012), these maps are characterized by high detail and accuracy of mapping the topography

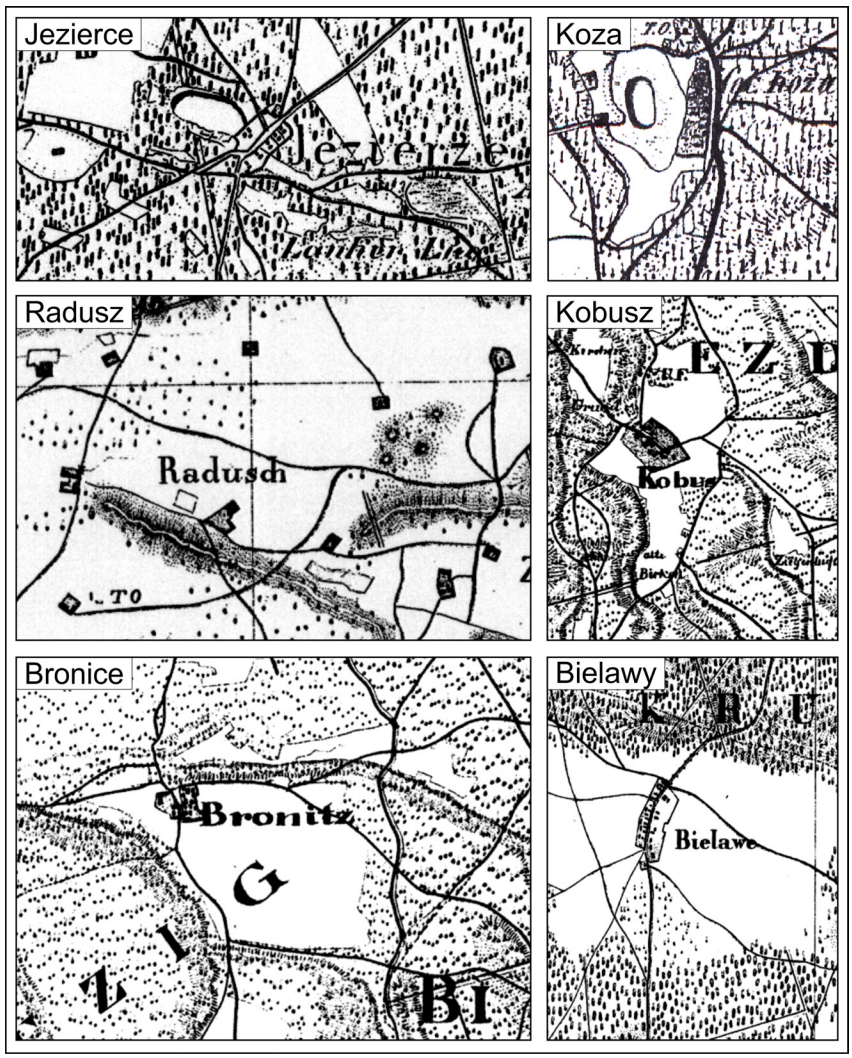


Fig. 2. Parts of Urmesstichblatter von Preussen maps from 1832–1833 covering selected parts of research areas

of the area, they are a very valuable document for research on, among others, changes in spatial development.

• The topographic map at the scale of 1:25,000, published in 1964, is the first post-war topographic study for economic purposes. This series of topographic maps was made from 1957 to 1966 by the Topographic Service of the Polish Army. Their drawback is impoverished content and deformations as a result of censorship interference. Important selected industrial and military objects and bridges were removed from the maps, and deformations were intentionally introduced. The map was also deprived of a coordinate grid (Stankiewicz, 2013). There is also no information on the applied projection. The maps used avoided any major interference with the content, as the research area is not particularly important from an economic and military point of view.

• The topographic map at the scale of 1:50,000 in the 1965 coordinate system

(EPSG: 2174), is the first Polish topographic map on this scale in the civil version. It was developed in the years 1977–1982. It was made available for general use in 1990. The maps in the 1965 coordinate system were devoid of a cartographic grid (Stankiewicz, 2013). The sheets used in the work come from 1977.

• Topographic maps at the scale of 1:10,000 in the 1965 coordinate system (EPSG: 2174) have been developed by GUGiK since 1970. In the following years, they were updated three times. They play a special role among topographic maps, because they cover the entire territory of Poland (Stankiewicz & Głażewski, 2000). The work uses maps published in 1991.

• Topographic maps at the scale of 1:50,000 in the 1992 coordinate system (EPSG: 2180) were issued since 1995 and replaced the civil maps in the 1965 coordinate system. They are characterized by high detail in relation to previous editions of topographic maps at this scale and a high cartographic level. The maps used in this study were published in 1998.

• VMap Level2 is a database of topographic objects developed with the detail and accuracy corresponding to the topographic map at the scale of 1:50,000. VMap L2 was developed in the WGS-84 system, in the UTM projection (EPSG: 4326). It is a map made in cooperation with the Head Office of Geodesy and Cartography and the Military Geography Board. The cartographic presentation of the data is a topographic map corresponding to NATO standards at the scale of 1:50,000, which is slightly different from the map in the civilian version. The differences result from different classification and editorial criteria of hydrography, buildings and road network (Stankiewicz, 2013).

• Database of Topographic Objects (BDOT10k) corresponds to the detail of a topographic map at the scale of 1:10,000. The BDOT10k is developed in the 1992 coordinate system (EPSG: 2180). The database includes 10 groups of layers – including forms of land cover. The functioning of BDOT10k is determined by the 'The regulation of the Minister of Economic Development and Technology of 27 July 2021 on topographic objects database, general geographic objects database and standard maps' (Ministerstwo Rozwoju, Pracy i Technologii, 2021). It is a study published by the Head Office of Geodesy and Cartography. The data used in this study come from 2013–2021.

• Numerical Forest Map (LMN). The map was made in accordance with the standard adopted in the State Forests and introduced as a tool supporting forest management. The basic geometric object is the forest sub-unit (Pietruńko & Bańkowski, 2005). The precision level is equivalent to the scale of 1:5,000 or greater. For the expression of plane coordinates of the location of objects, the system was adopted in 1992 (EPSG: 2180), and for the height – Kronstadt 1986. Thematic layers are developed in the ESRI Shape File format (Geomatyka w Lasach Państwowych, 2022). In the case of the LMN, the content of which covers only forests, the remaining analyzed types of use were developed on the basis of orthophotomaps provided by the Geoportal GUGiK and field reconnaissance. The data used in this study come from 2021.

4. Implementation of data sources

All maps were converted to the PL-1992 (ETRS 2180) system of coordinates obligatory for topographic and topical maps, based on the GRS 80 ellipsoid, in the Gauss-Krüger single zone projection. Archival maps (Messtischblatter, WIG, topographical map at the scale of 1:25,000 from 1964) were provided with georeferences on the basis of characteristic situational elements, which were identified both on the maps and in the field. Use was made characteristic crossroads, bridges, culverts, the existing fencing of old cemeteries, sacred buildings, geodetic points. Measurements of the geographical coordinates location of these points were performed using the GNSS technology. The conversion of maps drawn in the 1965 system of coordinates to the 1992 system was performed in the C-Geo programme. This process was presented by Kadaj (2000, 2002). The topographical map drawn in the 1992 system received georeferences on the basis of the cartographic grid. BDOT10k and LMN did not require a conversion of the system of co-ordinates. The following software was also used in the research: MapInfo Professional, QGis, Excel, Corel Draw.

The method used allowed for high accuracy of reference points, which were measured in the field. In the case of geodetic points, it ranges from 1 to 10 cm. The measurement result was compared with the coordinate data of the geo-

Table 1. Reclassification of divisions on the analyzed maps

Map type	Type of division on the map		
	Forests	**Arable lands**	**Meadows and pastures**
Messtischblatter 1:25,000	deciduous forest, coniferous forest, mixed forest, bushy and woody low vegetation	plough land, orchard, vegetables gardens	meadows, moorland, peat bogs
WIG Map 1:100,000	deciduous forest, coniferous forest, mixed forest, deciduous and coniferous shrubs	plough land	meadows, wastelands and pastures, wetlands and peat bogs
Topographic map 1:25,000	forest, rare forest, cutting, forest burned or withered, shrubbery, young forest	plough land, orchard, vegetable garden	meadows, scrub, reeds and rushes
Topographic map 1:50,000 (1965 system)	coniferous forest, deciduous forest, mixed forest, rare forest, shrubbery	plough land, orchard	meadows, scrub, reeds and rushes
Topographic map 1:10,000 (1965 system)	coniferous forest, deciduous forest, mixed forest, rare forest, shrubbery	plough land, orchard, vegetable garden, fallow land	meadows, pasture, scrub, reeds and rushes
Topographic map 1:50,000 (1992 system)	coniferous forest, deciduous forest, mixed forest, shrubbery	plough land, orchard	grassy plants, scrub, reeds, rushes and high grasses
VMap L2	forest, shrubbery	arable land, orchard	grassy plants, meadows
BDOT10k	forest, shrubbery, trees, forest nursery, small forest	cultivation on agricultural land, allotment garden, plantation, orchard	grassy plants
LMN	forest stands, forest nursery	plough land, orchards, fallow land	meadows, pastures, peat bogs

detic networks provided by National Geoportal (Geoportal Infrastruktury Informacji Przestrzennej, 2022). Lower accuracy was obtained for the remaining characteristic points. In the case of intersections, the error was not greater than half the road width (about 2–3 m). Another issue is the accuracy of identifying a given point on the map. Accuracy obtained here will depend on the quality of the archival map, raster resolution, its quality and calibration. The raster maps used in the research were 600 dpi. With such raster resolution, depending on the scale of the map, one pixel corresponded to a distance from 0.5 m to 4 m in reality.

Issues concerning the calibration of historical maps have been discussed, among others, by Guerra (2000), Affek (2012), and Panecki (2014). Molnár et al. (2014) and Biszak et al. (2017) whose research concerned the early editions of topographic maps of the Habsburg Empire, also draw attention to the problems of determining the exact georeferencing of archival topographic maps.

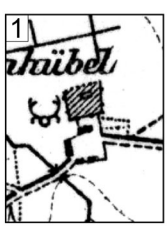
Selected elements of the contents of analogue maps, that is: forests, built-up areas, arable, meadows and pastures, cemeteries and surface waters were digitalized. In the case of topographic databases, selected layers or objects with appropriate attributes were adopted. The cartographic sources and databases used in the research are characterized by a different period of origin, a different scale and varied detail of each of the analysed forms of use, especially in the case of forests, arable lands, meadows and pastures. In order to standardize the data from various cartographic sources, it was necessary to reclassify the separations included in the source maps in order to assign them to the analysed forms of use. Table 1 presents the method of adapting the content of individual source maps. The separation of built-up areas, surface waters and cemeteries did not require reclassification.

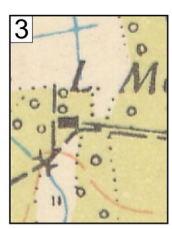
The used convention of presenting individual areas and objects on the map depends on the period of publication and the scale of the maps. In most cases, the method of presentation allows for an clear interpretation and separation of land use forms through the use of visible boundary lines on the map. The greatest difficulty is to precisely define the surface of built-up areas. Depending on the map, the surface or signature method was used. This makes it impossible to conduct comparative research. Figure 3 shows the methods of presenting built-up areas on individual maps. Built-up areas were calculated only where it was possible, i.e. on Messtischblatter at the scale 1:25,000, on the topographic map at the scale 1:10,000 in the 65 system, and BDOT10k and NML. The problems of presenting built-up areas on topographic maps were the subject of research, incl. Ostrowski (1994) and Hebdaś (2001).

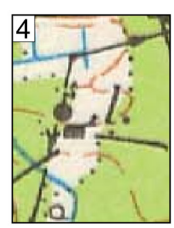
The procedure undertaken made it possible to compile all of the maps used – archival and contemporary, both in analogue and numerical format – into a single cohesive system. This in turn formed the basis for the commencement of comparative research and quantitative analyses of selected types of land usage in the period from the beginning of the 20th century till contemporaneity.

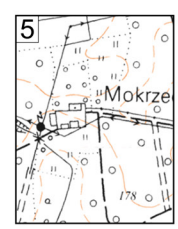
5. Cartographic analysis of changes in land management

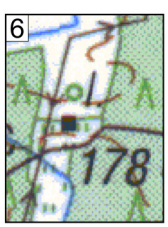
The analysis of changes in use was performed on the basis of all the above-mentioned carto-

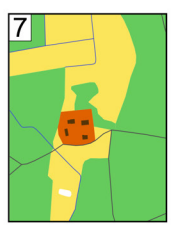












1. Messtischblatter 1:25,000 (1918)
2. Topographic Map 1:100,000 (1934)
3. Topographic Map 1:25,000 (1964)
4. Topographic Map 1:50,000 (1977)
5. Topographic Map 1:10,000 (1991)
6. Topographic Map 1:50,000 (1998)
7. Database of Topographic Objects *BDOT10K* (2020)

Fig. 3. Presentation of buildings on selected maps and BDOT10k visualization

graphic source materials. Figures 4, 5 and 6, visualize only content-related differences between the oldest (Messtischblatter) and the most recent cartographic work (Database of Topographic Objects) for selected townships: Jezierce, Smolarnia, Koza, Dębowiec, Kobusz, Bronice, Bielawy, and Ludomicko.

• Jezierce (Seewitz) – the map covers an area of 0.836 km^2. During the period of existence of the Grand Duchy of Posen (1845–1848), the settlement was ranked among the smaller villages in the then Prussian administrative district of Międzyrzecz in the Regierungsbezirk Posen. According to the census of 1837, the village

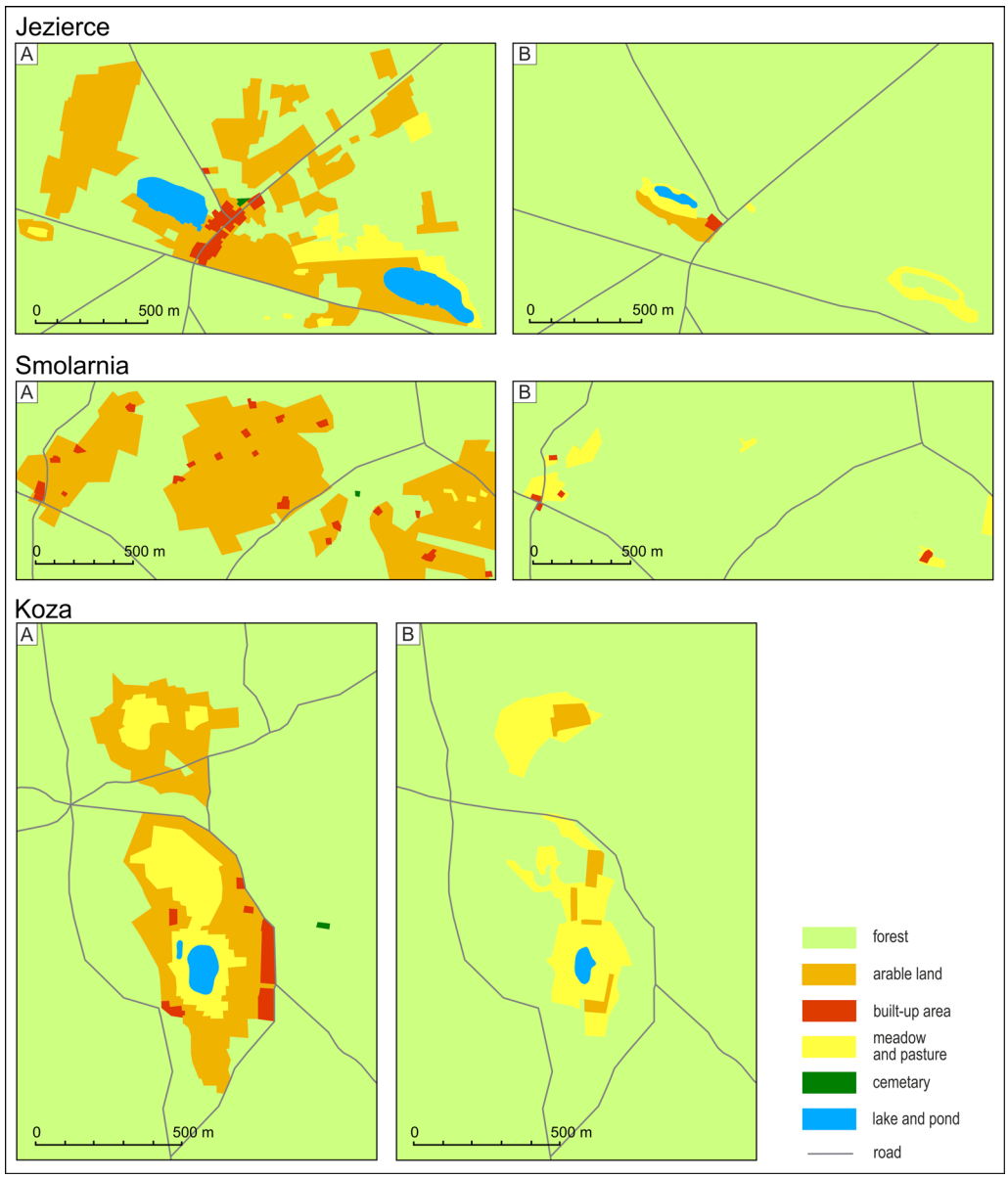


Fig. 4. Changes in land use structure in the villages of Jezierce, Smolarnia and Koza: A – Messtischblatter (1934), B – Database of Topographic Objects (2020)

comprised two manor farms and had 89 residents living in 13 homesteads. In 1936, Jezierce still had 10 buildings, and was also home to a school and a cemetery. After 1945, the majority of buildings were torn down, remains of the settlement is forester's lodge and the remains of the cemetery from the 19th and 20th centuries (Anders & Kusiak, 2005).

• Smolarnia (Hoffnung / Teerofen / Nadziejewki) – the map covers an area of 2.533 km^2. The village was established in the 18th century. In the inter-war period, it had 15 farmsteads

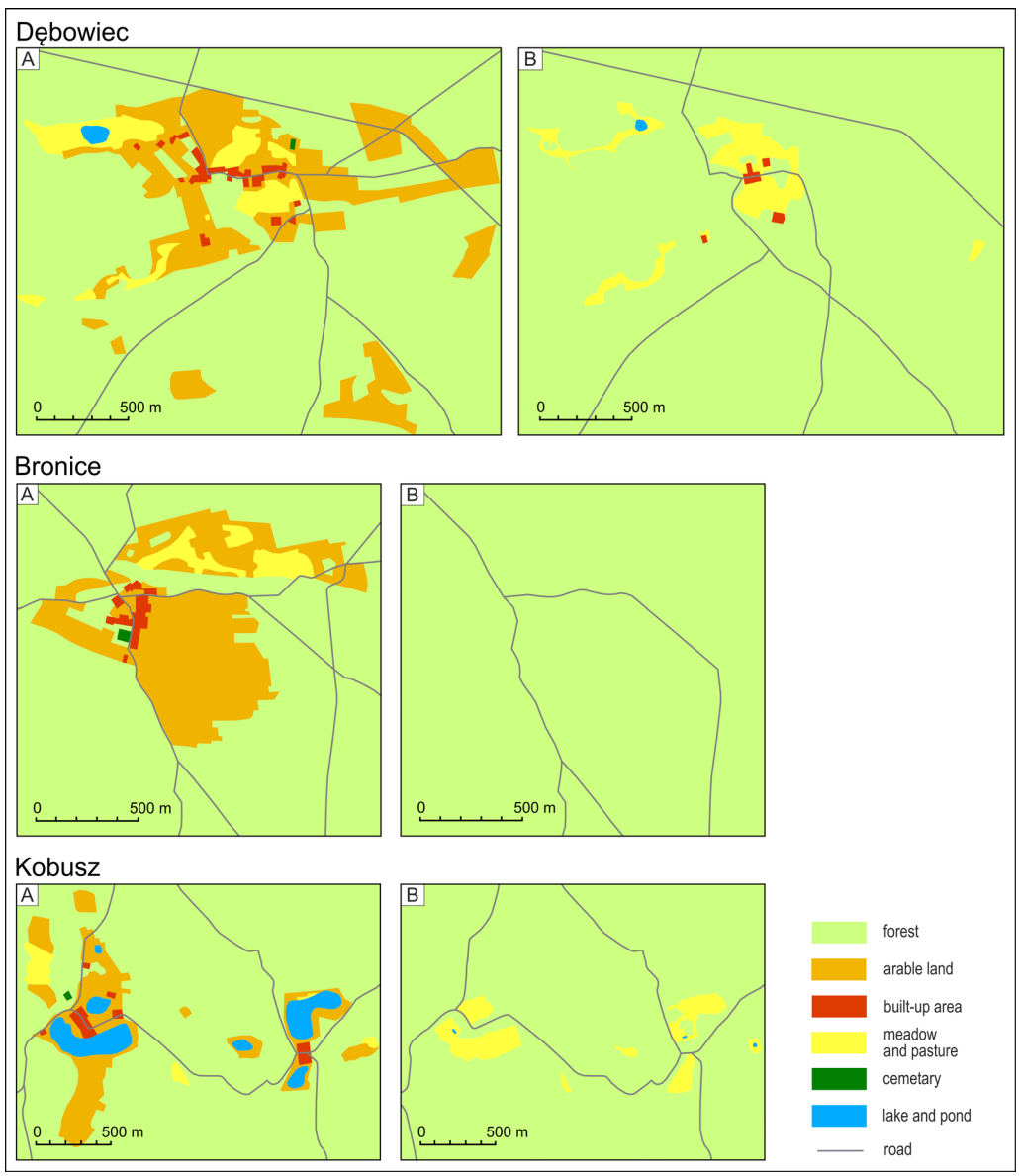


Fig. 5. Changes in land use structure in the villages of Dębowiec, Bronice and Kobusz: A – Messtischblatter (1918), B – Database of Topographic Objects (2020–2021)

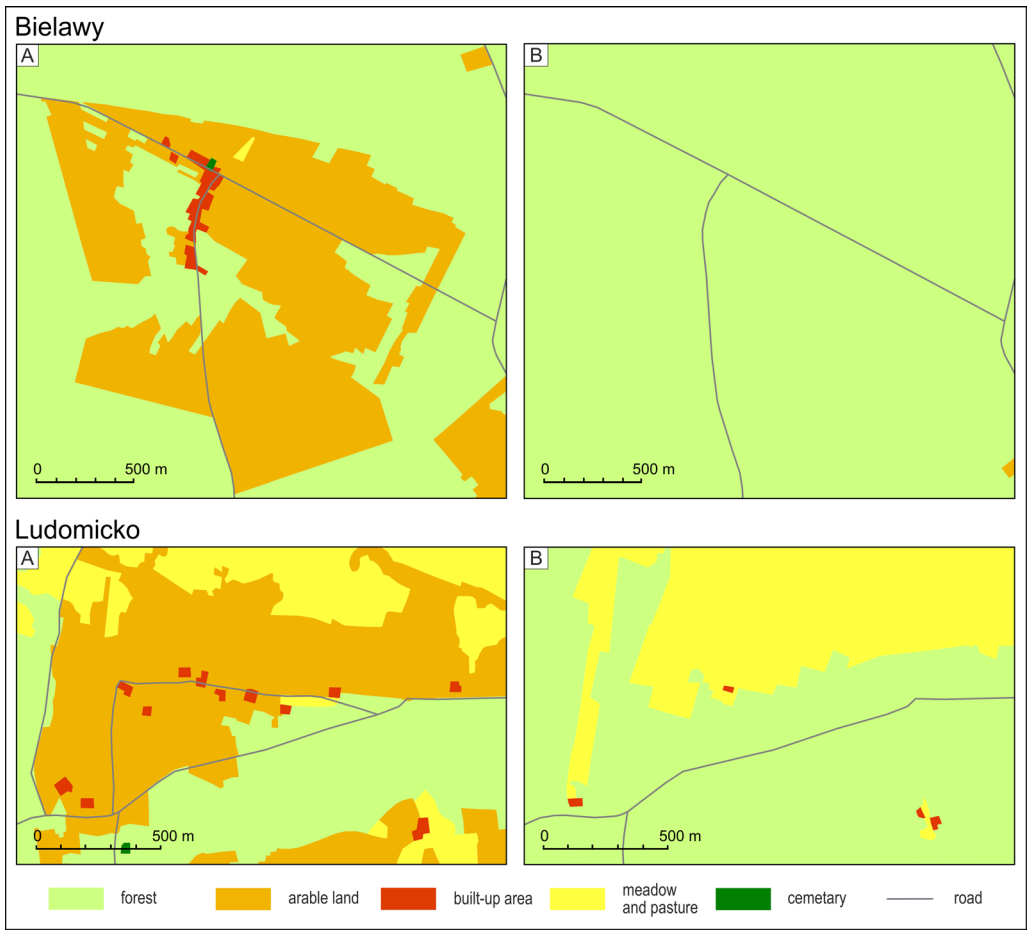


Fig. 6. Changes in land use structure in the villages of Bielawy and Ludomicko: A – Messtischblatter (1918), B – Database of Topographic Objects (2020–2021)

and 49 residents. Officially the village ceased to exist in 2008 (Anders & Kusiak, 2005). Currently, the only remains of the village are the ruins of the cemetery.

• Koza (Kaza, Waldluch) situated in the western part of the research area. In 1837, it had 9 farmsteads and 73 residents. Since then, the number of residents has been systematically dropping to 26 in 1939 (Anders & Kusiak 2005). Until 1939 the village belonged to Germany. After the Second World War, it found itself within the borders of Poland, and other residents of German nationality left it. The map covers an area of 2.323 km^2.

• Dębowiec – the village was established in the 19th century. At the time of its greatest prosperity, it was inhabited by over 90 residents (Polska Niezwykła, 2022a). It has been located in Poland territory since 1918. The map covers an area of over 5.719 km^2. The analysis of modern cartographic materials shows that there are currently 4 farms operating in the village. Their main functions are recreational.

• Bronice, the village was established in the 18th century. In 1910, it was inhabited by 112 residents. Since 1918, it has been located within the borders of Poland. The settlement existed until the Second World War, when the residents

were displaced by the German occupiers (Polska Niezwykła, 2022b). The map covers the area of 3,125 km^2.

• Kobusz – the map covers an area of 4.506 km^2. Today, nothing remains of this old 'Olęders' settlement, which was peopled in 1738 and 1746, and at the time comprised six farmsteads. During its period of greatest development, in the second half of the 19th century, it had 150 residents. In 1908, it had a population of 94, which by 1910 had fallen to 72. The settlement had a register office until 1930. After the Second World War, the primary school was closed, while the farmsteads and residential buildings were gradually torn down to make way for afforestation. By 1976, the settlement was completely depopulated (Anders, 1978; Anders & Kusiak, 2011).

• Bielawy, was established as far back as 1247, while in 1747 it was replaced with a 'olęderskie law' settlement that was inhabited by Poles and Germans. According to German statistical yearbooks, in 1845 it had 14 houses and 146 residents, while by 1880 these numbers had increased to 21 and 243, respectively. By 1929, the number of residents had fallen to 173. Before the First World War, the village had an elementary school, an inn and a small lumber mill. During the Second World War, the Germans expelled the residents and proceeded to afforest the region and populate it with game. After the war, some of residents returned, however the process of depopulation continued. The last householders left the village in 1968. All that now remains the ruins of settlement and old cemetery (Dziennik Urzędowy Województwa Wielkopolskiego, 2015) – the map covers an area of 6.098 km^2.

• Ludomicko – the map covers an area of 2.551 km^2. The village was founded in 1748. No more detailed information has survived about the village. All that is left of it is a 19th century cemetery, now closed (Anders & Kusiak, 2011). Currently, in land upon which Ludomicko stood is home to the 'Bagno Chlebowo' nature preserve, which was set up in 1959 and occupies 4.6 hectares.

• Radusz is a special area, the map covers an area almost of 16 km^2. In the case of this settlement, land use changes were visualized on four maps from the years 1918, 1964, 1991 and 2017 (fig. 7). The village was settled in the beginning of the 18th century. In its period of greatest prosperity, the colony numbered 700

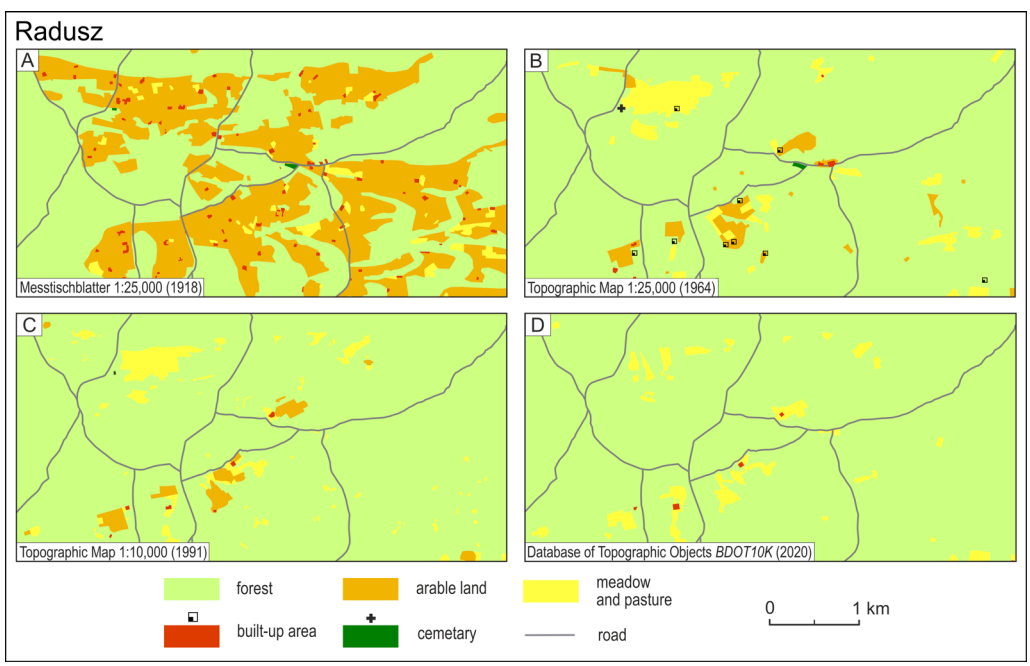


Fig. 7. Land use changes in the vicinity of the village of Radusz

residents. There were some 90 farmsteads ranging in size from 80 to as many as a few hundred hectares (Kusiak & Dymek-Kusiak, 2002), and, among others, a church, presbytery, school, post office, mills, inns and two cemeteries (fig. 7A). After 1918 Radusz was incorporated into Poland, and continued to thrive throughout the inter-war period. Based on the analysis of maps from that period, a slight increase in forest area was found. During the Second World War, indeed already in 1940, the Germans liquidated the village and evicted all its residents (Anders & Kusiak, 2005). In 1942, the buildings began to be torn down. The village was not rebuilt after the war. Today, the few surviving homesteads function as forester's lodges. What remains of the village are foundations, fragments of brick lined roads, filled in wells, fruit trees standing in the pine forest, and cemeteries. The first post-war topographic map of the area was drawn in 1964. It was used as the basis for a map (fig. 7B) on which we can clearly see results of the afforestation of previously agricultural lands and the considerable contraction of built-up areas. The course of this process is documented by topographic maps from later years. The share of forest areas continues to grow at the expense of agricultural land. In the case of meadows and pastures, a periodical increase in these forms of use was observed, caused by the abandonment of arable land cultivation due to the outflow of residents. In the following years, the area was gradually afforested (fig. 7C). The contemporary form of this area is visualized in figure 7D.

6. Results and conclusions

The numerous and varied archival and contemporary cartographic materials, topographic databases and thematic maps developed for Polish areas allow for a wide range of comparative studies and changes that have occurred in the structure of land use over the last decades. The field research has allowed us to determine that contemporary cartographic sources on the whole give a reliable presentation of actual conditions. They may well be used for spatial analyses and in research into the natural environment, providing trustworthy and commonly available quantitative data. At the same time, a review of archival sources shows that they are of value for comparative research. Unfortunately, despite the rich body of archival and contemporary materials, it is not possible to conduct such research on maps of identical scale, for there is no repeatability of the scale on maps from different time periods.

In general, in the analysed area we can observe changes characterised by a decrease in the share of arable, meadows and pastures and a concomitant increase in forested land, which were to a considerable extent impacted by geopolitical determinants. According to Rusiński (1947), the arrival of the colonists acted as an impulse for development of agriculture and husbandry. Settlement processes in the Noteć Forest underwent a weakening in the 19th century. After 1918, there was a slight migration of Germans from the lands that were incorporated into Poland. During the German occupation (1939–1945), mass deportations resulted in the collapse of numerous settlements. After 1945, many were viewed as unattractive, and this speeded up their depopulation and ultimate liquidation.

Presently, economic development in the region is to a certain extent restricted due to its location within the 'Natura 2000' area (Kusiak & Mysiak, 2019). There are no investments that would adversely affect individual ecosystems. Also, the development of recreational construction in the Noteć Forest is small. Townships located in the Warta and Noteć valleys are developing more dynamically.

The rich resource of cartographic source materials has made it possible to track changes in land usage that occurred in the area over the past 100 years. However, studies of archival topographical maps carry with them problems relating to quantitative analysis, since the oldest works lack cartometric corractness. In addition, it proved impossible to determine the surface area of built-up sectors on the basis of some of the maps (WIG topographic maps at the scale of 1:100,000, topographic maps at the scale of 1:50,000 in the 1965 and 1992 coordinate systems, and VMapL2), which was caused by their smaller scale and the utilization of point signatures. Observing the changes in the forms of land use taking place over the years, there is a noticeable increase in the area under the forests. On the other hand, the share of agricultural and built-up land has clearly decreased. The land classified as meadows and pastures is characterized by periodic variability towards

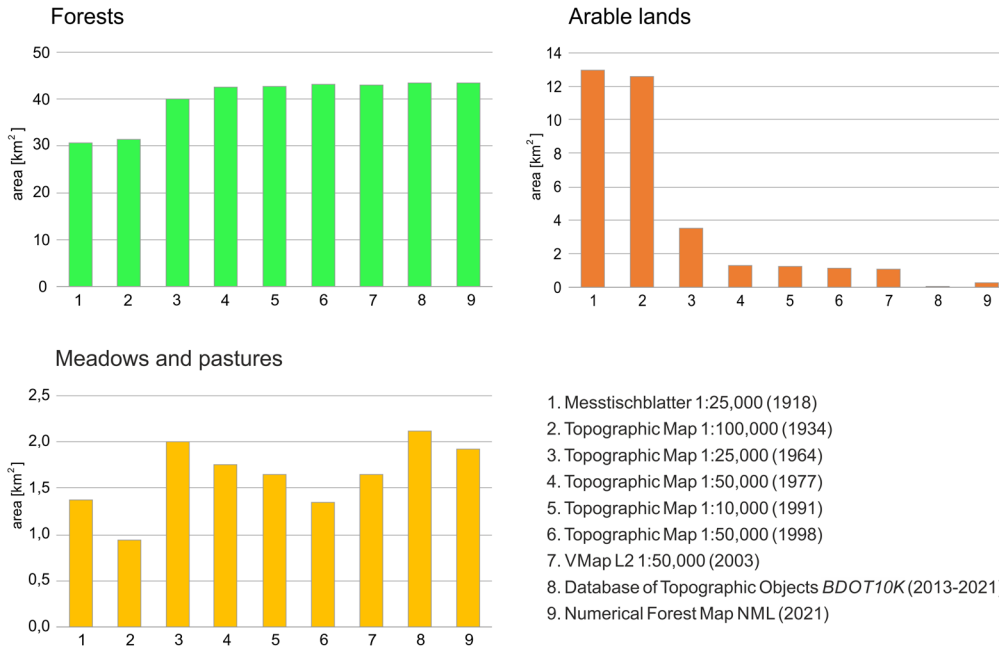


Fig. 8. Area of the analysed land use types based on cartographic sources

their increased share in the total area. There is also a noticeable loss of water surface as a result of the eutrophication process or the lack of maintenance of breeding ponds.

The summary structure and quantitative data on land use forms in the analysed areas are presented in figure 8. The graphs do not include surface waters and cemeteries due to their small area compared to other forms of land use.

The graph does not show changes in the area of built-up areas. Due to the nature of the research area (mostly dispersed rural buildings), they were presented using the signature method (fig. 3). The calculation of the area was possible only for: Messtischblatter (44.2 hectares), topographic map at the scale of 1:10,000 (3.3 hectares), BDOT10k (4.1 hectares), and NML (3.8 hectares).

Despite the immense progress achieved in methods of obtaining, storing and providing access to spatial data, traditional cartographic information continues to be excellent source of data about the natural, socio-economic and cultural environment. When conducting comparative research with the use of archival materials, attention should be paid not only to the aspect related to the separations used on the map, the classification used, but also to the use of other projections and reference ellipsoids on maps created before 1990. This requires the use of a wider range of activities and tools aimed at combining spatial data into a coherent system. An example of such an operation may be the adopted method of transforming the coordinate systems in order to preserve the geometrical properties of the map. In this process, deformations and errors of the primary system are always transferred to the secondary system (Kadaj, 2000; Janicka, 2012). The support during such works is the use of geomatics techniques, which, according to Kozieł (1997) provides research witch support through the automatic performance of operations on spatial data.

The research results presented may be used in works focusing on cultural heritage protection and promotion of the region, and also in studies devoted to spatial planning and protection of the natural environment. Finally, they constitute an example of the utilization of cartographic source materials.

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