Changes in land use in rural areas in north-eastern Poland

Olga MATUK, Poland

Keywords: land use, border zone, land and buildings register.

ABSTRACT

Land use changes are the subject of many studies. Different countries register different land use methods. The methods of land use are also defined differently across countries. The distinguished land use methods depend on, among others, geographical location and the historical and economic conditions. The basic public register in Poland that constitutes a source of information on land use is the real estate cadastre (called the land and building register). This register contains information on the division of land into types according to their actual use. The basic objective of the research was to examine the variability in time of the scope of land use functionally related to forest areas. The analyses carried out show the extent of changes in forest areas in the studied area, in particular their scope and area. The study answers the question of whether the dominant land use method changed from agricultural to forest in the analysed period (1981-2024). The research was conducted for the Sokółka county located near the border with Belarus, i.e. the north-eastern border of Poland, which is also the border of the European Union. The data sources used in the study were land use data collected in the real estate cadastre and aerial orthophotomaps. Cadastral (geodetic) data, including the cadastral map from 1981 and land and building records data from 2024, were obtained from the District Centre for Geodetic and Cartographic Documentation in Sokółka, Podlaskie Voivodeship. Aerial photos from 2002 and 2024 that allow for determining the actual changes in the use of the studied area, were obtained from a publicly available geodetic portal. The research revealed a slight increase in the forest area, up to 6%, at the expense of agricultural land. Therefore, the agricultural nature of the county has not changed. The research showed that agricultural land use remains dominant in the analysed area, just as it was in 1981 and in 2024.

Keywords: land use, border zone, land and buildings register, land management.

1. INTRODUCTION

The semantic approach to land is related to the purposes for which the land is used. In the field, it is difficult to distinguish land use from land cover, as indicated by Björk & Skånes (2016). In recent years, the changes in the way of land use in connection with increasing urbanization have gained popularity as the subject of research worldwide. Urbanization causes human interference with the natural environment. Analyses of land use changes are described and discussed in numerous research works focusing, among others, on mountain ecosystems described by Kaim et al. (2016) and Kurowska et al. (2020), metropolitan areas described by Tokarczuk-Dorociak et al. (2018), coastal zones described by Bielecka et al. (2020) and coastal zones described by Clerici et al. (2014). Few publications refer to the eastern part of Poland, which is a border zone. The way of managing these areas is influenced by the relations between

neighbouring countries. Proniewski (2014) described the structure of spatial conditions in Podlasie, emphasizing its low economic potential, low investment outlays, especially for innovation, poor infrastructure and transport potential, and pointing to human capital as the main driving force of the voivodeship. Research on global changes in land use is an important element in monitoring changes in the environment. Global changes in the structure of land use are closely linked to land use functioning locally. We still do not have sufficient knowledge about the global and regional changes in land use that are directly influenced by human activity. The definition of land use emphasizes this relationship. Land use is directly shaped by human activity, since it reflects the use and functions that a specific territory is to perform. Kaim et al. (2016) and Steffen et al. (2007) indicate that anthropogenic changes and modification of the earth's surface affect all of its ecological functions.

The conducted research aims to fill this gap by examining the characteristics of changes in land use over time in the village of Wojnowce, located in the northwestern part of the Polish-Belarusian border zone, from 1981 to 2024.

The article answers the question:

Q1 – How has land use changed in Wojnowce over a specific period of time?

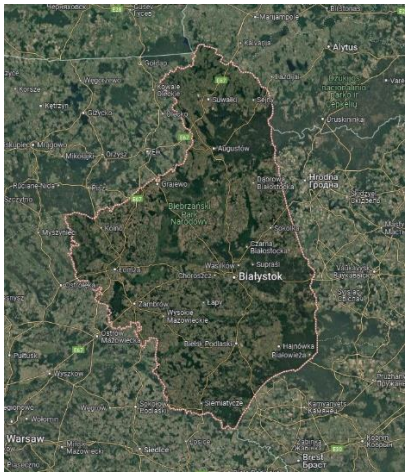
Q2 – Are there any noticeable trends in land use changes within the village and the municipality in which the village is located?

2. MATERIALS AND METHODS

2.1 Study area and material

Wojnowce is a village located in the Podlaskie Voivodeship, Sokółka County, Kuźnica Municipality (see Fig. 1). According to the 2021 National Census of Population and Housing, the population of the village of Wojnowce is 58 people. The village constitutes 1.4% of the total population of the municipality. From 1998 to 2021, the population of the village decreased by about 48.5%. In 2002, there were 24 households in Wojnowce, of which 12 were single-person households (GUS, 2024).

(a)



(b)

(c)

Fig. 1. a) Poland b) Podlaskie Voivodeship c) Wojnowce in the Kuźnica municipality, the study area location.
Source: www.google.com/maps

The cadastre in Podlaskie was created from scratch in the years 1957-1962. Buśko and Meusz (2014) found that the documents used in its creation came from land consolidation plans from 1935-1936, aerial photographs in a scale of 1:5000, and field measurements in the cities of Łomża and Augustów from 1936-1937 and 1949, respectively. Based on the materials stored in the Department of Cadastre and Real Estate in Sokółka, it is known that the land and building register (EGiB) in Wojnowce was created in 1981 on the basis of the decree of 2 February 1955 on the land and building register (Journal of Laws 1955, item 6). Before the planned land consolidation, land ownership was regulated, i.e. land ownership deeds were issued (1975-1977). In 2017, the EGiB was modernized and since then the register has been kept in digital form. The following data were used to conduct the study:

The cadastral map at a scale of 1:5000 from 1981 in the analogue form, prepared by the Provincial Office of Geodesy and Agricultural Land in Białystok, created based on the unification plan of 1931, updated by measurements in 1979, map of the classification of land based on soil type of 1980, received from the District Surveying and Cartographic Documentation Centre, Geodesy, Cadastre and Real Estate Department in Sokółka.

1. Aerial orthoimagery from the years 2002, 2010, 2016, and 2024 available online at geoportal.gov.pl, maintained by the Head Office of Geodesy and Cartography (Geoportal, 2024).
2. Population statistical data from Local Data Bank, maintained by the Central Statistical Office (GUS, 2024).

2.2 Methods

Due to restrictions resulting from the proximity of the Polish-Belarusian border, land use in the study area is slowly changing, which is manifested by the growth in forest areas at the expense of abandoned agricultural land. The aim of the study is to analyse land use in the years 1981-2024. The preliminary activities of the study consisted in converting the EGiB analogue map from 1981 into a digital vector file using QGIS 3.32 software and digitizing the land use ranges, in particular agricultural land, forests and shrubs and the total area of other land use classes (built-up, road, water, ecological (if separated) shown in the years 1981, 2002, 2010, 2016, 2024. Figure 2 shows vector data of land use in QGIS software.

Fig 2. Preview on land use, Wojnowce village. The black lines present the land use in 1981, the green lines - in 2010,
Source: *own study, based on cadastral map from 1981 form the Provincial Office of Geodesy and Agricultural Land in Białystok*.

As part of the study, the areas of agricultural, forest, and other land use classes in individual years were calculated and compared for the village of Wojnowce and for the municipality in which the analysed object is located. Finally, the results were documented in the form of tables, graphs and descriptions of land use changes.

3. RESULTS

Wojnowce is a village with a dominant share of forest in land use (accounting for 65% of the total area of the village). Agricultural land accounts for 28.4%, and urbanized areas for only 6.6%. The area of agricultural land in 2024 decreased by 12 ha compared to 1981. The area of forests and thickets was the smallest in 2002 and the largest in 2024, 266.1 and 269.2 ha, respectively. The areas of other types of land use remained the same (see graph 1, figure 3). There was also no clear trend in the changes in the area of agricultural land and forests. The area of forests is growing in accordance with a second-degree polynomial trend with a coefficient of determination R-squared of 0.57, while the area of agricultural land is decreasing at the same rate (R2=0.56).

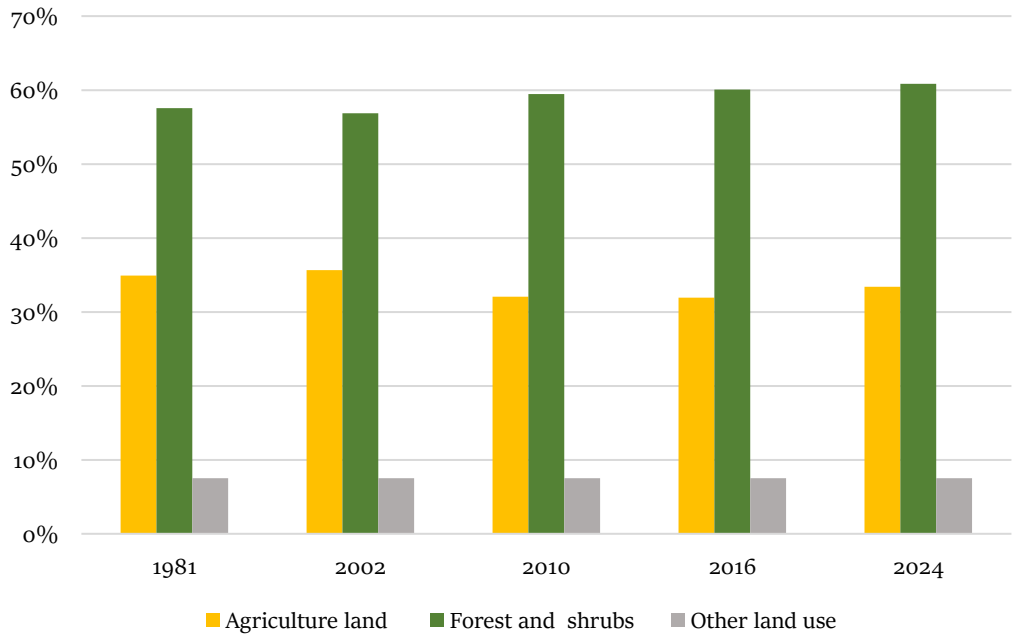


Chart 1. Changes in land use, Wojnowce
Source: own elaboration.

Fig 3. Afforestation, left 2002, right 2024
Source: own study.

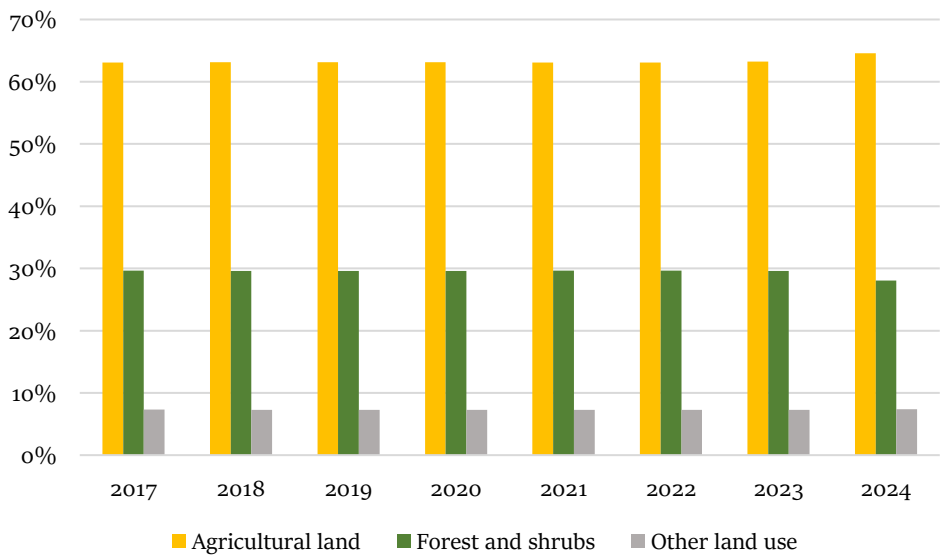


Chart 2. Changes in land use, Wojnowce
Source: own elaboration

The Kuźnica municipality, where the studied object is located, is an area characterized by agricultural and forest land use. In Kuźnica, 63% of the municipality area is used for agriculture, while 29% is forest land. In 2017, an increase in the area of agricultural land by 200 ha was observed, with an annual average of 33.6 ha, with a second-degree polynomial trend and an R-squared coefficient of determination of 0.76. This change occurred as a result of the reclamation of sand and gravel pits, some of which (approx. 1.2%) were transformed into meadows and pastures (Fig. 3).

Fig. 4. Kuźnica municipality, sand excavation areas
Source: own elaboration.

3. DISCUSSION

The factors that influence land use in relation to a farm or village are variable. They depend on social factors and the accessibility of these areas. On a regional scale, the factors that have been selected are topography and agroclimatic potential, while on a regional to national scale, climatic variables, as well as macroeconomic and demographic ones seem to determine land use. Wnęk et al. (2021) indicate that the main factors influencing land use change at the village and municipality level are local law acts and plans for protection against hazards (i.e. flood hazard zones). Sroka et al. (2019) identified 5 factors that contribute to changes in land use, i.e. (1) socio-economic: urbanization, number of enterprises, and income from agriculture, (2) location-related:, proximity to settlements, roads, and communal centres, (3) environmental: height, slope, and soil fertility (4) farm characteristics: low income and unfavourable farm structure, and (5) institutional, in particular agricultural policy at every level of administration. The identified factors of land use change confirmed the claim posed by Veldkamp and Lambin's (2001) that factors related to farm characteristics affect land use at the local level, while others most often affect it at the regional, national or global levels. Human potential, i.e. population size, also directly translates into changes in land use. In the Kuźnica municipality and Sokółka county, the population has been systematically decreasing since 1995. As can be seen in Figure 3, the decrease in the rural part of Sokółka county was more pronounced in agricultural areas.

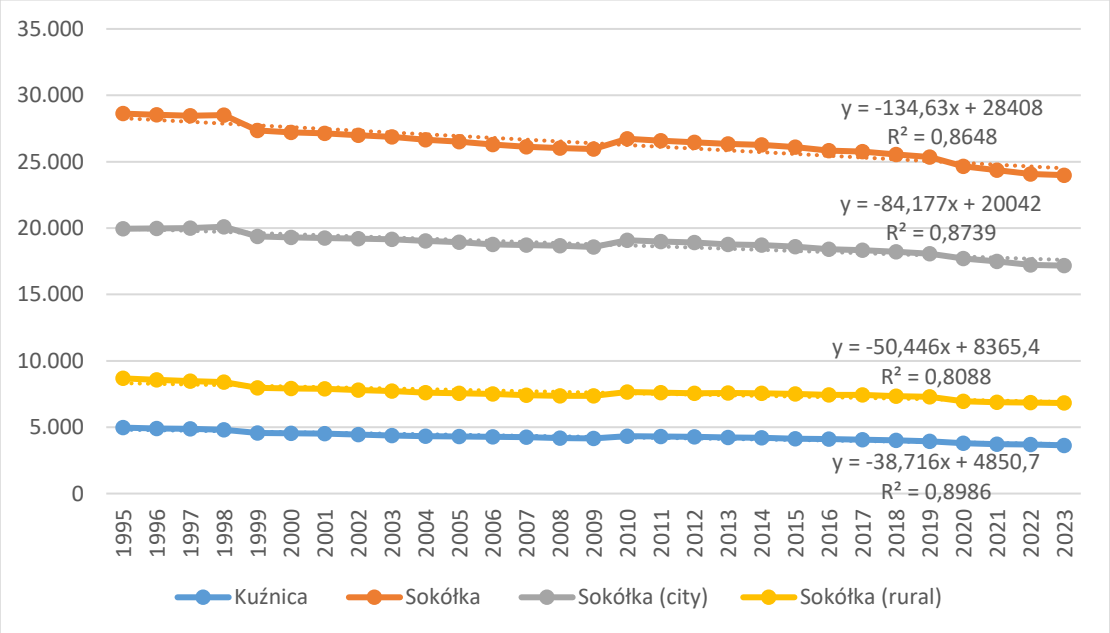


Chart 3. Population trends
Source: own study

The population loss, in the opinion of Śleszyński et al. (2017), is an important factor in the economic development of north-eastern municipalities that determines the quality of life and correlates with problem areas. The management of the real estate cadastre also depends on the geographical location. Busko and Meusz (2014) noted that the modernization of EGiB differs

depended on the voivodeship and was strongly dependent on the historical regions of Poland. The EGIB in Kuźnica was modernized in 2017. Until then, an analogue form of cadastral map had been in operation. The scope of registration and the method of collecting data on land use was influenced by legal acts that have changed many times in Poland. However, in the opinion of Matuk (2023), these changes had no impact on the registered data on land use, which was confirmed by Matuk.

CONCLUSIONS

The study too into consideration, among others, the social aspects that influenced the change in land use structures. The research revealed that the changes in the way of land use in the village of Wojnowce were rather minor. They were mainly related to the increase in the forest area in relation to agricultural land. The spatial arrangement of land use changes did not show statistically significant concentration or dispersion. Important sources of data used in the study were aerial orthoimages showing the actual way of land use in the selected periods of time. The study contributes to the discussion on changes in land use, which is very important in the context of joint EU projects in the field of agriculture and access to high-quality data.

REFERENCES

1. Bielecka, E., Jenerowicz, A., Pokonieczny, K., & Borkowska, S. (2020). Land cover changes and flows in the Polish Baltic coastal zone: A qualitative and quantitative approach. *Remote Sensing*, *12*(13), 2088. https://doi.org/10.3390/rs12132088
2. Björk, A. & Skånes, H. (2016) The need for awareness of semantic plasticity in international harmonization of geographical information: seen from a Nordic forest classification perspective. [In] O. Ahlqvist, D. Varanka, S. Fritz, K. Janowicz (Eds) *Land Use and Land Cover Semantics: Principles, Best Practices and Prospects* (pp. 41–58). CRC Press.
3. Busko, M. & Meusz, A. (2014). Current status of real estate cadastre in Poland with reference to historical conditions of different regions of the country. In *Environmental Engineering. Proceedings of the International Conference on Environmental Engineering. ICEE, 9.* http://dx.doi.org/10.3846/enviro.2014.196
4. Clerici, N., Paracchini, M. L., & Maes, J. (2014). Land-cover change dynamics and insights into ecosystem services in European stream riparian zones. *Ecohydrology & Hydrobiology, 14(2),* 107–120. http://dx.doi.org/10.1016/j.ecohyd.2014.01.002
5. Geoportal. (2024). https://mapy.geoportal.gov.pl/imap/Imgp_2.html?gpmap=gp0
6. GUS. (2024). Narodowy Spis Powszechnego Ludności i Mieszkań z 2024 https://bdl.stat.gov.pl/bdl/dane/podgrup/temat [National Census of Population and Housing in 2021]. https://www.polskawliczbach.pl/wies_Wojnowce
7. Kaim, D., Kozak, J., Kolecka, N., Ziółkowska, E., Ostafin, K., Ostapowicz, K., Gimmi, U., Munteanu, C. & Radeloff, V. C. (2016). Broad scale forest cover reconstruction from historical topographic maps. *Applied Geography, 67,* 39–48. https://doi.org/10.1016/j.apgeog.2015.12.003

8. Kurowska, K., Kryszk, H., Marks-Bielska, R., Mika, M., & Leń, P. (2020). Conversion of agricultural and forest land to other purposes in the context of land protection: Evidence from Polish experience. *Land Use Policy*, *95*, 104614. https://doi.org/10.1016/j.landusepol.2020.104614
9. Matuk, O. (2023). Zmiany rejestracji użytków gruntowych od założenia ewidencji grantów i budynków do chwili obecnej wraz ze zmieniającą się sytuacją polityczną [Changes in land use registration from the establishment of the land and building register to the present with the changing political situation]. *Przegląd Geodezyjny* [*Geodetic Review*], *10,* 38–41.
10. Proniewski, M. (2014). Polityka rozwoju regionów peryferyjnych [Development policy of peripheral regions] *Optimum. Studia Ekonomiczne, 6*(72*),* 79–80.
11. Rozporządzenie Ministrów Gospodarki Przestrzennej i Budownictwa oraz Rolnictwa i Gospodarki Żywnościowej z dnia 17 grudnia 1996 r. w sprawie ewidencji gruntów i budynków [Ordinance of the Ministry of Spatial Planning and Construction and of the Ministry of Agriculture and Food of December 17 1996 on the EGiB], Journal of Laws 1996 item 158 (1996) (Poland). https://isap.sejm.gov.pl/isap.nsf/download.xsp/WDU20210001390 /O/D20211390.pdf
12. Rozporządzenie Ministra Rozwoju Regionalnego i Budownictwa z dnia 29 marca 2001 r. w sprawie ewidencji gruntów i budynków [Ordinance of the Minister for Regional Development and Construction of March 29 2001 on the EGIB], Journal of Laws 2001, item 454 (2001) (Poland). https://isap.sejm.gov.pl/isap.nsf/download.xsp/WDU20210001390/O/ D20211390.pdf
13. Rozporządzenie Ministra Administracji i Cyfryzacji z dnia 29 listopada 2013 r. zmieniające rozporządzenie w sprawie ewidencji gruntów i budynków [Ordinance of the Minister of Administration and Digitisation on 29 November], Journal of Laws 2013, item 1551 (2013) (Poland). https://isap.sejm.gov.pl/isap.nsf/download.xsp/WDU20210001390/O/ D20211390.pdf
14. Rozporządzenie Ministra Rozwoju, Pracy i Technologii z dnia 27 lipca 2021 r. w sprawie ewidencji gruntów i budynków [Ordinance of the Minister of Development, Labor and Technology of July 27, 2021 on the register of land and buildings], (Journal of Laws 2021, item 1390 (2021) (Poland). https://isap.sejm.gov.pl/isap.nsf/download.xsp/ WDU20210001390/O/D20211390.pdf
15. Rozporządzenie Ministra Rozwoju, Pracy i Technologii z dnia 27 lipca 2021 r. w sprawie ewidencji gruntów i budynków [Ordinance of the Minister of Development, Labor and Technology of July 27, 2021 on the register of land and buildings], (Journal of Laws 2024 item 219 (2024) (Poland). https: /isap.sejm.gov.pl/isap.nsf/download.xsp/WDU20240000219/O/D20240219.pdf
16. Śleszyński, P., Bański, J., Degórski, M., & Komornicki, T. (2017). *Delimitacja obszarów strategicznej interwencji państwa: obszarów wzrostu i obszarów problemowych [Delimitation of areas of strategic state intervention: Areas of growth and problem areas]*. IGiPZ PAN.
17. Sroka. W., Pölling, B., Wojewodzic, T., Strus, M., Stolarczyk, P., & Podlinska, O. (2019). Determinants of Farmland Abandonment in Selected Metropolitan Areas of Poland: A Spatial Analysis on the Basis of Regression Trees and Interviews with Experts. *Sustainability, 11*(11), 3071. https://doi.org/10.3390/su11113071

18. Steffen, W., Crutzen, P. J., & McNeill, J. R. (2007). The Anthropocene: are humans now overwhelming the great forces of nature. *Ambio-Journal of Human Environment Research and Management, 36*(8), 614–621. https://doi.org/10.1579/0044-7447(2007)36[614:taahno]2.0.co;2.
19. The Provincial Office of Geodesy and Agricultural Land in Białystok (1981). Cadastral map.
20. Tokarczyk-Dorociak, K., Kazak, J., & Szewrański, S. (2018). The impact of a large city on land use in Suburban area–the case of Wrocław (Poland). *Journal of Ecological Engineering, 19(2),* 89–98. https://doi.org/10.12911/22998993/81783
21. Veldkamp, A., & Lambin, E. F. (2001). Predicting land-use change. *Agriculture, ecosystems & environment, 85(1-3),* 1–6. https://doi.org/10.1016/S0167-8809(01)00199-2
22. Wnęk, A., Kudas, D., & Stych, P. (2021). National Level Land-Use Changes in Functional Urban Areas in Poland, Slovakia, and Czechia. *Land, 10,* 39. https://doi.org/10.3390/land10010039
23. Zarządzenie Ministrów Rolnictwa i Gospodarki Komunalnej z dnia 20 lutego 1969 r. w sprawie ewidencji gruntów [Ordinance of the two Ministers of Agriculture and Public Utilities of 20 February 1969 on the land registry], M.P. 1969, item 98 (1969) (Poland). https://www.infor.pl/akt-prawny/MPO.1969.011.0000098,metryka,zarzadzenie-ministrow-rolnictwa-i-gospodarki-komunalnej-w-sprawie-ewidencji-gruntow.html

Olga Matuk, DSc., Eng.

Areas of interest: Cadastre, land use/land cover, real property management, spatial information systems. Author of several articles on cadastre and real property management.
Contact: olga.matuk@wat.edu.pl