GLL

HIERARCHISATION OF NEEDS WITH REGARD TO LAND CONSOLIDATION WORKS IN THE VILLAGES OF SOUTHERN POLAND ON THE EXAMPLE OF THE HACZÓW MUNICIPALITY

Justyna Wójcik-Leń, Przemysław Leń, Arkadiusz Doroż, Barbara Kępowicz

Summary

The aim of the research was to determine the needs with regard to land consolidation works and land exchange in the villages of the Haczów municipality. The analysis of the spatial structure was based on the calculated factors, and the following paper follows the applied statistical method to determine the necessary sequence of works in the studied area. It includes seven cadastral districts of the Haczów municipality, i.e. Jabłonica Polska, Wzdów, Jasionów, Buków, Haczów, Malinówka and Trześniów, located in the Brzozów district, in the Podkarpackie Voivodeship. The study had to take into account the structure of land ownership, land use, fragmentation of cadastral plots, and plots with no direct access to a public road. It also includes the calculation of the productivity index of arable land and grassland, as well as specific sizes of the occurrence of the external chessboard of land, i.e. differentials of local and nonlocal land. The analyses allowed us to determine, first, the factors characterising individual localities, and then to present the hierarchy of consolidation works and land exchange in the form of a ranking. The study applies the common method of zero unitarisation. This method consists in normalising diagnostic variables using feature range control. The obtained measures are included in the range [0.1]. The results represent the average optimal value of the measures obtained by each of the individual objects. The position in the ranking of urgency of the land consolidation works and land exchange depends on the size of the synthetic measure obtained. The analysis was based on data obtained from the Land and Building Register of the District Office in Brzozów.

Keywords

land consolidation • land exchange • spatial structure of land • land chessboard • agriculture

1. Introduction

Rural areas cover 85.0% of Poland's total area, with agricultural land constituting 52.0% of the country's area. As a branch of the national economy, agriculture consequentially performs economic (providing employment, contributing to national income, supplying feedstock to trade), social (ensuring necessaries, supplying food), spatial (shaping

the natural landscape, introducing changes to the natural environment) functions. The development of agriculture is influenced by two groups of factors: natural (climate, terrain, soils, hydrological conditions, slope) and non-natural (socio-economic development, agricultural development, agrarian structure, labour resources, state agricultural policy, and international market situation).

One of the tasks of the broader agricultural policy includes land consolidation as a tool to improve the functioning of agricultural holdings and establish a full rural development system [Sayılan 2014]. The main objective of land consolidation and land exchange is to create more favourable farming conditions in agriculture and forestry. It improves the quality of farms and forests, rationalises the distribution of plots within a farm, allows adjusting the boundaries of a property to the system of water drainage devices, roads, and terrain sculptures, and organises the networks of agricultural transport roads by designing and delineating a favourable network of access roads to agricultural and forest land as well as to farm buildings [Ustawa 1982].

Selecting agricultural areas subject to the procedure of land consolidation and exchange is a difficult and laborious task [Janus and Markuszewska 2017]. This process should be conducted rationally and cautiously, and its effect should bring benefits to the agricultural economy in the studied country [Zhang et al. 2014].

Selecting the areas for land consolidation works is based on analyses that concern, among others, the fragmentation of land as a factor limiting production capacity [Harasimowicz et al. 2017], which in turn may lead to abandoning production and, over time, to land degradation [van der Zanden et al. 2017]. Fragmentation is a problem faced by many countries in Europe: Cyprus [Demetriou et al. 2013], Turkey [Cay et al. 2010], Bulgaria [Di Falco et al. 2010], Spain [Gonzalez 2004], Czech Republic [Sklenicka et al. 2014], Poland [Noga 2001, Janus et al. 2017, Wójcik-Leń et al. 2020, Stręk et al. 2021, Wójcik-Leń and Leń 2021a, Wójcik-Leń and Leń 2021b, Wójcik-Leń 2022, Wójcik-Leń et al. 2022], or Slovakia [Gašincová et al. 2018, Hudecová and Kyseľ 2019, 2020]; as well as beyond Europe, among others: Mexico [Bentley 1987], India [Manjunatha 2013] or China [Guo et al. 2015].

In addition to the analysis of land fragmentation, important factors indicating the priority of the implementation of land consolidation works include the dispersion of land of individual farms, the assessment of parameters describing the spatial structure of the land and their impact on agricultural use [Leń 2018], and the analysis of the accessibility of plots to agricultural transport roads. The scope of research also includes the possibilities for a synthetic indicator for the assessment of the shape of plots [Janus et al. 2017] and analyses based on statistics of selected geometric features of cadastral plots [Kwinta and Gniadek 2017].

The history of land consolidation and exchange in Poland begins at the end of the 18th century. After becoming an independent country in 1918, following a long period of the Partitions, Poland required significant structural transformations due to with different economic development levels of rural areas. At the beginning of the 21st century, in preparation for Poland's accession to the European Union, the process of land consolidation was expanded. Its effects are related mainly to:

- modernisation of agricultural transport routes,
- arranging the area to enable the inclusion of newly subdivided properties,
- modernisation of the system of drainage ditches, culverts, road signs, and other devices [Woch 2012].

After Poland acceded to the European Union, the concept of land consolidation and the results of related procedures became subject to more stringent requirements. This meant subjecting to analysis the existing legal provisions on land consolidation and exchange in Poland so that they met current social demands (e.g. in terms of maintaining a balance in the use of the countryside's natural resources and the possibility of developing tourist and linear infrastructure). In result of this process a reform was enforced, which led to the improvement of road infrastructure and the promotion of social changes and amendments [Dobrowolski et al. 2009].

The research aimed to determine what needs to be done to conduct land consolidation works and land exchange in the villages of the Haczów municipality. An analysis of the spatial structure was based on the calculated factors; the zero unitarisation method was also applied to determine the order of works to be carried out in the studied area. This area covers seven cadastral districts of the Haczów municipality located in the Brzozów district, in the Podkarpackie Voivodeship. To carry out the study, the structure of ownership, use, fragmentation, and plots with no road access were taken into account, and the productivity index of arable land and grassland, and the extent of the occurrence of external land checkerboard were calculated. The research employed the data from the Land and Building Register of the District Starosty in Brzozów.
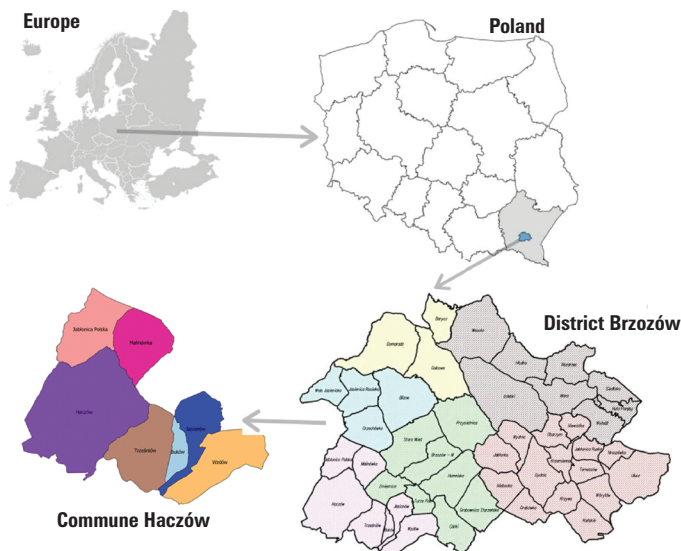
Source: Authors' own study

Fig. 1. Location of the studied area

2. Material and methods

To create a ranking of urgency of land consolidation works and land exchange for each of the seven villages belonging to the Haczów municipality, it was necessary to determine the factors characterising the studied areas [Szarow 2022]. The ranking includes 29 factors assigned to individual groups:

General Information:

x_1 – the total area of a village (in hectares),

x_2 – total number of plots,

x_3 – population,

x_4 – population per 1 km^2,

x_5 – number of residents per 100 hectares of agricultural land,

x_6 – the percentage of the number of plots in the individual sector.

Ownership structure:

x_7 – the percentage of individual farms land,

x_8 – the percentage of municipal land,

x_9 – the percentage of land of the Agricultural Property Agency, the State Treasury,

x_{10} – percentage share of State Forests.

Usage structure:

x_{11} – the percentage of arable land,

x_{12} – the percentage of orchards,

x_{13} – the percentage of meadows,

x_{14} – the percentage of pastures,

x_{15} – the percentage of agricultural construction land,

x_{16} – the percentage of transport areas,

x_{17} – the percentage of forests.

Soil productivity:

x_{18} – production value index of grassland,

x_{19} – production value index of arable land.

Dispersion:

x_{20} – the percentage of chequerboard plots belonging to landowners from outside of the district in the total number of plots,

x_{21} – the percentage of the chequerboard plots belonging to landowners from outside of the district in total land area,

x_{22} – the percentage of chequerboard landowners from outside of the district in the total number of landowners,

x_{23} – the percentage of chequerboard plots belonging to landowners within the district in the total number of plots,

x_{24} – the percentage of the chequerboard plots belonging to landowners within the district in total land area,

x_{25} – the percentage of chequerboard landowners within the district in the total number of landowners,

Plots without road access:

x_{26} – the percentage of the number of plots without access to a public road,

x_{27} – the percentage of plot area without access to a public road.

Land fragmentation:

x_{28} – fragmentation index,

x_{29} – an average area of plots in the individual sector.

These factors allowed to accurately determine the order and urgency of land consolidation works and land exchange for each village in the Haczów municipality.

Determining the ranking of objects by defining their features is one of the basic tasks of statistical analysis. In this case, a multivariate analysis was used to classify objects due to a set of assumed characteristics. Diagnostic variables that describe a complex phenomenon through the norming and standardisation methods contain similar values, and have no titre. The examination of the range of incidence and aggregation of features provided with synthetic indicators that characterise each of the studied villages. The obtained synthetic features of individual villages are the basis for the elaboration of a ranking, which is supposed to classify them from the lowest synthetic value to the highest. To create a ranking for the studied area, the zero unitarisation method was applied.

This zero unitarisation method consists in norming the diagnostic variables through a feature range control. Diagnostic variables include [Kukuła 2012]:

- *stimulants* – an increase in the value of a variable leads to higher evaluation of the feature of the studied object. Normed variables are calculated on the basis of the equation:

$$Z = \frac{(x - x_{min})}{(x_{max} - x_{min})}$$

- *destimulants* – an increase in the value of the variable leads to lower evaluation of the feature of the studied object. Normed variables are calculated according to the equation:

$$Z = \frac{(x_{max} - x)}{(x_{max} - x_{min})}$$

- *nominators* – variables receiving the highest rating (optimum) only for a certain value or range of values. The evaluation of the phenomenon decreases with moving

away from the optimum. Normed variables are calculated according to the following equation:

$$Z = \frac{(x - x_{min})}{(x_{opt} - x_{min})}, \quad \text{dla} \quad x < x_{opt}$$

$$Z = \frac{(x - x_{max})}{(x_{opt} - x_{max})}, \quad \text{dla} \quad x > x_{opt}$$

where:
- Z – normed variable,
- x – variable before norming,
- x_{max} – the maximum value of a variable in a given set,
- x_{min} – the minimum value of a variable in a given set,
- x_{opt} – the optimum value of a variable in a given set,

The first stage involves norming the diagnostic features of an analysed area and delivering a joint multi-criteria assessment for each tested object. The aggregation results in a complete assessment of individual objects.

To obtain a synthetic measure, the average values of the sets representing individual features should be calculated from the following equation:

$$Z_i = \frac{1}{p} \sum_{j=1}^{p} x_{ij} (i = 1, ..., m)$$

The obtained measures are within the range [0.1]. The results represent the average optimal value of the measures obtained by each object. The position in the ranking of urgency of land consolidation works and land exchange depends on the value of the synthetic measure obtained [Leń and Mika 2016].

3. Results

When determining the order of land consolidation works and land exchange, the first stage is to analyse the distribution characteristics of individual variables expressed by descriptive statistics. Each variable is assigned a titre of stimulants or destimulants. Table 1 presents selected factors containing 25 features as stimulants and 4 as destimulants.

Table 1. Statistical analysis of adopted factors

	Selected features	Average	Min.	Max.	Median	Variance	Standard deviation	Coefficient of variation
Stimulants	x_1 – the total area of a village [ha]	1023.86	217.13	2673.97	847.87	604420.76	777.45	75.93
	x_2 – the total number of plots	2664.14	871.00	6052.00	1894.00	3043520.81	1744.57	65.48
	x_3 – population	1342.29	338.00	3318.00	1086.00	869960.57	932.72	69.49
	x_4 – population per 1 km^2	140.69	98.04	226.41	128.09	1709.13	41.34	29.39
	x_5 – the number of residents per 100 ha of agricultural land	180.92	116.08	266.02	180.23	2361.31	48.59	26.86
	x_6 – the percentage of the number of plots in the individual sector	88.96	86.43	92.25	88.63	3.93	1.98	2.23
	x_7 – the percentage of individual farmland	75.27	66.75	90.91	70.58	71.94	8.48	11.27
	x_8 – the percentage of municipal land	3.08	1.51	6.01	2.23	2.45	1.57	50.86
	x_9 – the percentage of land of the Agricultural Property Agency, the State Treasury	3.33	0.87	9.45	2.44	8.36	2.89	86.85
	x_{11} – the percentage of arable land	49.44	37.95	60.86	48.13	50.83	7.13	14.42
	x_{12} – the percentage of orchards	0.43	0.00	1.17	0.23	0.26	0.51	117.53
	x_{13} – the percentage of meadows	12.28	1.72	24.23	14.21	73.91	8.60	69.99
	x_{14} – the percentage of pastures	12.08	8.79	14.86	12.32	3.57	1.89	15.65
	x_{15} – the percentage of agricultural construction land	4.15	2.81	7.16	3.30	2.45	1.57	37.76
	x_{16} – *the* percentage of transport areas	2.56	1.52	3.89	2.59	0.49	0.70	27.49
	x_{18} – the production value index of grassland	52.71	40.00	60.00	54.00	52.24	7.23	13.71
	x_{19} – the production value index of arable land	64.57	52.00	71.00	66.00	41.62	6.45	9.99

Table 1. cont.

Stimulants	x_{20} – the percentage of chequerboard plots belonging to landowners from outside of the district in the total number of plots	8.13	1.56	24.80	5.76	60.65	7.79	95.83
	x_{21} – the percentage of the chequerboard plots belonging to landowners from outside of the district in total land area	7.51	0.83	23.14	4.74	55.51	7.45	99.20
	x_{22} – the percentage of chequerboard landowners from outside of the district in the total number of landowners	10.84	1.80	39.94	5.81	178.38	13.36	123.22
	x_{23} – the percentage of chequerboard plots belonging to landowners within the district in the total number of plots	6.22	1.42	12.52	4.80	17.56	4.19	67.39
	x_{24} – the percentage of the chequerboard plots belonging to landowners within the district in total land area	6.23	1.46	11.01	6.05	16.94	4.12	66.11
	x_{25} – the percentage of chequerboard plots belonging to landowners within the district in the total number of landowners	7.01	2.35	17.33	6.10	27.71	5.26	75.04
	x_{26} – the percentage of the number of plots without access to a public road	38.21	9.56	62.03	35.96	332.43	18.23	47.72
	x_{27} – the percentage of plot area without access to a public road	30.96	5.38	55.46	29.30	302.06	17.38	56.14
Destimulants	x_{10} – the percentage share of State Forests	10.96	1.51	18.76	10.20	38.54	6.21	56.65
	x_{17} – the percentage of forests	16.25	5.87	35.57	10.39	115.32	10.74	66.10
	x_{28} – fragmentation index	4.05	3.12	4.68	4.20	0.30	0.54	13.44
	x_{29} – an average area of plots in the individual sector	0.32	0.22	0.44	0.32	0.01	0.08	26.66

Source: Authors' own study

Before developing a synthetic ranking, there should be an initial selection of the magnitude of diagnostic features. The analysis adopts criteria that have nothing to do with the inclusion of variables with a low level of variation. Only the value of the V coefficient of variation above 20% is taken into account.

The preliminary analysis of the examined factors showed that seven initial values do not meet any criterion. However, these factors were included in the preparation of the ranking due to their significant value in the conducted analysis.

This examination delivered the synthetic measure values for the created ranking of urgency of land consolidation works and land exchange. The magnitude of the obtained synthetic measure allows determining the order in which these works should be carried out. The higher the rate, the greater the degree of urgency assigned to a given village. Table 2 presents the ranking of villages based on the calculated synthetic measure. A spatial image of the urgency of land consolidation and exchange in the Haczów municipality is presented in Figure 2.

Table 2. The ranking of villages based on the calculated synthetic measure

No.	Synthetic measure	Rank
1	0.60	Buków
2	0.50	Trześniów
3	0.49	Jasionów
4	0.46	Haczów
5	0.40	Wzdów
6	0.28	Jabłonica Polska
7	0.23	Malinówka

Source: Authors' own study

The application of the zero unitarisation method allowed for the preparation of the ranking, which in turn determined the urgency of land consolidation and exchange works. The analysis identified the greatest urgency of land consolidation works in the village of Buków. In administrative terms, it is a village with the smallest cadastral area, but at the same time with the largest fragmentation and dispersion of land of individual farms. The village has the highest production value index of grassland and a high production index of arable land, which confirms its agricultural nature. The least need for land consolidation works was identified in the village of Jabłonica Polska. It is a village with a relatively large area of cadastral plots, small dispersion, and average quality of arable land and grassland.

The analysis showed that the order of the land consolidation and exchange works in individual villages belonging to the Haczów municipality can be determined based on

the obtained results. The results used in the calculation of rankings are highly relevant for the analysed area, which is characterised by a defective spatial structure. A spatial image of the location of the studied villages is illustrated in Figure 2.

Source: Authors' own study

Fig. 2. Ranking of urgency of land consolidation and exchange works with the use of the zero unitarisation method

4. Conclusions

To carry out land consolidation and exchange works it is necessary to identify the degree of urgency. The urgency of these works is determined based on a spatial analysis, which consists of research on the following issues: ownership, use, fragmentation, and road network. It is not possible to proceed with the restoration of area structure at the same time in all precincts, therefore the order of urgency of the works is determined in advance. After applying the methods of multidimensional statistics, a ranking can be created, which determines the order of land consolidation and exchange works.

The structure of ownership in the analysed municipality is evidently dominated by land belonging to natural persons. They cover an area of 5633.37 ha, which constitutes 78.60% of the municipality's total area. The conducted analysis showed that the use structure is dominated by arable land, covering over 52.35% of the municipality's total area, which translates into 3752.16 ha. In addition, a productivity index has been calculated for grassland and arable land. For grassland, the indicator reaches the lowest value in the village of Malinówka (40), while the highest is in the villages of Buków and Wzdów (60). The lowest production value index for arable land occurs in Malinówka (52), and the highest in the village of Wzdów (71). The analysis of land fragmentation

found the highest land fragmentation of individual farms in the village of Haczów, where this indicator reached 4.68. The fragmentation indicator for individual villages varies and its average value is 4.05. The average area of a plot in the individual sector reaches 0.32 ha. Based on the analysis of the road network, it can be concluded that in the villages comprising the Haczów municipality, the percentage of plots without road access is 46.13%. In terms of area, 39.29% of the total area of the municipality has no road access. There is a certain percentage of chequerboard plots belonging to local and nonlocal landowners. A small number of plots remained in the possession of natural persons living outside of the municipality, however, this fact may adversely affect land consolidation and exchange works.

The use of the zero unitarisation method allowed for the creation of a ranking of urgency of land consolidation and exchange works. Studies have shown that the spatial structure in the Haczów municipality needs to be improved. It is therefore necessary to carry out the process of land consolidation and land exchange. Due to the large financial outlay involved in land consolidation works, it is not possible to proceed simultaneously throughout the municipality. The created ranking is an optimal way to determine the urgency of land consolidation and exchange works for individual areas.

References

Bentley J. 1987. Economic and ecological approaches to land fragmentation: in defense of a much-maligned phenomenon. Annual Review of Anthropology, 16, 31–67.

Cay T., Ayten T., Iscan F. 2010. Effects of different land reallocation models on the success of land consolidation projects: Social and economic approaches. Land Use Policy, 27(2), 262–269. https://doi.org/10.101/j.landusepol.2009.03.001

Demetriou D., See L., Stillwell J. 2013. A parcel shape index for use in land consolidation planning. Trans, GIS.

Di Falco S., Penov I., Aleksiev A., van Rensburg T. 2010. Agrobiodiversity, farm profits and land fragmentation: Evidence from Bulgaria. Land Use Policy, 27, 763–771.

Dobrowolski K., Dziedzic W., Skorupka M. 2009. Scalenia gruntów jako jeden z podstawowych warunków uniknięcia napięć i konfliktów społecznych w procesie budowy dróg w tym autostrad i dróg ekspresowych oraz innych inwestycji liniowych. Materiały Ogólnopolskiej Konferencji, Puławy.

Gašincová S., Gašinec J., Hudecová Ľ., Černota P., Staňková H. 2018. Analysis of the usability of the maps from the former cadastre of lands in terms of parcels area registered in the cadastral documentation. Inżynieria Mineralna, 2, 191–200.

Gonzalez X.P., Alvarez C.J., Crecente R. 2004. Evaluation of land distributions with joint regard to plot size and shape. Agricultural Systems, 82, 1, 31–43. https://doi.org/10.1016/j.agsy.2003.10.009

Guo B., Jin X., Yang X., Guan X., Lin Y., Zhou Y. 2015. Determining the effects of land consolidation on the multifunctionality of the cropland production system in China using a SPA-fuzzy assessment model. European Journal of Agronomy, 63, 12–26.

Harasimowicz S., Janus J., Bacior S., Gniadek J. 2017. Shape and size of parcels and transport costs as a mixed integer programming problem in optimization of land consolidation. Comput. Electron. Agric.

Hudecová Ľ., Kyseľ P. 2019 Displaying of easements on the web portal within the context of the Slovak Republic. Geodetski List, 73(1), 67–80.

Hudecová Ľ., Kyseľ P. 2020. Vector cadastral maps numerical homogeneity analysis. Geodetski List, 74(1), 41–56.

Janus J., Markuszewska I. 2017. Land consolidation – a great need to improve effectiveness. A case study from Poland. Land Use Policy, 65, 143–153.

Janus J., Bozek P., Taszakowski J., Glowacka A. 2017. Road accessibility problem as part of land consolidation planning. Engineering for Rural Development, 16. https://doi.org/10.22616/ERDev2017.16.N221

Kwinta A., Gniadek J. 2017. The description of parcel geometry and its application in terms of land consolidation planning. Comput. Electron. Agric.

Kukuła K. 2012. Metody ilościowe w badaniach ekonomicznych. Propozycja budowy rankingu obiektów z wykorzystaniem cech ilościowych oraz jakościowych, XIII/1. Katedra Ekonometrii i Statystyki SGGW, Warszawa.

Leń P., Mika M. 2016. Ranking przeznaczenia obszarów do prac scaleniowych ze względu na rozmiary szachownicy gruntów na przykładzie gminy Sławno. Infrastruktura i Ekologia Terenów Wiejskich, II/1, PAN, Kraków.

Leń P. 2018. An algorithm for selecting groups of factors for prioritization of land consolidation in rural areas. Comput. Electron. Agric., 144.

Manjunatha A.V., Anik A.R., Speelman S., Nuppenau E.A. 2013. Impact of land fragmentation, farm size, land ownership and crop diversity on profit and efficiency of irrigated farms in India. Land Use Policy, 31, 397–405. https://doi.org/10.1016/j.landusepol.2012.08.005

Noga K. 2001. Metodyka programowania i realizacji prac scaleń i wymiany gruntów w ujęciu kompleksowym. Szkoła wiedzy o terenie. Kraków.

Sayılan H. 2014. Importance of land consolidation in the sustainable use of Turkey's rural. Procedia, 120.

Sklenicka P., Janovska V., Salek M., Vlasak J., Molnarova K. 2014. The Farmland Rental Paradox: Extremel and ownership fragmentation as a new form of land degradation. Land Use Policy, 38, 587–593.

Stręk Ż., Leń P., Wójcik-Leń J., Postek P., Mika M., Dawid L. 2021. A proposed land exchange algorithm for eliminating the external plot patchwork. Land, 10(1), 1–15, 64.

Szarow W. 2022. Analysis of the spatial structure of rural areas in the context of the demand for land consolidation works on the example of the Haczów commune. Master thesis. Kielce University of Technology.

Ustawa z dnia 26 marca 1982 r. o scalaniu i wymianie gruntów (Dz.U. 2014 poz. 700).

Van der Zanden E.H., Verburg P.H., Schulp C.J.E., Verkerk P.J. 2017. Trade-offs of European agricultural abandonment. Land Use Policy, 62.

Woch F. 2012. Ocena efektywności scaleń gruntów realizowanych Polsce w ramach wspólnej polityki rolnej Unii Europejskiej. Infrastruktura i Ekologia Terenów Wiejskiej, 2/III. PAN, Kraków.

Wójcik-Leń J., Leń P. 2021a. Proposed algorithm for the identification of rural areas with regard to variability of soil quality Computers and Electronics in Agriculture, 188, 106318.

Wójcik-Leń J., Leń P. 2021b. Evaluation of the symmetry of statistical methods applied for the identification of agricultural areas. Land, 10(7), 664.

Wójcik-Leń J., Postek P., Stręk Ż., Leń P. 2020. Proposed algorithm for the identification of land for consolidation with regard to spatial variability of soil quality. Land Use Policy, 94, 104570.

Wójcik-Leń J. 2022. An Algorithm for Delimiting Rural Areas According to Soil Classes. Land, 11(2), 158.

Wójcik-Leń J., Maciąg K., Maciąg M., Moskla A., Moskal K., Leń P. 2022. Analysis of the implementation of land consolidation and exchange in the villages of the Leżajsk district. Geomatics, Landmanagement and Landscape, 1, 7–24.

Zhang Z., Zhao W., Gu X. 2014. Changes resulting from a land consolidation project (LCP) and its resource-environment effects: a case study in Tianmen City of Hubei Province, China. Land Use Policy, 40.

Dr Justyna Wójcik-Leń
Kielce University of Technology
Faculty of Environmental Engineering, Geomatics and Energy Engineering
Department of Geodesy and Geomatics
e-mail: jwojciklen@tu.kielce.pl
ORCID: 0000-0002-1130-9156

Dr hab. Przemysław Leń, prof. UPL
University of Life Sciences in Lublin
Department of Environmental Engineering and Geodesy
ul. Akademicka 13, 20-950 Lublin
e-mail: przemyslaw.len@up.lublin.pl
ORCID: 0000-0003-0810-9986

Dr inż. Arkadiusz Doroż
University of Agriculture in Krakow
Department of Agricultural Land Surveying, Cadastre and Photogrammetry
ul. Balicka 253a, 30-198 Kraków
e-mail: arkadiusz.doroz@urk.edu.pl
ORCID: 0000-0001-5775-9112

Mgr inż. Barbara Kępowicz
University of Life Sciences in Lublin
Department of Environmental Engineering and Geodesy
ul. S. Leszczyńskiego 7, 20-400 Lublin
e-mail: barbara.kepowicz@up.lublin.pl
ORCID: 0000-0002-0673-8618