The Ranking Destination Areas for Land Consolidation Works, due to the Size Checkerboard Land on the Example of Białaczów

Przemysław Leń

Department of Environmental Engineering and Geodesy, University of Life Sciences, Lublin, Poland
E-mail: przemyslaw.len@up.lublin.pl

Abstrakt. The aim of this paper was to analyze the degree of fragmentation of the checkerboard of land ownership to determine a priority ranking of areas intended for land consolidation in the commune of Białaczów, the Łódź Province (Voivodeship). For a village to be qualified for land consolidation, according to the Act of 26 March 1982 on the Consolidation and Exchange of Land (Official Journal of Laws of 2003, no 178, item 1749, as amended), more than 50% of land owner signatures have to be obtained. On the other hand, the guiding principle for the qualification of a village for a land merger, within the framework of a consolidation program, is that the highest percentage of owners accede to the program. A common obstacle to collecting signatures from landowners is that some of them live outside the village concerned (non-resident owners). The aim of this article was to identify those villages in which land consolidation was an urgent priority.

Keywords: patchwork of plots, land consolidation, land fragmentation.

Conference topic: Technologies of geodesy and cadastre.

Introduction

In Poland, there is a growing problem of faulty land structure, which is an obstacle to establishing a fully functional real estate cadastre (Mika, Leń 2016) and distorts the spatial order, especially in south-eastern Poland (Mika, Sałata 2015). The problem, which is particularly vexing in rural and suburban areas, can be viewed from several perspectives. One such perspective is the land ownership structure. In this context, the main predicament is the so-called patchwork (checkerboard) of land ownership. The concept of land ownership patchwork has been introduced into Polish agricultural geodesy by Koncent-Zieliński, who defined it as an area of land belonging to one village, in which land owned by an individual farmer is not located in one piece next to the house, but is fragmented into a number of (usually narrow and long) parcels scattered over a large space and partitioned by parcels belonging to other owners (Koncent-Zieliński 1907). In later studies, the concept of patchwork was broadened to cover agricultural land and soil quality classes. One area of research pertaining to this subject matter regards non-resident owners, i.e. owners of land located within a patchwork of parcels. Analyses of this phenomenon can be found, among others, in the following publications (Rabczuk 1968; Noga 1977, 1985a, 1985b, 2001; Leń 2009, 2012; Dudzińska 2012; Gniadek 2013; Leń *et al*. 2015; Leń, Mika 2016a, 2016b, 2016c, 2016d; Król, Leń 2016; Mika, Leń 2017). Some specific studies of this subject-matter are devoted to the spatial distribution of land belonging to non-resident owners in relation to their place of residence. Bearing in mind the fact that Poles mass migrate from rural areas to cities, and, more and more often, emigrate to other countries, the problem is of considerable significance, e.g. in the context of planning new investments, which require the permission of land owners and their presence at the location at different stages of the investment process.

For a village to be qualified for land consolidation, in accordance with the Act of 26th March 1982 on the Consolidation and Exchange of Land (Official Journal of Laws of 2003, No. 178, item 1749, as amended), signatures of over 50% of the land owners have to be obtained. The general guideline for qualifying a given village for consolidation, within a given program, is that the largest possible percentage of owners accede to the program. A major hindrance to collecting signatures from land owners is the fact that part of them live outside the village considered for consolidation (non-resident owners) (Leń, Mika 2016b). The aim of the present article was to analyze the scope of the patchwork land ownership problem in Białaczów, Poland, with a view to determining the priority schemes for land consolidation in that commune.

Experimental

To establish the priority of land consolidation and exchange, calculations were done using 23 factors characterizing every village of the commune under study. The factors were grouped under four heads: land fragmentation, demographic conditions, land owned by local non-residents and land belonging to out-of-village owners. The first group of factors included the total area of the commune, the total number of parcels, average parcel area in the surveying section, the number of privately owned parcels and their percentage share in the particular sectors. This group of factors also included the fragmentation coefficient, calculated in previous studies, which is a synthetic measure of land fragmentation. The second group of factors, based on data obtained from the Commune Office of Białaczów, were associated with the number of inhabitants in the particular villages and the number of inhabitants per km^2. The third and fourth groups were created on the basis of values calculated previously using checkerboard land ownership tables. They included information on the number of local and out-of-village non-resident owners, and the number, area and average share of parcels owned by them in the analyzed commune. The factors studied are shown in Table 1.

Table 1. The list of factors characterizing the area under study (Source: own elaboration)

1. Land fragmentation	2. Demographic conditions	3. Land belonging to out-of-village owners	4. Land owned by local non-resident owners
x1 - Total area	x10 - Number of inhabitants per km2	x12 -Number of out-of-village owners in the district	x18- Number of local non-resident owners in the district
x2 - Total number of parcels	x11 - Number of inhabitants	x13 - Number of plots in the district belonging to out-of-village owners	x19- Number of plots in the district belonging to local non-resident owners
x3 - Average area of a parcel in the surveying section		x14 - Percentage of the number of plots belonging to out-of-village owners	x20 - Percentage of the number of plots belonging to local non-resident owners
x4- Number of privately owned plots		x15 - Area of land in the district belonging to out-of-village owners	x21- Area of land in the district belonging to local non-resident owners
x5- Percentage of privately owned plots		x16 - Percentage of the area of plots belonging to out-of-village owners	x22- Percentage of the area of plots belonging to non-resident owners
x6- Area of land belonging to individual agricultural holdings		x17 - Average area of plots belonging to out-of-village owners	x23- Average area of plots belonging to local non-resident owners
x7 - Percentage of land belonging to individual agricultural holdings			
x8 - Average area of a plot belonging to an individual agricultural holding			
x9 - Fragmentation coefficient			

The analysis of the factors shown in Table 1 was based on the examination of the distribution of the values of these variables expressed as descriptive statistics. Each factor was defined as either a land consolidation stimulant or destimulant. Twenty two out of the 23 factors were adopted as stimulants, and one normalized variable (fragmentation coefficient) was regarded as a destimulant. Normally, before a synthetic ranking is determined on the basis of the initial values of diagnostic features, the features are screened for inclusion, as described by Leń and others (2016). The screening is based on two criteria:

- Exclusion of features which are highly correlated with each other, since they provide similar information on the rank of classified objects. Table 2 shows the values of Spearman's rank correlation coefficient, which indicate that some of the variables were very strongly correlated with each other. The highest correlation values were found between the number of privately owned plots and the total number of plots (R = 0.99) and between the fragmentation coefficient and the average area of plots belonging to individual agricultural holdings (R = 0.96). In the present study, however, these features were included in the ranking because of their high relevance.
- Exclusion of those variables which show low variability (a coefficient of variation V lower than 20%). That criterion was met by the percentage of privately owned parcels (V = 5.8) and the fragmentation coefficient (V = 10.8). However, because these variables provided important information regarding the priority of consolidation, they were taken into consideration in further analysis.

The features weighing in favour/against (stimulats/destimulants) of land consolidation and land exchange along with the coefficients of variation and coefficients of correlation are shown in Tables 2 and 3.

Table 2. Coefficients of correlation between the selected factors (Source: own elaboration)

	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}	X_{16}	X_{17}	X_{18}	X_{19}	X_{20}	X_{21}	X_{22}	X_{23}
X_1	1.00																						
X_2	0.51	1.00																					
X_3	0.39	-0.51	1.00																				
X_4	-0.33	0.20	-0.45	1.00																			
X_5	0.47	0.71	-0.17	0.62	1.00																		
X_6	0.48	0.99	-0.53	0.25	0.72	1.00																	
X_7	0.04	-0.36	0.40	-0.19	-0.26	-0.35	1.00																
X_8	0.73	0.72	0.02	-0.09	0.58	0.68	-0.29	1.00															
X_9	-0.81	-0.26	-0.46	0.31	-0.35	-0.25	0.02	-0.30	1.00														
X_{10}	-0.05	-0.32	0.46	-0.09	-0.05	-0.36	0.01	0.27	0.27	1.00													
X_{11}	0.48	0.32	0.24	-0.02	0.37	0.35	-0.04	0.38	-0.43	-0.20	1.00												
X_{12}	0.50	0.72	-0.37	-0.13	0.33	0.73	-0.33	0.56	-0.32	-0.40	0.45	1.00											
X_{13}	-0.18	-0.52	0.28	-0.45	-0.63	-0.51	0.12	-0.31	0.07	0.02	0.19	0.16	1.00										
X_{14}	0.09	0.13	-0.03	-0.20	0.01	0.12	-0.39	0.52	0.15	0.47	0.24	0.46	0.45	1.00									
X_{15}	-0.28	-0.64	0.31	-0.42	-0.63	-0.62	-0.02	-0.36	0.09	0.13	0.13	-0.02	0.92	0.47	1.00								
X_{16}	-0.31	-0.52	0.33	0.01	-0.19	-0.54	-0.03	0.02	0.42	0.85	-0.22	-0.57	0.08	0.41	0.32	1.00							
X_{17}	0.29	0.36	0.00	0.60	0.84	0.39	-0.19	0.36	-0.27	0.10	0.35	0.04	-0.56	-0.03	-0.41	0.11	1.00						
X_{18}	0.40	0.34	0.09	0.45	0.77	0.33	-0.24	0.53	-0.21	0.37	0.18	0.07	-0.49	0.16	-0.42	0.26	0.80	1.00					
X_{19}	-0.20	-0.41	0.33	0.24	0.13	-0.42	-0.06	-0.01	0.19	0.70	-0.18	-0.54	-0.10	0.23	0.19	0.85	0.45	0.55	1.00				
X_{20}	0.49	0.49	0.02	0.47	0.86	0.49	-0.37	0.61	-0.33	0.25	0.17	0.16	-0.62	0.09	-0.56	0.09	0.84	0.94	0.38	1.00			
X_{21}	0.13	0.22	-0.01	0.67	0.75	0.24	-0.34	0.27	-0.12	0.28	0.06	-0.14	-0.60	-0.07	-0.47	0.22	0.88	0.86	0.53	0.90	1.00		
X_{22}	0.32	0.25	0.08	0.15	0.31	0.25	-0.20	0.07	-0.45	-0.33	0.09	0.08	-0.36	-0.52	-0.45	-0.55	0.18	0.05	-0.42	0.31	0.31	1.00	
X_{23}	0.07	-0.29	0.56	-0.30	-0.13	-0.33	0.13	0.32	0.18	0.96	-0.10	-0.33	0.08	0.44	0.14	0.74	-0.01	0.29	0.56	0.16	0.13	-0.31	1.00

[0,5=<rXY<0.7a high correlation.*,0.7=<rXY<0.9 a very high correlation **,0.9=<rXY<1 an almost complete correlation ***)

Table 3. The features under study categorized as stimulants and destimulants of features selected for analysis (Source: own elaboration)

Features	Stimulants	Destimulants	Me	min	max	V
x1 – Total area	↑	820.3	736.3	364.7	2214.9	57.9
x2 – Total number of parcels	↑	1313.7	1314.0	516.0	2537.0	47.0
x3 – Average area of a parcel in the surveying section	↑	0.7	0.6	0.3	1.4	46.5
x10 – Number of inhabitants per km²	↑	54.1	53.1	8.1	100.2	45.0
x11 – Number of inhabitants	↑	420.8	355.0	74.0	1142.0	67.6
x4 – Number of privately owned plots	↑	1040.9	980.0	437.0	1804.0	44.8
x5 – Percentage of privately owned plots	↑	80.1	81.9	71.1	85.0	5.8
x6 – Area of land belonging to individual agricultural holdings	↑	517.7	474.0	151.6	1150.0	46.0
x7 – Percentage of land belonging to individual agricultural holdings	↑	69.1	76.1	16.7	91.6	2.4
x8 – Average area of a plot belonging to an individual agricultural holding	↑	0.5	0.5	0.3	1.1	39.8
x12 – Number of out–of–village owners in the district	↑	152.1	158.0	67.0	242.0	28.7
x13 – Number of plots in the district belonging to out–of–village owners	↑	358.6	344.0	191.0	594.0	39.2

Features	Stimulants	Destimulants	Me	min	max	V
x14 – Percentage of the number of plots belonging to out–of–village owners	↑	36.7	37.5	21.9	57.0	27.6
x15– Area of land in the district belonging to out–of–village owners	↑	174.3	169.4	72.5	264.8	34.9
x16 – Percentage of the area of plots belonging to out–of–village owners	↑	36.8	36.6	13.4	52.5	31.0
x17 – Average area of plots belonging to out–of–village owners	↑	0.5	0.5	0.2	1.1	44.3
x18–Number of local non–resident owners in the district	↑	32.9	29.0	1.0	69.0	60.2
x19 – Number of plots in the district belonging to local non–resident owners	↑	67.8	62.0	3.0	131.0	55.2
x20 – Percentage of the number of plots belonging to local non–resident owners	↑	7.3	7.4	0.5	21.8	69.8
x21 – Area of land in the district belonging to local non–resident owners	↑	31.6	24.0	2.9	123.9	95.3
x22 – Percentage of the area of plots belonging to local non–resident owners	↑	5.6	4.3	1.9	11.8	56.7
x23 – Average area of plots belonging to local non–resident owners	↑	0.5	0.4	0.3	1.0	49.4
	Destimulants					
x9 – Fragmentation coefficient	↓	3.8	3.9	3.2	4.5	10.8

The results allowed us to create a priority ranking of land consolidation and land exchange. A value of the synthetic measure obtained using the zero unitarisation method (Leń 2013) indicates in what order these interventions should be carried out. The higher the value of the measure, the higher the urgency of consolidation.

Table 4. Ranking of villages according to the calculated synthetic measure (Source: own elaboration)

Lp	Village name	Synthetic measure	Position in the ranking
1	Białaczów	0.65	1
2	Petrykozy	0.53	2
3	Skronina	0.50	3
4	Wąglany	0.46	4
5	Żelazowice	0.46	5
6	Parczów	0.45	6
7	Miedzna Drewniana	0.44	7
8	Kuraszków	0.43	8
9	Parczówek	0.40	9
10	Sobień	0.40	10
11	Sędów	0.35	11
12	Zakrzów	0.35	12
13	Ossa	0.31	13
14	Radwan	0.25	14

The results of the present study indicate that land structure improvement is most urgent in localities in the middle-eastern part of the analyzed district. They include, among others, Białaczów, which is characterized by the highest value of the synthetic measure (0.65). This is a village with the largest area occupied by privately owned land and the largest number of inhabitants. The village of Petrykozy ranks second, with the value of the synthetic measure of 0.53. This area is characterized by the greatest population density of 100 people/km², and a relatively high land

fragmentation (4.15). Over 40% of parcels and over 40% of the total area of the village belong to out-of-village owners. The third position in the land consolidation and land exchange priority ranking is occupied by the village of Skronina (0.50). Like Białaczów, it has a large number of inhabitants, a relatively large area and a similar percentage of parcels belonging to private owners. The adjacent villages of Wąglany and Żelazowice have the same value of the synthetic measure (0.46), which secures them a high position in the ranking. In both of these localities, similar percentages of parcels and similar total areas of land (around 40%) are owned by non-residents. The two villages are also characterized by a relatively small average plot size of individual holdings. The lowest urgency of consolidation was found for the villages of Ossa and Radwan. They are some of the commune's smallest villages, and their inhabitants are owners of the smallest area of land located outside the cadastral borders of the investigated commune. A map of the urgency of land consolidation is presented in Figure 1.
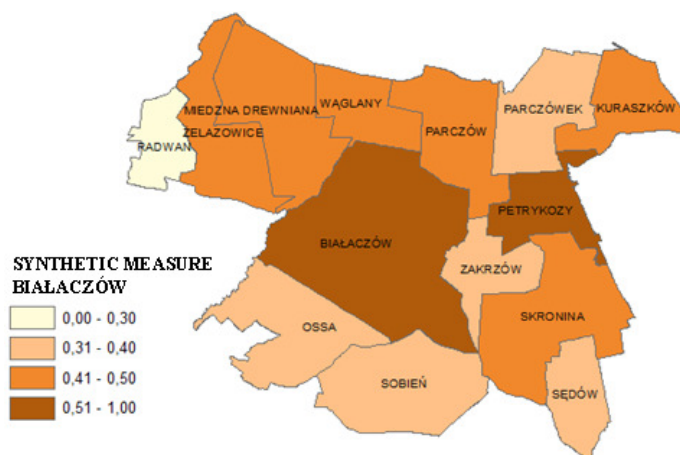

Fig. 1. A map of the urgency of land consolidation and land exchange
in the commune of Białaczów (Source: own elaboration)

Conclusions

The current land use structure of Polish villages is an effect of long-lasting socio-economic and demographic processes, resulting in a continuous increase in the number of plots, combined with a decrease in their area. The excessive fragmentation of agricultural holdings in the examined area affects the profitability of agriculture, which employs almost half of the inhabitants of the commune. Another important problem concerning all the localities under study is the high share of land belonging to out-of-village owners and local non-resident owners. A considerable number of parcels are in the possession of persons residing outside the cadastral borders of the commune, which might reduce the chances of consolidating the lands. The analysis of the land use structure of the commune of Białaczów has shown how important it is for this region to implement a comprehensive land consolidation and land exchange program. The wide gamut of activities leading to consolidation are aimed at improving land use and ameliorating the agricultural production space, improving the system of access routes, and, consequently, refining the living and working conditions for the inhabitants.

Due to the complexity of the interventions needed to create a new spatial order, it is important that these works are prioritized. It is impossible to simultaneously consolidate and exchange lands in the entire study area, since this would involve the deployment of enormous financial and human resources. Therefore, these interventions should be first initiated in those places where they are the most urgently needed. The specific character of the localities under study and the set of features describing them allowed us to calculate a synthetic measure which was used to determine the priority of land consolidation and land exchange in the commune of Białaczów.

References

Dudzińska, M. 2012. Szachownica gruntów rolnych jako czynnik kształtujący przestrzeń wiejską, *Infrastruktura i Ekologia Terenów Wiejskich*, No. 02/3.

Gniadek, J. 2013. Ocena przestrzennego ukształtowania działek różniczan na przykładzie Mciwojowa, *Infrastruktura I Ekologia Terenów Wiejskich*, No. 3/II Polish Academy of Sciences.

Koncent-Zieliński, W. 1907. *Jak usuwać szachownicę i przeprowadzać kolonizacje gruntów*. Warsaw.

Król, Ż.; Leń, P. 2016. Szachownica gruntów indywidualnych wyznacznikiem pilności wykonania prac scalenia i wymiany gruntów, *Infrastruktura i Ekologia Terenów Wiejskich*, No. II/1.

Len, P.; Oleniacz, G.; Skrzypczak, I.; Mika, M. 2016. The Hellwig's and zero unitarisation methods in creating a ranking of the urgency of land consolidation and land exchange work, in *16th International Multidisciplinary Scientific GeoConference*

SGEM 2016, www.sgem.org, SGEM2016 Conference Proceedings, 28 June – 6 July 2016, Book2, 2: 617–624. ISBN 978-619-7105-59-9 / ISSN 1314-2704.

Leń, P. 2009. *Rozmiary gruntów różniczan i możliwości ich likwidacji (na przykładzie wsi w powiecie Brzozów, województwo Podkarpackie*. Rozwój obszarów wiejskich – stan obecny i perspektywy, Puławy.

Leń, P. 2012. Prawidłowości w rozmiarze występowania gruntów różniczan zamiejscowych na przykładzie wsi w powiecie Brzozów, *Infrastruktura i Ekologia Terenów Wiejskich*. Polish Academy of Sciences in Cracow.

Leń, P. 2013. *Sposób określenia pilności potrzeb scalenia i wymiany gruntów*: A doctoral dissertation. Akademia Górniczo – Hutnicza, Cracow.

Leń, P.; Matysek, I.; Kovalyshyn, O. 2015. Dimensions of Plots Belonging to Out-of-village Owners in the Village of Będziemyśl, Commune of Sędziszów Małopolski, *Geomatics and Environmental Engineering* 9/2.

Leń, P.; Mika, M. 2016a. The impact of socio-economic factors on the size of the external plot patchwork – a case study of Brzustowiec Village, in the Łódzkie Voivodship, *Geomatics and Environmental Engineering* 10(2): 43–51. https://doi.org/10.7494/geom.2016.10.2.43

Leń, P.; Mika, M. 2016b. Ranking przeznaczenia obszarów do prac scaleniowych, ze względu na rozmiary szachownicy gruntów, na przykładzie gminy Sławno, *Infrastruktura i Ekologia Terenów Wiejskich*, No. II/1.

Leń, P.; Mika, M. 2016c. Estimation of the size of the external land patchwork based on test areas in Podkarpackie Voivodship in Poland. Geomatics, *Landmanagement and Landscape* No 1. Cracow.

Leń, P.; Mika, M. 2016d. Determination of the urgency of undertaking land consolidation works in the villages of the Sławno municipality, *Journal of Ecological Engineering* 17(4 Sept.): 163–169.

Mika, M.; Len, P. 2016. Analysis of the faulty spatial structure of land in the context of assessing the quality of cadastral data in Poland, in *16th International Multidisciplinary Scientific GeoConference SGEM 2016*, www.sgem.org, SGEM2016 Conference Proceedings, 28 June – 6 July 2016, Book2, 2: 91–100. ISBN 978-619-7105-59-9 / ISSN 1314-2704.

Mika, M.; Leń, P. 2017. Rozmiary gruntów różniczan i możliwości ich likwidacji na przykładzie wsi gminy Sławno, powiat opoczyński, województwo łódzkie, *Infrastruktura i Ekologia Terenów Wiejskich* I/1. Polish Academy of Sciences in Cracow.

Mika, M.; Salata, T. 2015. The use of local databases of spatial information for the preservation of spatial order on example of selected units of local government in Poland, in *15th International Multidisciplinary Scientific GeoConference SGEM 2015*, www.sgem.org, SGEM2015 Conference Proceedings, 18–24 June 2015, Book2, 2: 1163–1174. ISBN 978-619-7105-35-3 / ISSN 1314-2704.

Noga, K. 1977. *Analiza miedzywioskowej szachownicy gruntów na przykładzie wsi położonych w górnym dorzeczu Soły*. ZN AR in Cracow No. 133, Sesja Naukowa 7.

Noga, K. 1985a. Możliwość likwidacji szachownicy zewnętrznej gruntów. *Prace Naukowe Politechniki Warszawskiej*, series Geodezja, v. 26.

Noga, K. 1985b. *Problematyka likwidacji międzywioskowej szachownicy gruntów*. Nowe tendencje scalania gruntów indywidualnych w terenach wyżynnych, górzystych i górskich, IUNG, Puławy, vol. I.

Noga, K. 2001. *Metodyka programowania i realizacji prac scalenia i wymiany gruntów w ujęciu kompleksowym*. Szkoła wiedzy o terenie. Cracow.

Rabczuk, I. 1968. *Problemy różniczan w pow. proszowickim, woj. Krakowskie*. Aktualne zagadnienia geodezji urządzenioworolnej. SGP, Warsaw.

Ustawa z dnia 26 marca 1982 roku o scalaniu i wymianie gruntów. Act of 26th March 1982 on the Consolidation and Exchange of Land, *Official Journal of Laws of 2003*, No. 178, item 1749, as amended.