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GIS analyses of land consolidation in case of the highly fragmentated of parcels

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Abstract

Spatial planning and arrangement work of rural areas is constantly being renovated to improve the living conditions, land distribution and to facilitate work in this area by reducing the costs of transport. The most effective solution is consolidation and exchange of land, which is a difficult and time-consuming process. However, it significantly facilitates everyday functioning of the inhabitants of the village. It assumes reduction of plots of land belonging to the farm by increasing the area of other plots, regulating the shape, ensuring access to the public road and shortening the distances of individual farmland to their habitats (built on site). The purpose of this work was the analysis of land consolidation and exchange process for the village of Łukowa with the use of Geographical Information System (GIS) tools. Primary aim set at the beginning of the project is to compare the state before the land consolidation and the design of the parcel posting after consolidation. QGIS free software has been used to solve this problem. Two basic activities were carried out to compare the distance between built-up land and the remaining farmland. For this purpose, two analyses were performed: network analyses assuming the calculation of distance along the shape of roads and linear analyses determining the shortest distances between plots on a straight line. The work considers the real land distribution, the calculation of which is a time-consuming task. Many factors must be considered to accurately determine the correct distances. It is shown what difficulties and problems occur during the collection of data for analysis, with the correct indication of habitats and indicating the road network or aggregation of adjacent plots of one owner.

Key words

land distribution, land consolidation, forest, GIS analysis, network analysis, Poland, spatial planning, rural area, transport, village

Introduction

Nowadays, time plays a very big role, especially in the department of transport and fast movement, both in large cities and in villages (Suchodolski 2021). In the latter, a very important factor in facilitating the work of farmers is to be able to move quickly between a plot of land developed with various types of technical and agricultural equipment and the rest of the land of the farmer in question (Borkowski and Łuczkiewicz 2023). For many years, measures have been carried out in an attempt to improve the layout, shape and quality

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of land cultivated by farmers, as the spatial arrangement of an agricultural or forestry plot has a significant impact on the production effects obtained (Heider et al. 2018; Muchová 2019). The length of the field has the strongest influence on cultivation costs, the width has a slightly less influence, while the area and perimeter of the agricultural plot play an equally significant role (Gniadek 2010). In the case of forest land, the fragmentation of the land itself is a very big problem (Dobrzyńska et al. 2020). Private forests in Poland occupy about 19% of the total forest area, and the average forest area per owner is probably less than 2 ha (Paradowski 2020). The authors Gołos and Gil (2020) note that, among other things, the high fragmentation of forest plots contributes to the fact that the forest is treated more as a handy store of timber used for farm and household needs than as capital or a source of income for farmers. This problem is also noted in other countries such as the Czech Republic (Sarvašová and Jarský 2020) and Slovenia (Krč and Pezdevšek Malovrh 2020).

For this reason, processes of consolidation and exchange of agricultural and forest land have been carried out in rural locations for many years. This is one of the most effective ways of improving the distribution and concentration of farms and thus streamlining farmers' work and reducing its input and transport costs, while increasing the yields. It is a very time-consuming and complicated process that usually takes several years. It has the effect of reducing the number of parcels of land included in the farm, minimising the distance of and travel time to a farmer's land and eliminating uncultivated and neglected lower-class land (Lu et al. 2018; Stręk and Noga 2019). Improving land distribution also has a positive impact on parcels' access to the public road and drainage facilities. The consolidation and exchange of agricultural and forest land is carried out on an equivalent basis, which should be the same before and after consolidation. The plots are assessed on the basis of comparative estimation and their use value in the adopted comparative units (Ertunç et al. 2022).

This reorganisation of the rural area structure provides a very good basis for planning and implementing agroforestry solutions in the area. Agroforestry integrates trees and shrubs with agricultural land cultivation and animal husbandry. Agricultural crop cultivation and animal production take place on an agricultural land in a system that mimics the forest floor. This combination of agriculture and forestry has great advantages in terms of ecology, landscape enrichment and biodiversity conservation (Osińska and Baj-Wójtowicz 2020).

The aim of this study is to compare the state of land distribution in the village of Łukowa before and after its consolidation. To solve this problem, Geographical Information System (GIS) software was used, which offers a wide range of tools (Basista 2015; Chwedczuk et al. 2022; Magiera et al. 2022). The scope of the study was divided into two parts. One involves network analyses, through which the distances between farmlands along the road network were determined. The second tool used is a linear analysis, which calculates the shortest distances along a straight line from the geometric centre of the habitat. This type of work makes it possible to compare the distribution of land before and after consolidation and to draw conclusions as to whether such complex measures have the desired effect and actually improve the functioning of the village.

The consolidation of agricultural and forest land refers to the elimination of the breakdown of agricultural holdings into small plots of various sizes and shapes that are unevenly distributed at considerable distances from each other and the creation of holdings with a compact surface structure, a rational formation, without changing the ownership status. The aim of such a measure is to carry out rational agricultural and forestry management and to create more favourable conditions for land management. As a result of this work, land located in one or several villages is reorganised and forms the so-called consolidation area. The effect of consolidation may be to reduce the number of plots of land in a farm, to enlarge the area of plots of land or to bring them closer to a habitat, and to create a new road network. The process of consolidation and land exchange is very labour-intensive and requires many steps and contact with the participants of the consolidation (Cienciała et al. 2022). It usually takes up to about 3 years for a village of 1000 ha, while the post-consolidation procedure, which is carried out subsequently, takes between 1 and 2 years.

Land distribution is the arrangement of farmland in relation to developed land. The desirable state of a farm is to have as few parcels of land as possible close to one farm centre, as this facilitates their use and reduces transport costs. Unfavourable distribution, that is, time-consuming and inconvenient access to agricultural or forestry land, is a cause of increased field cultivation expenses and reduced income obtained from land cultivation (Manjunatha et al. 2013; Looga et al. 2018).

The land distribution of the farm takes into account the habitat plot (the built-up land of the farm), the registered plots (the other land of the farm) and the roads connecting these structures. It is described by the distance of the fields from the habitat plot, the area, length, width, extension, regularity of the boundaries, field obstacles in the field and the slope of the land. The farm layout can be assessed in several ways. The most accurate and also the most time-consuming method is to calculate the distance of the farm fields from the habitat plot calculated along the actual roads. Most often, to simplify the calculation, a rectilinear method of determining the distance is used. Also, the place of reference, that is, the habitat, is defined in a more general way, for example, as the centre of the village or the centre of gravity of the farm (Janus 2020). Using different methods to calculate the distribution can give very different results (Janus 2018). The popularity of simplified distance data is partly due to the limited access to data that can be used to calculate distances accurately (Demetriou et al. 2013). Most problematic here is the indication of the habitat plot as well as the determination of the correct road network. Older methods of calculating land distribution are based on describing the space occupied by a given farmer's land through a simplified form such as the area of a triangle (Thunen's method), a rectangle (Kozisk's method) or a circle (Sazanov-Vajnsztajn's method) (Wolszczan 1965).

The calculated value of the land distribution forms the basis for the calculation of various land distribution coefficients (Perujo Villanueva and Colombo 2017; Heider et al. 2018; Janus 2018; Janus and Taszakowski 2018; Janus et al. 2018; Basista and Balawejder 2020). One of these is the form factor of the internal road network, which is the quotient of the average actual distance and the average rectilinear distance (equation 1):

$$Ud = \frac{Lr}{Lp} \qquad (1)$$

where:
Lr – the actual distance in the expanse,
Lp – the rectilinear distance for the distribution.

The above coefficient was used in this study.

Study area

The village of Łukowa lies in Tarnów County, Lesser Poland Voivodeship, in the Lisia Góra Municipality (Fig. 1). It is located 10 km from Tarnów and borders the village of Kobierzyn to the east, Śmigno and Pawęzów to the south, Łęg Tarnowski to the west and Laskówka Chorąska to the north. Łukowa is situated at an altitude of 259 m above sea level. The two streams Żabnica and Koźmiejówka flow through it, and its area is 9.31 km^2.

Since 2009, work on the land consolidation and exchange project for the village of Łukowa has been ongoing. Three years later, the decision to approve the land consolidation and exchange project was issued. Tables 1 and 2 present the status before and after land consolidation and a list of the number of farms analysed in the following part of the work, respectively.

Table 1. Status of Łukowa before and after land consolidation

Component	Status consolidation	
	before	after
Number of registration units	743	725
Number of plots	3182	1652
Average number of plots per registered unit	4.35	2.28

Table 2. List of the number of holdings selected for analysis in the study

Component	Status consolidation	
	before	after
Number of plots selected for analyses carried out in the study	1287	607
Average number of plots per farm	10.55	4.98

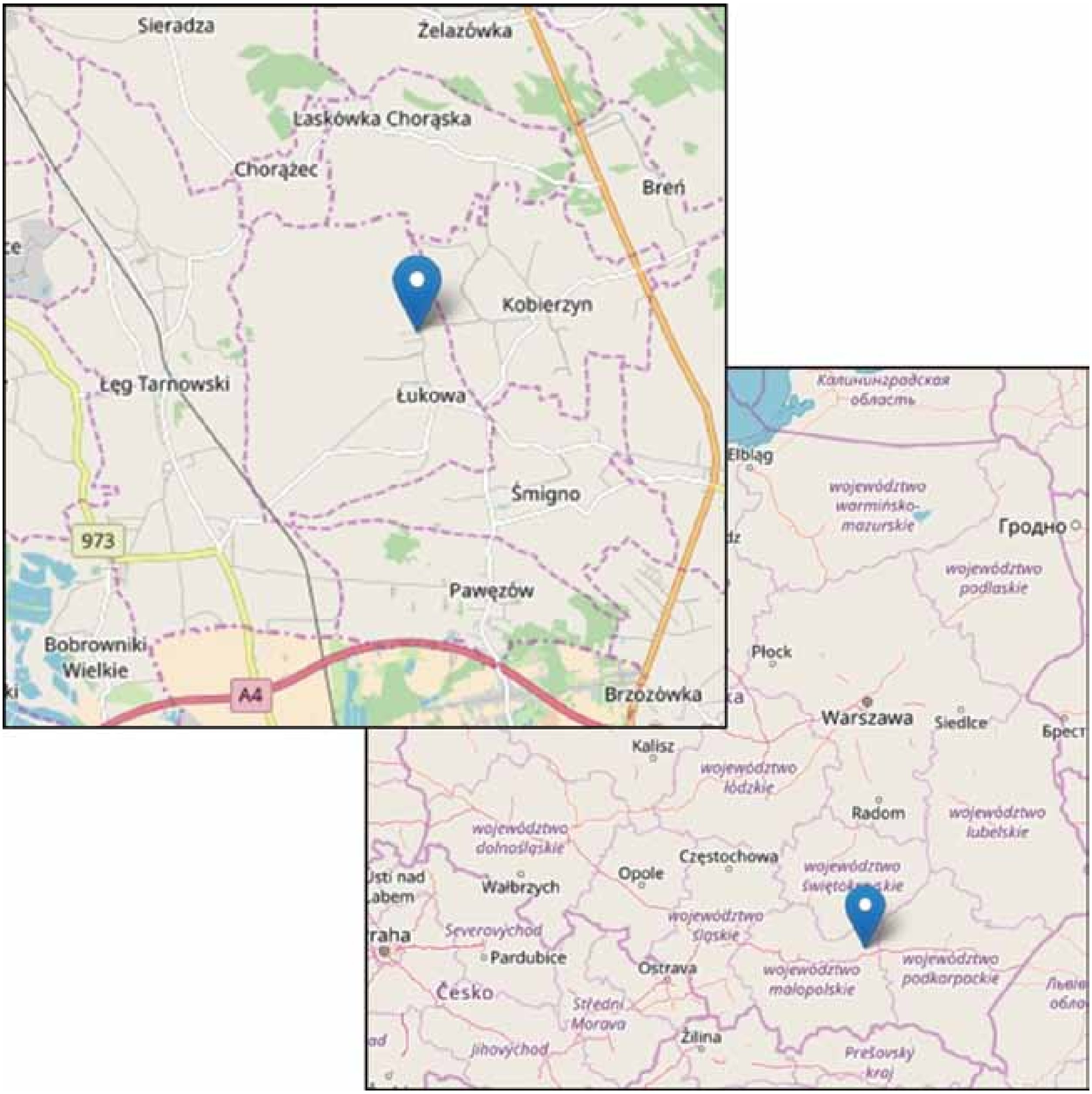

Figure 1. Location of Łukowa [12]

Research methodology

The work considers the actual distribution of land, the calculation of which is a time-consuming process. To accurately determine the correct distances, it is necessary to not only prepare the data in a properly recorded format, but also to correctly indicate the location of habitats, the course of the road network, as well as to check the proximity of plots under one owner. The entire methodology of the survey is presented in the following subheadings.

Analysis and preparation of data

The work started with the analysis of data made available by the Małopolska Office of Geodesy and Agricultural Land in Tarnów, the company executing the

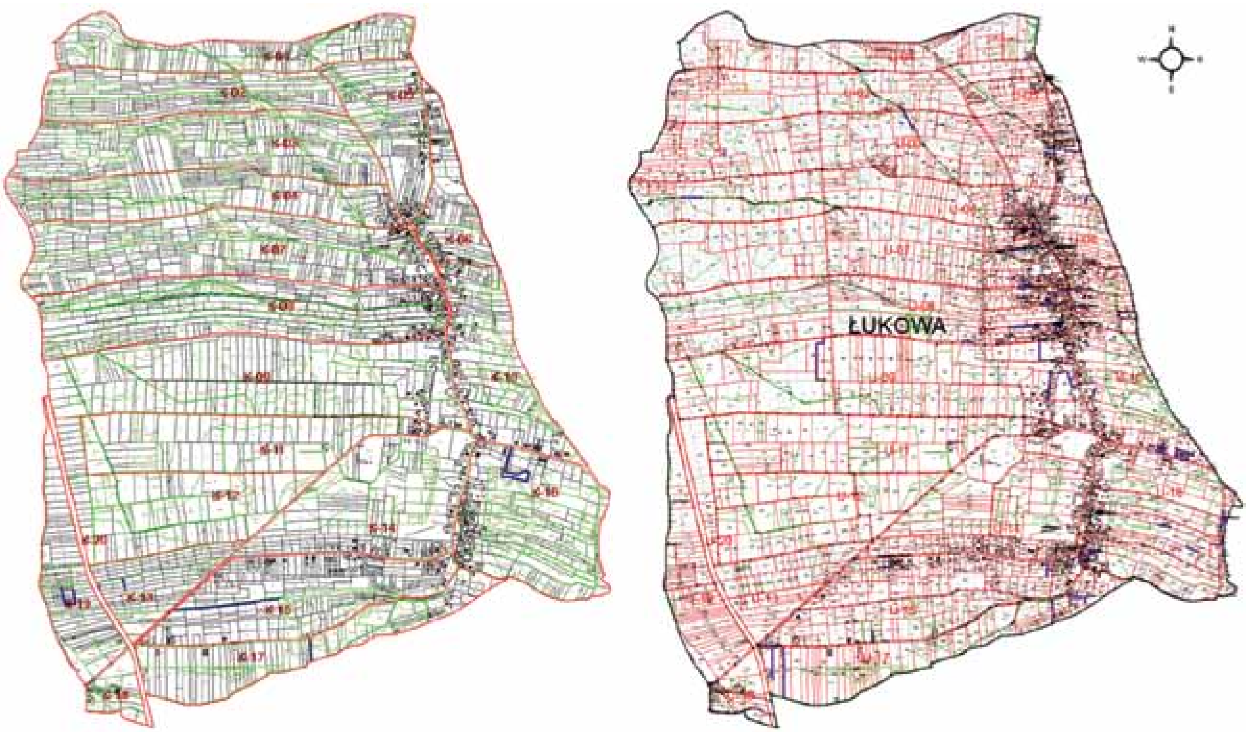

Figure 2. Data for analysis from the Małopolska Office of Geodesy and Agricultural Land in Tarnów. Raw data for Łukowa before and after land consolidation

Figure 3. Presentation of processed data needed for analysis. Processed data for Łukowa before and after land consolidation

Figure 4. Distribution of selected habitat plots. Selection of habitat plots before and after consolidation

consolidation project. The source materials were two files in DGN format for the village of Łukowa before and after the consolidation, containing the numbers and boundaries of cadastral plots, land uses and buildings (Fig. 2), as well as the personal database of the participants in the consolidation.

This data was then processed to produce data in shapefile format: land parcels as polygon objects with descriptive attributes in the form of parcel numbers, registration unit numbers and parcel areas; buildings also as polygon objects with an attribute describing the function of the building; and land uses as polygon objects with land use designation in the attribute table. Land parcel, land use and building layers were used for further analysis (Fig. 3).

Selection of holdings for analysis

The next step was to verify the residential plots, which should be habitat plots. The verification was based on the residential buildings layer, data from the BDOT10k database (Database of Topographic Objects) and the addresses of the consolidation participants from the personal database. Objects before and after the consolidation were checked. Residential plots that were located in registration units with less than two plots were excluded. Plots of registration units such as municipalities and other public institutions were not included in the analysis.

In the end, 122 registration units were selected for the analysis, which included 1287 registration plots before consolidation and 607 after consolidation. The maps show the status of habitat selection before and after consolidation (Fig. 4).

The next step was to aggregate plots of the same registration unit lying next to each other. Two examples and explanations of this procedure are presented below.

1. Aggregation of a habitat plot with other agricultural plots (Fig. 5 and 6). The rationale for this is the possibility of direct access and movement between such plots without commuting costs.

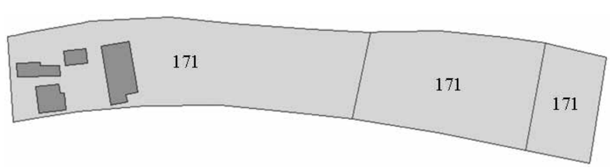

Figure 5. Land status of registration unit number 171 before aggregation

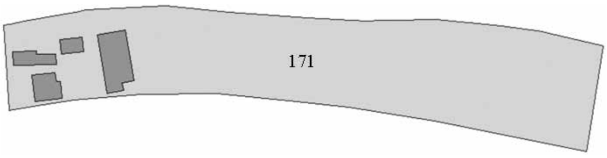

Figure 6. Land status of registration unit number 171 after aggregation

2. Aggregation of non-habitat plots located next to each other (Fig. 7 and 8). Transit between such plots exists without incurring time or distance costs.

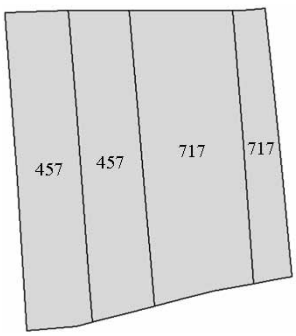

Figure 7. State of land of registration unit numbers 457 and 717 before aggregation

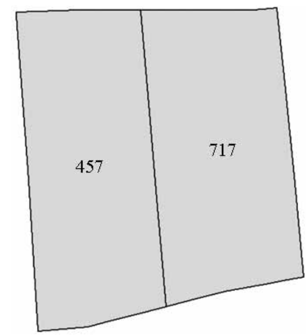

Figure 8. State of land of registration unit numbers 457 and 717 after aggregation

After aggregation, the number of parcels taken into account in the network analyses was reduced. Plots with an area of less than 100 m^2 and those under roads were also removed. After these actions, the number of objects before the consolidation decreased to 976 plots, while after the consolidation, it was 590. One can notice a significant difference for the original state by as many as 311 objects. On the other hand, after the consolidation only by 17, as most of the objects located next to each other were merged (Fig. 9).

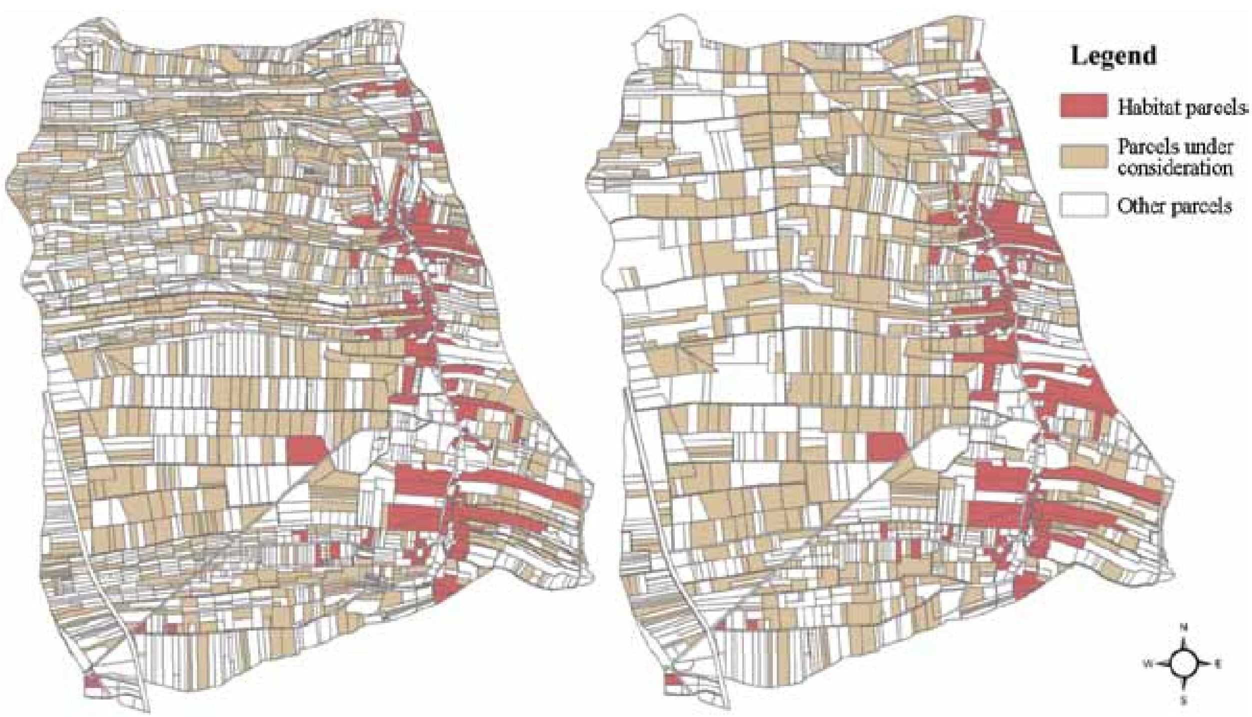

Figure 9. Presentation of land after aggregation. Aggregated parcels for the state before and after consolidation

Figure 10. Vectoring of the road network

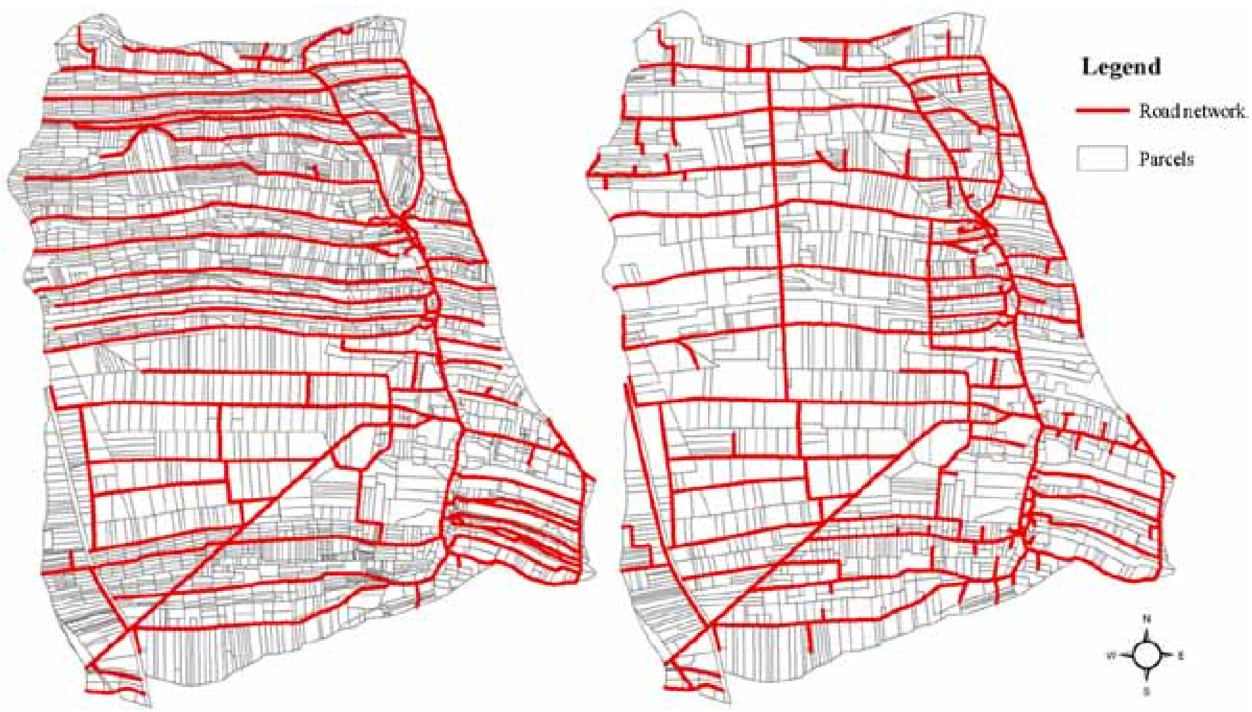

Figure 11. Distribution of vectorised roads for the state before (left) and after land consolidation (right)

The next step in data preparation was to create the centroids needed for further analysis and to vectorise the road network (Fig. 10 and 11).

Calculation of land distribution along the road network and straight line

The most widely used function in GIS software is that of finding the optimal route between two points, which is based on the Edsger Dijkstra algorithm (Dijkstra 1959). The algorithm finds all shortest paths between the selected vertex and all other vertices and calculates

the cost of taking each path. The basis for these analyses is a network, that is, a collection of interconnected objects:
– linear (edges) representing the axes of roads and streets and
– points (junctions) representing the start and destination point of the route and the connection (road junction).

In the network, the traffic analysed follows an edge. Nodes occur at the junction of two or more edges and provide flow between them. The linear objects representing the road network should be associated with additional information about the passability of a section, describing traffic that can travel in one or two directions and providing answers about the passability of a section.

First, the average distance along the road network between the habitat and the rest of the farmland was determined (Fig. 12).

Figure 12. Graphical representation of the determination of the distribution along the road network

The shortest distance between the habitat and the rest of the farmland from the geometric centre of the parcel (in a straight line) was then calculated, and the average value for a given registration unit was determined (Fig. 13).

Figure 13. Graphical representation of the determination of the distribution along a straight line

Results

The results of the conducted analysis are as follows:
1) the average distance along the road network before consolidation is 329 m;
2) the average distance along the road network after consolidation is 299 m;
3) the average linear distance before merging is 271 m,
4) the average linear distance after merging is 250 m.

The analyses took into account the neighbourhood of parcels of the same registration unit. The parcels lying opposite to each other on the other side of the street were assigned a distance of 0 m in the network analyses, as reaching them required no or very minimal costs.

The next step was to analyse the results obtained. The distribution road coefficient was calculated (equation 1). It shows how many times the average actual distance, along the road network (network analyses), compared to the rectilinear distance from the habitat to the remaining land on the farm (linear analyses). The results are presented in Table 3.

Analysing Table 3, it can be concluded that the largest number of holdings has a distribution road co-

Table 3. Analysis of the distribution road coefficient

Distribution road coefficient	Before consolidation		After consolidation	
	number of objects in the interval	percentage share in the interval (%)	number of objects in the interval	percentage share in the interval (%)
More than 2.5	1	0.82	1	0.82
2.0–2.5	2	1.64	1	0.82
1.5–2.0	7	5.74	8	6.56
1.0–1.5	104	85.25	99	81.15
0.5–1.0	7	5.74	12	9.84
Below 0.5	1	0.82	1	0.82

efficient between 1.0 and 1.5. The largest coefficient was obtained by registration unit number 128, which is 2.92 for the state before consolidation and 3.0 for the state after land consolidation. These values show how many times the average distance against the road network determined by the network analyses is greater than the average rectilinear distance calculated by the linear analyses. The smallest coefficient has the registration unit number 95, for which the linear distances

Table 4. List of objects for which the road network has been changed

Registration unit	Number of plots before consolidation	Number of plots after consolidation	Difference in network distances before and after consolidation (m)	Difference in linear distances before and after consolidation (m)
131	3	2	–43.38	62.68
133	6	3	–910.71	–467.72
268	6	3	–2.13	45.54
371	4	3	–236.09	–4.87
545	8	2	–419.30	–29.01
737	9	7	–164.03	41.64
763	5	4	–89.02	29.77
806	13	5	–96.66	31.93
Mean values	6.75	3.63	–245.17	–36.26

Figure 14. Land distribution of registration unit number 545 before and after consolidation

are much greater than those determined following the road network. This situation is explained by the distribution of land on the opposite side of the street, in which case the distance following the road network was taken as 0 m.

When considering the results obtained, it can be seen that there are cases that deviate from the assumptions of land consolidation and exchange. The explanations for the situation where the distances between the land of a given farmer are larger after land consolidation could be the following:

1. Change in road network after land consolidation – extension of road from the habitat plot (Tab. 4)

   Register unit number 545 – following land consolidation there has been a change in the road network (Fig. 14).
2. Elimination of land closer to the habitat in favour of increasing the area of the remaining land or combining it into a single plot, which is mostly far away from the habitat (Tab. 5)

Table 5. List of objects that have been merged or moved away from the habitat plot

Registration unit	Number of plots before consolidation	Number of plots after consolidation	Difference in network distances before and after consolidation (m)	Difference in linear distances before and after consolidation (m)
1	2	3	4	5
43	22	7	–79.16	–42.60
58	5	2	–66.88	–62.35
79	13	5	–418.51	–375.54
101	9	5	–171.94	–318.17
115	11	3	–165.78	–301.15
126	10	4	–256.45	–258.81
128	5	3	–540.04	–134.89
140	4	3	–102.43	–42.41
154	23	9	–248.80	–288.00
168	9	4	–377.71	–261.75
193	18	7	–448.39	–341.70
212	12	5	–74.73	–2.23
213	10	8	–127.76	–99.21
223	8	4	–59.23	–195.33
267	13	6	–95.84	–72.06
284	4	3	–324.85	–202.50
303	4	2	–205.04	–39.44
336	8	4	–386.27	–151.12
363	20	8	–93.21	–90.55
380	16	3	–166.70	–148.69
387	19	5	–175.65	–122.48
512	9	3	–359.36	–219.48
727	15	5	–261.18	–244.92
Mean values	11.61	4.70	–226.34	–174.58

Examples of land distribution where the average distance between the land of a given farmer increased after land consolidation are shown in Figures Figure 15. Land distribution of registration unit number 58 before and after consolidation and Figure 16. Land distribution of registration unit number 128 before and after consolidation. Register unit number 58 – after land consolidation: merging of land parcels into one with a larger area, but much further away from the habitat.

Registration unit number 128 – after land consolidation, plot number 1108 located further from the habitat than the land before consolidation.

3. Change of plot location – location of plot(s) further away from habitat (Tab. 6)

Table 6. List of objects for which the distance from the habitat has increased

Registration unit	Number of plots before consolidation	Number of plots after consolidation	Difference in network distances before and after consolidation (m)	Difference in linear distances before and after consolidation (m)
390	6	6	–45.57	–0.18
749	3	2	–620.53	–544.62
Mean values	4.50	4.00	–333.05	–272.40

Register unit number 749 – following land consolidation, the distance to the habitat has increased, but the plot has gained a more favourable shape and access to a public road (Fig. Figure 17. Land distri-

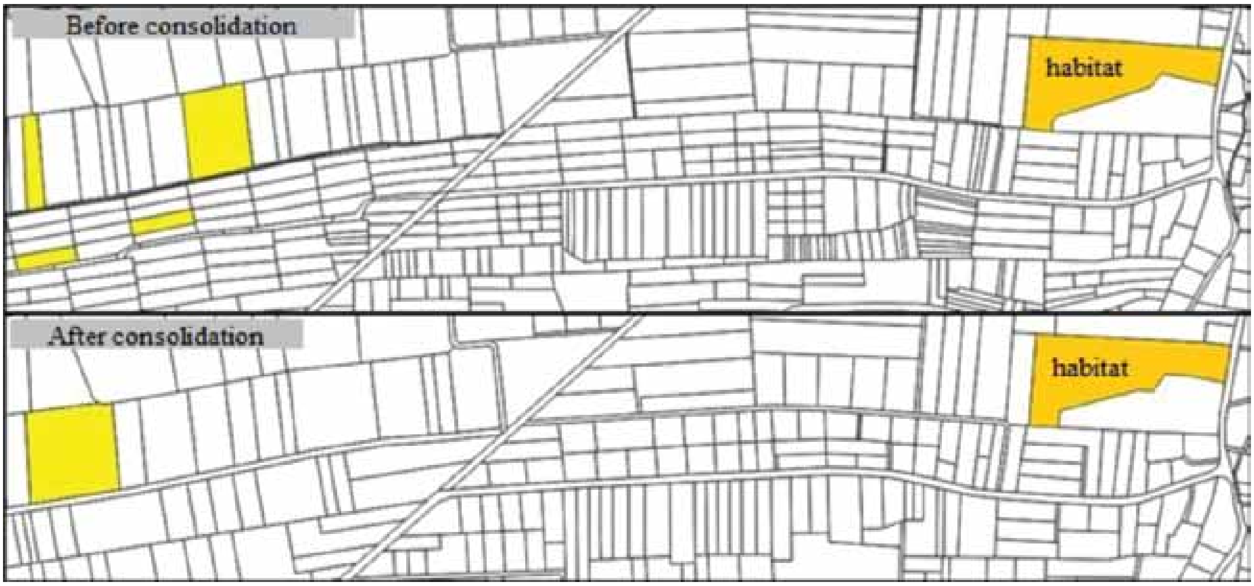

Figure 15. Land distribution of registration unit number 58 before and after consolidation

Figure 16. Land distribution of registration unit number 128 before and after consolidation

bution of registration unit number 749 before and after consolidation).

Analysing the tables above, it can be concluded that, despite the greater distance between plots after consolidation, there are benefits from such a change, which are a significantly reduced number of plots after land consolidation, a change in their shape to a more regular shape, and an increase in the area of one plot far from the habitat in favour of the elimination of small and irregularly distributed land.

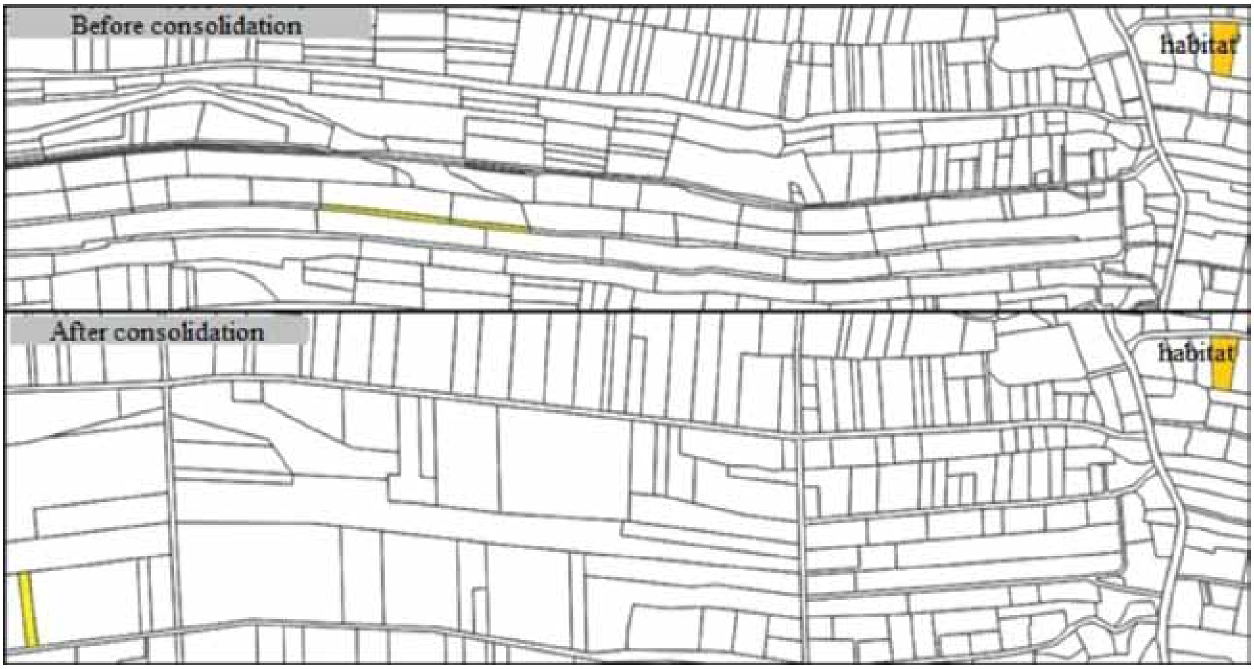

Figure 17. Land distribution of registration unit number 749 before and after consolidation

Table 7 presents a summary of the differences in distance between the states before and after land consolidation. On analysing the results, it can be concluded that as much as 41.80% (for network analyses) and 48.36% (for linear analyses) of the registration units improved their location in relation to the habitat, obtaining an average reduction in distance from the habitat up to 250 m. Adding up the values obtained, that is, for 71.31% (network distances) and 65.57% (linear distances) of the holdings, the analyses gave positive results in terms of the difference in distance between the pre- and post-consolidation status.

Table 7. Comparison of differences between before and after land consolidation

Ranges of distance differences between pre- and post-land consolidation	Network analyses		Linear analyses	
	Number of objects in the interval	Percentage share in the interval (%)	Number of objects in the interval	Percentage share in the interval (%)
Above 1000 m	1	0.82	0	0.00
750–1000 m	6	4.92	3	2.46
500–750 m	4	3.28	3	2.46
250–500 m	25	20.49	15	12.30
0–250 m	51	41.80	59	48.36
–250–0 m	23	18.85	32	26.23
–500 to –250 m	9	7.38	9	7.38
Above –1000 m	3	2.46	1	0.82

The average distance differences between the network and line analyses are 219.44 m for the state before consolidation and 190.6 m for the state after consolidation. This is due to the different assumptions of the analyses performed. In the network analyses, the distances are determined following the shape of the roads from the centre of the object at the road and their length is greater than in the linear analyses, where the distances are determined in a straight line from the centroids. Most differences of determined distances are in the range from 100 to 200 m both for the state before (30.33%) and after land consolidation (27.87%, Tab. 8). Only 7.38% of the before consolidation and 12.30% of the after consolidation objects belong to the range in which the determined distances are greater for linear analyses. A summary of the above values is provided in Table 8.

Table 8. Comparison of network and linear analyses

Ranges of differences between network analyses and linear analyses	Before consolidation		After consolidation	
	Number of objects in the interval	Percentage share in the interval (%)	Number of objects in the interval	Percentage share in the interval (%)
Above 600 m	5	4.10	2	1.64
500–600 m	3	2.46	6	4.92
400–500 m	9	7.38	8	6.56
300–400 m	11	9.02	12	9.84
200–300 m	28	22.95	22	18.03
100–200 m	37	30.33	34	27.87
0–100 m	20	16.39	23	18.85
Below 0 m	9	7.38	15	12.30

The change in land area in the registration units before and after land consolidation was also analysed. Absolute values of area differences for the state before and after land consolidation were used for the analysis. Table 9 shows the list of changes in the area of plots of a particular registration unit before and after land consolidation.

Table 9. Differences in farm area between before and after land consolidation

Ranges of area difference	0.0–0.1(ha)	0.1–0.2(ha)	0.2–0.3(ha)	0.3–0.4(ha)	0.4–0.5(ha)	0.5–1.0(ha)	Above1 ha
Number of registration units in the area interval	78	19	8	2	0	4	2
Percentage share of parcels in total	62.9	15.3	6.5	1.6	0	3.2	1.6

For more than half of the farms (62.9%), the change in area was small – up to 0.1 ha. On the other hand, there are register units with a significant difference in area, in which case there was a sale or purchase of land, which may also affect the results of the analysis of the distance between plots. The largest differences occurred in register units with number 279 – sale of land and 798 – purchase of land.

Discussion and conclusion

The aim of the study was to compare the status before and after land consolidation and land exchange for the village of Łukowa. The presented work is a whole set of activities leading to the determination of the distance between the land of a given farmer before and after consolidation. In order to achieve this goal, network and linear analyses were applied, which were carried out in the free software QGIS.

A detailed analysis of this particular consolidation project demonstrates the complexity of the issues undertaken in the paper. The accuracy of the determination of the land distribution depends on how accurate the data is taken for the analysis. The work considers the actual land distribution, the calculation of which is a time-consuming task. Many factors have to be taken into account to accurately determine the correct distances. It is shown which difficulties, problems occur during the collection of data for the analysis; in the correct delimitation of habitats; the road network or the aggregation of neighbouring plots of one owner.

During the implementation of the assumed plan, land of 122 register units meeting the conditions assumed in the project was analysed.

The results of the distances obtained in the network analyses are summarised as follows: for 71.31% of the holdings, the distance between habitat plots and other plots in a given registration unit was reduced; for 28.69% of the sites, the average distances increased. On the other hand, in linear analyses, these values differed slightly, affecting 65.57% of the farms positively and 34.43% negatively. The improvement in distribution would certainly have been greater had there been no aggregation of single-owner plots, which is not infrequently overlooked in such analyses. However, when comparing the broader aspect of consolidation, it should be noted that for farms where the average lengths have lengthened, there are other benefits from this, such as reducing the number of plots in the registration unit, increasing their area and giving them a regular shape. The shape of the road network has also been improved, so that each plot has access to a public road. Thanks to the land consolidation and exchange project, the number of plots in the village decreased from 3156 to 1652.

Comparing the general indicators of fragmentation of the examined land consolidation project and other projects, Łukowa looks very positive. In the work Balawejder et al. (2021), 21 consolidation projects in Poland were analysed, which showed a percentage change in the number of plots before and after consolidation in the entire facility in the range of about 10%–46% and the average number of plots in a given farm from about 11% to 63%. In the Łukowa facility, the percentage change in the number of plots was 48%, both in the entire facility and in a given farm.

Comparing the obtained results regarding the distance of the plots of a given farm from the habitat with the results of the work of Basista and Balawejder (2020), it can be seen that the average distance values for the entire Łukowa facility are not significant both in the case of rectilinear distances and along the road network. Nevertheless, the distances on some farms have changed significantly. Detailed analysis showed that for the majority of 71.31% (network) and 65.57% (rectilinear) distances, the distance from the habitat decreased.

In the work of Janus and Ertunç (2021), the average elongation of the road network (re) in the analysed eight land consolidation projects in Poland and Turkey was about -11% to 6%. In the Łuków facility, it was -1.65%. This is partly explained by the specificity of each study area. It is difficult to compare the average values of parameters here.

The results obtained allow us to conclude that there would be a significant improvement in the distribution of land in the village of Łukowa. This would probably translate into easier and more efficient movement of farmers, thus reducing transport costs, time and labour. In such a prepared area, it will be much easier to introduce sustainable agricultural production methods such as agroforestry systems, which are a tool for adapting agriculture to climate change.

The activities described make it clear that the consolidation and exchange of agricultural and forest land is a lengthy and very difficult process, not only technically, but also socially.

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