

PRIORITIZATION OF LAND CONSOLIDATION AND EXCHANGE WORKS IN VILLAGES OF EASTERN POLAND USING EXAMPLE OF FRAMPOL COMMUNE

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Abstract. Land consolidation and land exchange are two important measures that can be used to improve the spatial structure of farm holdings. Unfortunately, land cannot be consolidated and exchanged in all villages of a given area simultaneously, due to economic, technical, and social considerations. Instead, an analysis has to be carried out, which allows one to rank the villages with regard to how urgently they need consolidation and exchange of land. When analyzing and assessing which areas require land management measures most urgently, and especially when performing comparative spatial analyses, it is recommendable to use the methods of multidimensional statistics to determine a synthetic measure. Synthetic measures convert the features of an object analysed into one aggregate variable, allowing one to determine, which objects require consolidation and exchange of land more urgently than others. The aim of this study was to determine the need for consolidation and exchange of land in sixteen villages of the commune of Frampol, located in Biłgoraj District, Lubelskie Voivodship. The research area covered 1,0293.55 ha of farmland divided into 27,417 land parcels (cadastral plots). The Helwig's method was used to determine the ranking list. The calculations were done using a group of factors identified on the basis of data obtained from a real estate cadastre database for each of the locations studied. The results, expressed in the form of a synthetic measure for each village, allowed us to develop a prioritization scheme for consolidation interventions in the area discussed.

Keywords: land consolidation, Hellwig's method, ranking.

Introduction

Defective spatial structure of agricultural land in Poland is considerably differentiated. The defects are particularly visible in the structure of ownership of land, use of land, lack of roads providing access to crop fields, excessive fragmentation of land and disadvantageous shape of plots. Large fragmentation of land is a problem affecting many countries in Europe and in the world, as recounted by many authors [1-2; 3-5; 6; 7]. The scale of the analyzed phenomenon is determined by the geographical situation. It refers mostly to rural areas. In addition, in southern, eastern and central Poland it is characterized by considerable distribution of land that is the property of the same owner [8-10] and by the irregular shape of the plots. In central Poland the plots are narrow and excessively elongated; similar problems occur for land in the villages of central Poland [11]. Defects in spatial structure can be eliminated by means of land consolidation works, as these are an effective tool to rectify the identified defects and provide a possibility of alternative management of unfavourable, useless agricultural land, so-called agricultural problem areas [12-14]. Due to financial restraints, it is necessary to identify the most defective areas and eliminate them, which will have a positive impact on the construction of a full-featured real property cadastre [15-21]. For many years studies have been carried out pertaining to comprehensive programming of land consolidation works [22-25], aiming to develop a universal algorithm for the hierarchization of land consolidation works.

This paper aims to determine the needs for land consolidation and exchange in the villages of the commune of Frampol, in the Biłgoraj District, in Lubelskie Voivodship (Fig. 1).



Fig. 1. Map of location of analyzed commune

The ranking was established based on Hellwig's synthetic development measure. The calculations were based on 24 features characterizing each of the villages. The results in the form of a synthetic measure for each of the villages made it possible to create a hierarchy of urgency of land consolidation works.

Materials and methods

The study covered 17 precincts within the commune of Frampol, in the Biłgoraj District. Features characterizing the analyzed area were selected based on the algorithm for grouping the factors for hierarchization of land consolidation works in rural areas designed by Leń [26]. The implemented method made it possible to select 24 features at 3 specificity levels. The first level of specificity of data includes general features:

Gx_1 – total area of the precinct [ha], Gx_2 – total number of plots in the precinct, Gx_3 – percentage of the number of plots owned by individual farmers, Gx_4 – percentage of the area of plots owned by individual farmers, Gx_5 – average area of the plot in the village [ha].

The second significant group of features at the first level of specificity of data includes: PLx_1 – number of registration units in the precinct, PLx_2 – number of registration units of farms, PLx_3 – percentage of registration units of farms, PLx_4 – number of registration units of land which does not form part of farms, PLx_5 – percentage of registration units of land which do not form part of farms, PLx_6 – number of plots per registration unit of farms, PLx_7 – area of plots owned by farms [ha], PLx_8 – percentage of the number of plots owned by farms in relation to all private lands, PLx_9 – percentage of the area of plots in relation to all private lands, PLx_{10} – average number of plots per registration unit, PLx_{11} – average area of a registration unit [ha]. The third group of features refers to plots without direct access to agricultural transport roads: Rx_1 – percentage of the number of plots without access to roads and Rx_2 – percentage of the area of plots without access to roads. The fourth group of features refers to agricultural productivity ratio: APx_1 – *cropland productivity ratio*, APx_2 – *grassland productivity ratio*.

The second level of specificity of data includes information about fragmentation of land owned by individual farmers: (area) Ax_1 – average plot area [ha], (land fragmentation) LFx_1 – synthetic land fragmentation index.

The third level of specificity of features characterizes the analyzed area in terms of effectiveness and project potential during land consolidation works. Two features were selected for analysis: LUX_1 – percentage of orchards – S, and LUX_7 – percentage of forestland – Ls.

The ranking was created using Hellwig's synthetic measure of development, which facilitates standardization of diagnostic variables by determining the Euclidean metrics and then the synthetic measure. The created synthetic measure is at the same time a relative measure of urgency of land consolidation and exchange works for the specific precinct in comparison to a certain model object [9]. The sequence of calculations in the used method can be presented by means of the following algorithm.

- Based on matrices of standardized input data a model object with standardized coordinates (standardized variables) is designated:

$$\mathbf{O}_0 = [z_{oj}], j = 1, 2, \dots, m. \quad (1)$$

- The coordinates of the model object are determined according to the following formula:

$$z_{oj} = \max_i \{z_{ij}\} \text{ – when the selected feature is an LTB (larger-the-better) characteristic}$$

$$z_{oj} = \min_i \{z_{ij}\} \text{ – when the selected feature is an STB (smaller-the-better) characteristic}$$

$$j = 1, 2, \dots, m. \quad (2)$$

- Next, for each object we calculate the distance from the model object, most often applying the Euclidean metric:

$$d_{i0} = \left[\sum_{j=1}^m (z_{ij} - z_{0j})^2 \right]^{\frac{1}{2}}, i = 1, 2, \dots, m. \quad (3)$$

- The synthetic measure is finally defined as:

$$s_i = 1 - \frac{d_{i0}}{d_0}, i = 1, 2, \dots, m, \quad (4)$$

where

$$d_0 = \bar{d}_0 + 2S(d_0), \quad (5)$$

whereas

$$\bar{d}_0 = \frac{1}{n} \sum_{i=1}^n d_{i0}; S(d_0) = \left[\frac{1}{n} \sum_{i=1}^n (d_{i0} - \bar{d}_0)^2 \right]^{\frac{1}{2}} \quad (6)$$

Measure s_i normally assumes values in the range [0; 1]. These values are higher, when the specific object is closer to the model.

Results and discussion

Based on the calculations, the ranking of land consolidation and exchange works urgency was developed (Table 2). The spatial location of the ranking is illustrated in Figure 2.

Table 1

Land consolidation urgency ranking

No.	Measure s_i	Village
1	0.976	Kolonia Kąty
2	0.710	Radzięcin
3	0.647	Chłopków
4	0.482	Karolówka
5	0.450	Wola Radzięcka
6	0.426	Teodorówka
7	0.377	Frampol
8	0.360	Komodzianka
9	0.359	Rzeczyce
10	0.344	Kąty
11	0.337	Smoryń
12	0.300	Stara Wieś
13	0.285	Korytków Mały
14	0.230	Sokołówka
15	0.224	Pulczynów
16	0.222	Kolonia Teodorówka
17	0.138	Wola Kątecka

Respective villages located in the commune of Frampol were considerably differentiated in terms of the calculated synthetic measure at the same time being the relative measure of urgency of land consolidation and exchange works in the specific precinct. Studies showed that, based on the selected features, land consolidation and exchange works were a priority in three villages: Chłopków, Kolonia Kąty and Radzięcin. These villages are not neighbours but they are characterized by similar defectiveness. The second stage should comprise land consolidation works in the villages of: Karolówka, Wola Radzięcka and Teodorówka, where the synthetic measure ranged from 0.426 to 0.482. Next, rural management works must be undertaken in the villages of Komodzianka and Rzeczyce. Further works aiming at improvement of the spatial structure of the analyzed commune should be performed according to the hierarchy presented in Table 1 and Fig. 2.

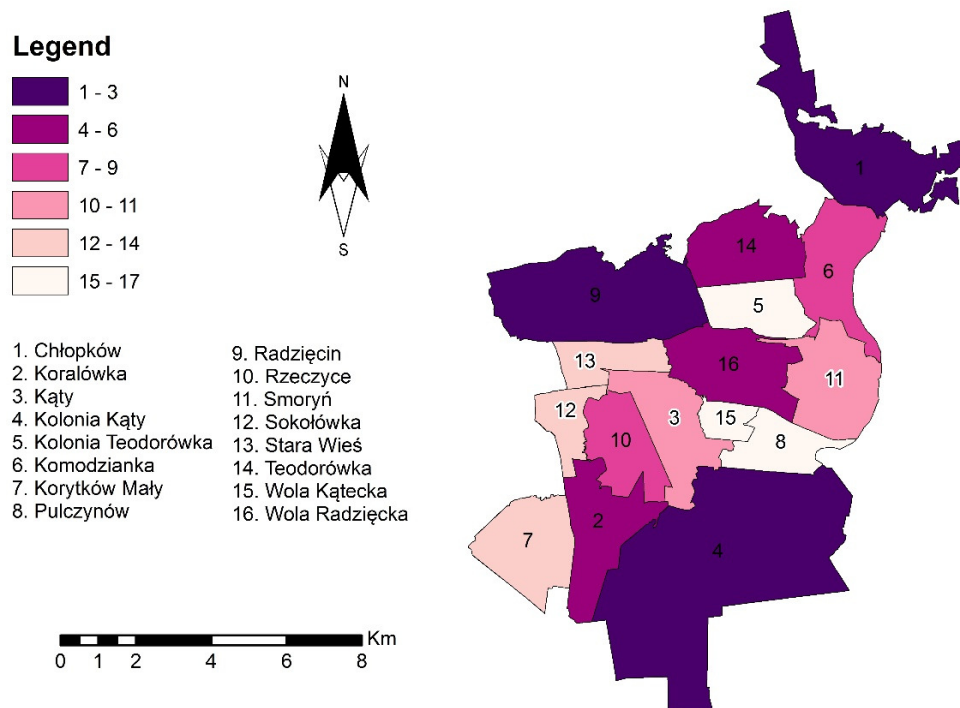


Fig. 2. Ranking of villages determined by Hellwig's method

It is impossible to undertake works aiming at improvement of the agricultural production space in all the villages at the same time due to economic, technical and social reasons. Therefore, works aiming at transformation of the defective structure of land should be undertaken as a priority in the villages, where they are most urgent.

Conclusions

1. Undertaking land consolidation and exchange works in the sequence presented in Table 1 and Figure 2 would certainly facilitate improving spatial parameters, which affect the conditions of agricultural activities. To sum up, it must be stated that the selected features correctly describe the defectiveness of the spatial structure of the analyzed commune. The conditions for agriculture can be certainly improved through the consolidation and exchange of land.
2. The universal algorithm used for selecting the features for grouping can be a helpful tool for the hierarchization of land consolidation works. Its advantage is that it can be used in any region of Poland, no matter where the land consolidation object is located.
3. In the analyzed commune measures to liquidate the presented defects should be undertaken, which will have an influence on improving and developing agricultural production and the working and living conditions of farmers. Calculation of the synthetic measure for grouping of the villages according to defectiveness makes it possible to determine the hierarchy of land consolidation and exchange works in the commune of Frampol.
4. Undertaking rural management works in all the villages at the same time is not possible. The barriers are financial, human resources and social restraints. If we want to reconstruct the defective spatial structures of fragmented agricultural land in a planned and rational manner, we need to determine the hierarchy of needs for consolidation in the analyzed area. To this end, the above-presented method of hierarchization could be used.

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