

THE IDEA OF RANKING IN SETTING PRIORITIES FOR LAND CONSOLIDATION WORKS

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Summary

Functioning conditions of agriculture are closely related to the spatial structure of rural areas, which is one of the most important factors influencing profitability of agricultural production. Essential changes in rural space can be effected in a short period of time only as a result of land management works. The scope of these works is limited because the financial resources are often insufficient. As a result, scarce funds must be distributed in such a way as to ensure their flow to where they are mostly needed or where the return on investment, in the form of improvement of farming conditions, would be the highest [Błaż et al. 2010, Gawroński 2005].

The article presents the idea of creating multicriteria ranking of surveying sections of Małopolskie Voivodeship aimed at identifying areas that should be the subject of land management works in the first place. It is suggested that to achieve this goal databases of rural areas in the Małopolska region, including data from the descriptive and graphic part of the land and building register as well as digital orthophotomap.

Voivodeship authorities, having access to the results of the proposed calculation process, could play an important role in programming the land management works.

Keywords

land consolidation • land spatial structures • land management works

1. Introduction

Małopolska region has a specific spatial structure of rural areas, because large fraction of the rural population is engaged mainly in subsistence farming, and farming is not its primary source of income. There is a large number of adverse factors lowering the profitability of commercial agricultural production in the region, such as relatively small mean size of farms, significant land fragmentation together with unfavourable shape of parcels and domination of poor soils.

In order to improve the conditions of farming and to stimulate the development of rural areas, it is necessary to accurately assess the status quo, and particularly the problems and limits related to agricultural production areas. The assessment will allow

to identify areas of highly distorted agricultural and non-agricultural production activity and to find measures to limit the scope of these distortions.

This study presents the main assumptions of creating the ranking of the rural areas (surveying sections) in which agricultural and non-agricultural production activity faces major difficulties and where consolidation and exchange of lands is most urgent.

For the purposes of this study a farms' land has been defined as a parcel (land plot) belonging to one land registration unit according to a registration group 7.1. The definition involves certain degree of simplification that results from the specificity of the processed databases such as land and building register data saved in the Register Data Exchange Standard (SWDE, Standard Wymiany Danych Ewidencyjnych). In these databases it is not specified which units could be merged into one farm nor other attributes defining a particular parcel as part of a given farm. This problem however does not affect the essential aspect of the results, namely the opportunity to make a comparison of various phenomena within a given section, and it is related to individual sections with similar (in percentage terms) intensity of traits, and it is only a systematic error, which should be kept in mind during description and interpretation of the results.

2. Characteristic of spatial structure of rural areas in the Małopolska region

The main features of spatial structure that are exceptionally unfavourable for the development of standard agriculture are too small mean size of farms and parcels. Spatial differentiation of these features in communes of Małoposka is shown in Figures 1 and 2.

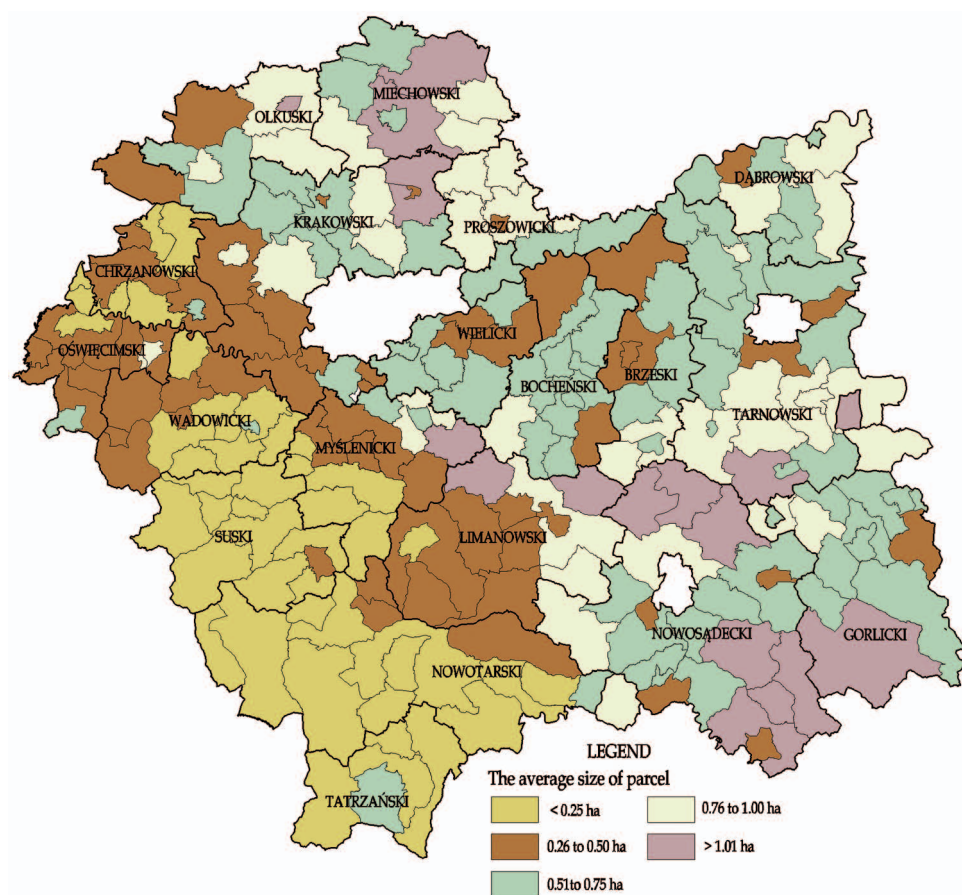
The analysis of chosen parameters of spatial structure, some of which have been presented in Tables 1 and 2, shows what are the main obstacles in development of rural areas in the Małopolska region.

When analysing Table 1 one can conclude that out of four millions record parcels in Małopolska, slightly more than 2 millions belong to farms, and nearly equally large group (almost 1.5 mln) belong to natural persons, and these lands are not even part of small farms (agricultural property). The mean size of a parcel in rural areas of both rural and rural-urban communes is 0.37 ha. And the mean size of land registration unit in rural areas of both rural and rural-urban communes is 2.56 ha.

In Figure 1 the mean size of parcels in a farm in different communes of Małopolskie Voivodeship is presented. The smallest parcels can be found in the south-west part of the voivodeship, mainly in communes of Nowy Targ, Tatra, Sucha, and partly in Myślenice and Wadowice districts. The largest record parcels occur in some parts of communes of Miechów, Kraków, Nowy Sącz, Gorlice (Uście Gorlickie commune), Tarnów and Limanów districts.

In Table 2 farms of size 1–2 ha are dominant, but when the total surface area of farms is considered, the largest group (almost 37%) are farms of acreage of 2–5 ha.

In Figure 2 the mean size of family farms in communes of Małopolskie Voivodeship is shown. The smallest farms (up to 2 ha) can be found mainly in communes of Chrzanów and Wieliczka districts, and the largest (up to 5 ha) in Uście Gorlickie commune in Gorlice district and Piwniczna commune in Nowy Sącz district.



Source: authors' study based on EGIB (Land and Building Register) 2010

Fig. 1. Differences in mean size of parcel in a family farm in the communes of Małopolskie voivodeship

Table 1. Chosen parameters of spatial structure of lands in Małopolskie voivodeship

No.	Feature	Value
1	Total number of record parcels	4 052 284
2	Number of record parcels of farms' lands (land registration unit)	2 071 983
3	Number of record parcels being agricultural land properties	1 489 929
4	Mean size of record parcel [ha]	0.37
5	Mean size of farms (land registration unit) [ha]	2.56

Source: authors' study based on data from EGIB (Land and Building Register), 2010



Source: authors' study based on EGIB (Land and Building Register) 2010

Fig. 2. Differences of mean size of family farms in communes of Małopolska

Table 2. Structure of land fragmentation of farms in Małopolska

No.	Size of farms	Number of farms		Total surface area of farms	
		Number	[%]	[ha]	[%]
1	1–2 ha	150 875	51.19	213 596	22.33
2	2–5 ha	114 809	38.95	353 404	36.92
3	5–10 ha	24 594	8.34	160 386	16.76
4	more than 10 ha	4 481	1.52	229 519	23.99
Total		294 759	100.00	956 905	100.00

Source: authors' study based on EGIB (Land and Building Register) 2010

Development of agricultural production environment in Małopolska is influenced not only by parameters of spatial structure of lands but also by quality of soils (Table 3). As Table 3 shows, in Małopolska soils of middle quality dominate (4th class – 41%) and there is only small share of high quality soils (both 1st and 2nd class soils constitute around 5%). The numbers show that during land management works non-agricultural aspects of development of rural areas should be emphasised.

Table 3. Soil quality in Małopolska

No.	Total surface areas and percentage of arable lands	Surface area	Percentage
		[ha]	[%]
1	1 st class	15 726	1.37
2	2 nd class	46 576	4.08
3	3 rd class	272 773	23.83
4	4 th class	469 510	41.02
5	5 th class	232 295	20.29
6	6 th class	107 716	9.41
Total		1 144 596	100.00

Source: authors' study based on EGIB (Land and Building Register) 2010

In spite of numerous flaws of spatial structure of Małopolska, many areas of the region, where there is no modern, large-scale extensive farming, have exceptional cultural and scenic values. Undoubtedly the process of transformation and revitalization of rural areas in Małopolska should be implemented with the utmost attention paid to maintaining these unique elements, constituting real cultural landscapes [Cymerman et al. 1992, The European Landscape Convention 2002]. Apart from care given to maintenance of these elements, when improving the functioning of these areas (including land consolidation) measures should be taken to emphasize their non-agricultural values.

3. The idea of creating ranking defining demand for land consolidation works

One of the priorities of the voivodeship self-government is a coordination and facilitation of actions aimed at improvement of area structure of farms and proper farming in rural areas. These actions are realized by the authorities in accordance with their legal provisions, capabilities and limits (mostly financial, sometimes procedural). The basic instrument of making comprehensive changes in rural environment is land consolidation, which together with investments made as part of post-consolidation management can improve conditions of farming and provide a developmental stimulus for the whole village and thus result in better standard of living of inhabitants.

The programme for agriculture and rural development in Małopolskie voivodeship [Program 2010] shows that land consolidation should be popularized, but it does not contain practical solutions as to how to make an informed choice of objects of that procedure.

To achieve this goal the study proposes fast and convenient method of analysis of rural areas (communes, districts and voivodeships), and presents ways of its application for identifying group of surveying sections in which there is simultaneously high intensity of negative traits of spatial structure of farms and a good chance that the land consolidation works would bring satisfactory results. For this reason, on the basis of a number of partial indices of features important in planning land consolidation works, a characteristics of individual survey sections has been proposed, and then the use of these indices in the process of creation the final ranking has been shown.

The following partial indices were used. The way they were calculated has been described in detail in other scientific papers:

- index related to the size of farms (W_1), presented in Janus and Taszakowski [2013a],
- index of land fragmentation (W_2), presented in Janus and Taszakowski [2013b],
- index related to soil quality (W_3), presented in Janus and Taszakowski [2014],
- index showing lack of road access to parcels (W_4), presented in Janus and Taszakowski [2013c],
- index related to analysis of aerial photographs (W_5), presented in Janus and Taszakowski [2014].

The data used for calculations of individual indices are graphic data and descriptions from land and building register in the form of SWDE (the Register Data Exchange Standard). As an IT-tool, MkScal was used, a software for comprehensive services of land management works. By means of its modules the software generates sets of data essential in calculation of separate partial indices.

In the process of determining the index related to the size of farms survey sections with large group of big farms and simultaneously with relatively small group of small farms must be identified. Therefore it has been assumed that the occurrence of large number of bigger farms (with highly fragmented lands) in a given area increases the possibility of positive outcomes of land consolidation, and that the large share of small farms results in less significant changes of an area spatial structure during its consolidation. The group of middle size farms, as having a neutral effect, has not been taken into account. The process of calculation of this index had two stages. In the first stage the share of land registration units within the range 1–2 ha has been calculated, while the lowest value of this share received highest points. Accordingly, individual sections are awarded points within the range from 0 to 100. Next the share of large units is calculated, those of 5–10 ha, and large share of such units get maximum number of points. Likewise the sections are valued from 0 to 100. The sum of these two values for a given section is ultimately brought to such a form so that a section is rated between 1 and 100 points.

The way of calculation of the above index can be presented as follows:

$$W_1 = (W_{WG} - \text{Min}(W_{WG})) / \text{Max}(W_{WG} - \text{Min}(W_{WG})) \cdot 100$$

where:

$$W_{WG} = W_{G1-2(0-100)} + W_{G5-10(0-100)}$$

Max(), Min() – maximal and minimal value of expression in brackets for individual sections,

where:

$$W_{G1-2(0-100)} = W_{G1-2} / \text{Max}(W_{G1-2}) \cdot 100$$

$$W_{G5-10(0-100)} = W_{G5-10} / \text{Max}(W_{G5-10}) \cdot 100$$

where:

$$W_{G1-2} = (100 - U_{1-2\%}) - \text{Min}(100 - U_{1-2\%})$$

$$W_{G5-10} = (U_{5-10\%}) - \text{Min}(U_{5-10\%})$$

where:

$U_{1-2\%}$ – percentage of 1–2 ha farms in the total area of farms' lands,

$U_{5-10\%}$ – percentage of 5–10 ha farms in the total area of farms' lands.

The index of land fragmentation is also the result of adding up two partial indices according to a formula given below. One half of the index value is estimated on the number of parcels in a given area group of farms. The other half of the index is related to the size of parcels in a given area group of farms.

The way the above index has been calculated can be presented as follows:

$$W_2 = W_{Ldz} + W_{Pdz}$$

where:

$$W_{Ldz} = Ldz_{1-2} \cdot U_{1-2} \cdot w_{1-2} + Ldz_{2-5} \cdot U_{2-5} \cdot w_{2-5} + Ldz_{5-10} \cdot U_{5-10} \cdot w_{5-10}$$

where (by way of example for an area group of farms of 1–2 ha)

Ldz_{1-2} – mean number of parcels in farms from 1 to 2 ha range,

U_{1-2} – percentage of group of farms from 1 to 2 ha range,

w_{1-2} – weight of the part of formula related to a given area group of farms.

The value of partial index W_{Ldz} is converted to a form in which its lowest value corresponds to 0 points, and its highest value to 50 points, and the variability of the received value is proportional to variability of an output index W_{Ldz} .

If the default weights in the above formula are 1, they can be omitted and thus the formula is much simpler. Leaving the weights in place gives a possibility to change the significance of a share of area group of farms in the final form of index, as it is during calculation of the second part of land fragmentation index.

The second half of the land fragmentation index (0–50 points) is related to the size of parcels in a given area group of farms, calculated according to the formula:

$$W_{Pdz} = PdZ_{1-2}^{-1 \cdot U_{1-2}} \cdot w_{1-2} + PdZ_{2-5}^{-1 \cdot U_{2-5}} \cdot w_{2-5} + PdZ_{5-10}^{-1 \cdot U_{5-10}} \cdot w_{5-10}$$

where (by way of example for an area group of farms of 1–2 ha):

- Pdz_{1-2} – mean size of parcels (in ha) in farms from 1 to 2 ha range,
- U_{1-2} – percentage of group of farms from 1 to 2 ha range,
- w_{1-2} – weight of the part of formula related to a given area group of farms.

In this case, the default weights can be proposed as 1, for a group of farms from 1 to 2 ha range, 1.5 for group of 1–2 ha farms, 2 for farms larger than 5 ha. Such a differentiation of weights is aimed at singling out sections in which larger farms have large number of small parcels, because it means that the area is especially recommended for land consolidation works. However it should be remembered that the proposed weights can be easily modified, and they can as well be omitted and then it would be assumed that their values would equal 1.

Similarly, as in the case of partial index W_{Ldz} , the value of partial index W_{Pdz} is brought to a form in which its lowest value corresponds to 0 points, and the highest – to 50 points.

The final land fragmentation index W_2 is the result of adding up values W_{Ldz} and W_{Pdz} , which again is brought to a form in which it receives values from 0 to 100 (the lowest valued section will receive 0 points, the highest valued section – 100 points).

The soil quality index is first of all based on the calculation of the surface area of classification contour in each surveying section. Finally the index is calculated on the basis of division of the sum of the surface area of individual classification contours (multiplied by the appropriate score for a contour presented in Witek and Górski [1977]) by the total sum of classification contours.

The value of soil quality index can be calculated according to the following formula:

$$W_3 = \sum_1^n \frac{P_{kk} \cdot W_p}{P_{ckk}}$$

where:

- P_{kk} – the surface area of individual classification contours,
- W_p – point values of individual classification contours,
- P_{ckk} – the total surface area of contours classified within a surveying section.

One half of the value of an index measuring lack of road accessibility to parcels is the result of share of surface area of parcels from the 7th registration group, which have no connection to the road network in a total surface area of parcels from that registration group. The second half of the value takes into consideration the share of number of parcels with no access to the road network (also form the 7th group) in the total number of parcels belonging to that group.

The way this index was calculated can be presented as follows:

$$W_4 = (W_{BD} - \text{Min}(W_{BD})) / \text{Max}(W_{BD} - \text{Min}(W_{BD})) \cdot 100$$

where:

$$W_{BD} = W_{BDpowdz(0-100)} + W_{BDldz(0-100)}$$

Max(), Min() – maximal and minimal value of expression in brackets for a given sections,

where:

$$W_{\text{BDpowdz}(0-100)} = W_{\text{BDpowdz}} / \text{Max}(W_{\text{BDpowdz}}) \cdot 100$$

$$W_{\text{BDldz}(0-100)} = W_{\text{BDldz}} / \text{Max}(W_{\text{BDldz}}) \cdot 100$$

where:

$$W_{\text{BDpowdz}} = W_{\text{BDpowdz}\%} - \text{Min}(W_{\text{BDpowdz}\%})$$

$$W_{\text{BDldz}} = W_{\text{BDldz}\%} - \text{Min}(W_{\text{BDldz}\%})$$

where:

$$W_{\text{BDpowdz}\%} = \Sigma(\text{Pow}_{\text{DzBd}}) / \Sigma(\text{Pow}_{\text{Dz}}) \cdot 100$$

$$W_{\text{BDldz}\%} = \Sigma(L_{\text{DzBd}}) / \Sigma(L_{\text{Dz}}) \cdot 100$$

where:

$\Sigma(\text{Pow}_{\text{DzBd}})$ – the sum of surface area of parcels from the 7th registration group, that do not have access to roads,

$\Sigma(\text{Pow}_{\text{Dz}})$ – the sum of surface area of parcels from the 7th registration group,

$\Sigma(\text{Pow}L_{\text{Dzbd}})$ – the total number of parcels from the 7th registration group that do not have access to roads,

$\Sigma(\text{Pow}L_{\text{Dz}})$ – the total number of parcels from the 7th registration group.

The index related to the analysis of aerial photographs (W_s) consists in categorization of all voivodeship sections through an analysis of the occurrence of factors that hinder the free shaping of new arrangement of parcels and producing satisfactory effects of land consolidation works.

The most important hindrances in the process of creating new parcels arrangement or the factors that put usefulness of land consolidation in question are:

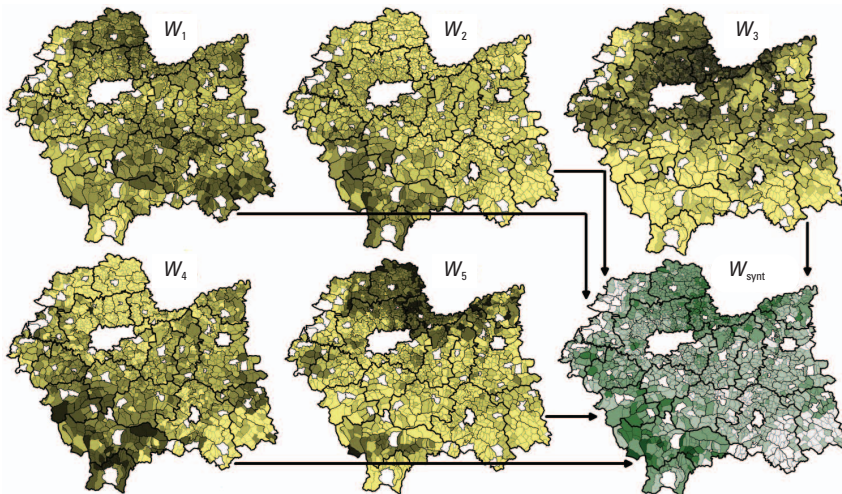
- occurrence of large number of field obstacles that have to be taken into consideration at the stage of measuring invariants and subsequent planning process (high boundary strips, slopes, afforestations, orchards etc.),
- occurrence of succession of forests on large areas of the section,
- large number of irregular afforestations or afforestation along the existing boundaries in the area of a possible consolidation,
- large areas taken up by permanent, multi-annual plantations (orchards),
- large percentage of permanent fallow lands because of low soil quality,
- exceptionally small size of sections.

The significance of the above factors is difficult to assess in an automatic way, as they are not derived from data contained in the land and building register. For this reason the index has been proposed, the value of which is determined by means of an analysis of intensity of their occurrence. The value of this index should be the result of an assessment of individual sections by experienced (with many years of practice) people having sufficient amount of knowledge about shaping the rural landscape by means of consolidation works and having required qualifications to carry out geodesic management of rural and forest areas.

The following method of calculating the index has been proposed. Each of the sections should be assessed independently as to the intensity of the occurrence of the above mentioned factors by at least two persons. Such an assessment consists in putting each section into one of the five categories. These assessment should than be averaged out and in some cases, when significant differences in the results are observed, discussed. Then each section should receive appropriate number of points and as a consequence be put into one of the five categories:

- I (100 points) – lack of significant obstacles in free shaping of new arrangement of parcels,
- II (75 points) – minor obstacles in free shaping of new arrangement of parcels,
- III (50 points) – average possibilities of significant improvement of spatial structure of lands by means of consolidation works,
- IV (25 points) – major obstacles in proper shaping of new arrangement of parcels,
- V (0 points) – section is not fit for consolidation works because its arrangement of parcels cannot be improved and its agricultural character is in decline.

The result of suggested calculation process related to multicriteria analysis of spatial structure is a synthetic index, which allows for the ranking of the survey sections of the studied area by the value of this index. In practice it means creation of a ranking determining the usefulness of land consolidation works in each of the section, according to accepted criteria. A diagram showing how the priority ranking of consolidation works has been created is presented in Figure 3. It shows that the set of accepted partial indices and their values influence the final form and value of the ranking.



Source: authors' study

Fig. 3. Creation of priority ranking of consolidation works

The way a synthetic index has been calculated can be presented as follows:

$$W_{\text{synt}} = W_1 \cdot w_1 + W_2 \cdot w_2 + W_3 \cdot w_3 + W_4 \cdot w_4 + W_5 \cdot w_5$$

where:

W_1, W_2, W_3, W_4, W_5 – partial indices,
 w_1, w_2, w_3, w_4, w_5 – weights of partial indices.

The method of calculating the final ranking consists in adding up all partial indices with selection of respective values of indices weights.

One of the assumption of the analysis is a great deal of freedom in shaping components in calculating values for each section and its weights. Hence there is a possibility of creating many different sets (rankings) of sections, each is related with assuming different premises regarding sets of partial indices and their weights. Using weights with a higher value than one for a given partial index will prove that the analysis is oriented toward the choice of sections in which features measured by a given index are the most important from the point of view of demand for consolidation works.

It is essential to enable the choice of ranking parameters (as to the number of features considered in the calculation process and their weights), so that the identification of problem areas is adjusted to current priority actions of voivodeship authorities and changing rules of law, especially those defining the basic goals of land management works.

4. Usage, role and significance of ranking determining the urgency of land consolidation works

The role of data in the form of objective ranking will be growing especially in the long-term perspective. It is probable that there would be an ever increasing interest in using the EU funds for improvement of living standard in rural areas. One can predict that an informed choice of objects for land management works would be necessary. The role of the correct assessment of problem areas should increase with time, also due to vast possibilities of modification when preparing ranking of criteria.

The ranking can be used in the continuation of process of creating programmes of land management works for the chosen communes of Małopolskie voivodeship. Using the proposed or different set of criteria will allow for singling out the communes in which conditions of the agricultural production environment should be improved in the first place.

The proposed ranking can also improve the accuracy of assumptions of land consolidation project. The project assumptions should still regard the areas where the land consolidation works are planned in the foreseeable future. These surveys should precisely indicate which methods in a given area are best for improving technical and spatial functioning parameters of family farms, and propose changes in the road network and land reclamation structures. The surveys should also include recommendations for investments in the technical and social infrastructure and broadly understood elements related to land reclamation, protection and revival of landscape values,

environment protection and increase of forestation rate. When preparing the consolidation works project an assessment of impact of the planned works on the environment should be taken into account.

It is also suggested that the promotional actions aimed at popularizing knowledge about the advantages (not only of strictly agricultural nature) of consolidation works in rural areas should focus on the areas chosen by means of the proposed ranking that indicates where these works in Małopolskie voivodeship are most urgent.

5. Conclusions

The idea of creating the ranking of survey sections in a voivodeship, showing where the land management works are mostly needed, has many advantages. The most important of them is a great accuracy of an analysis of individual survey sections where land consolidation works could be carried out. The calculation process, based on data from land and building register, is also relatively little time-consuming. The result of implementing the idea would be a precious material helping the institutions, responsible for spatial structures transformations of rural areas in a voivodeship, to focus their activities on places where consolidation works are mostly needed and where they could be most effective.

Implementing the idea can also contribute to the better use of available funds allocated for improvement of functioning of rural areas in Małopolskie voivodeship, because the money can be spent on objects with the highest needs. The proposed idea will also give the chance to verify and increase the social acceptance for the proposed works. Consolidation works in these areas should be carried out faster, they should cause less complaints, and their results could be positively verified as to the usefulness and effectiveness of the money expended and be an example to the neighbouring areas.

Data acquired and processed during the preparation of the ranking, due to their high accuracy, could also be used in many other studies characterizing rural areas of Małopolska.

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