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Automated Processing of Data in the Comparative Estimation of Land Value during Land Consolidation Works

Przemysław Leń [1], Klaudia Maciąg [2], Michał Maciąg [2], Justyna Wójcik-Leń [3] and Katarzyna Kocur-Bera [4,*]

1 Faculty of Geodesy and Geotechnics, Rzeszów University of Technology, 35-959 Rzeszów, Poland; p.len@prz.edu.pl
2 Faculty of Environmental Engineering and Geodesy, University of Life Sciences in Lublin, 20-950 Lublin, Poland; k.maciag@pbgitr.geodezja.pl (K.M.); m.maciag@pbgitr.geodezja.pl (M.M.)
3 Faculty of Environmental, Geomatic, and Energy Engineering, Kielce University of Technology, 25-314 Kielce, Poland; jwojciklen@tu.kielce.pl
4 Institute of Geodesy and Civil Engineering, Faculty of Geoengineering, University of Warmia and Mazury in Olsztyn, 10-720 Olsztyn, Poland
* Correspondence: katarzyna.kocur@uwm.edu.pl

Abstract: Estimation of the value of land, underlying the design of constituent plots of the farmstead, is a decisive element of the complex procedure of land consolidation and exchange. Correctly estimated value of agricultural land is a prerequisite for adequate and equitable delimitation of land plots to improve the living conditions of local residents and ensure efficient and profitable agricultural activity. The dynamic development of technology contributes to the development of multiple tools, considerably improving design works and field surveys in the land consolidation process. The world reference literature also gives numerous examples of surveys to optimise the methods for estimating a land value for consolidation projects. However, in our opinion, despite a vast collection of self-designed calculation methods, available sources insufficiently address the optimisation of existing methods based on the current legal framework and implementing practices. This paper presents a self-designed solution for the fully automated performance of complex comparative estimation of land based on the existing cadastral data and a simplified array showing the estimated value. The tool resulted in developing a set of data for directly importing the outcomes of calculations into land surveying software supporting steps of the land consolidation process. Following detailed evaluation, the proposed self-designed solutions were implemented at the Subcarpathian Office of Land Surveying, and Agricultural Areas in Rzeszow for land consolidation works in the Subcarpathian voivodeship in southeastern Poland.

Keywords: comparative estimation of land value; land consolidation; algorithm; GIS; automation

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1. Introduction

The idea to consolidate land, pursued by many countries as an effective measure preventing poor spatial structure of rural areas and, at the same time, a practical, multi-faceted instrument for optimising the living and economic conditions in rural areas, is expressly marked in discussions undertaken by researchers from Central and Eastern Europe [1–11], and from Asian countries [12–18]. The commonly observed fragmentation of land due to historical, socio-economic factors is a particular disadvantage affecting the productivity of local, national and global agriculture. Muchová and Raškovič describe the problem of excessive land fragmentation using the example of farms in Slovakia. Based on an extensive analysis of archival documents, they outline the main historical reasons behind land fragmentation, including but not limited to rules for inheriting land, and later real property regulations distinguishing between buildings and land. They also criticised insufficient measures taken by the government concerning agricultural policy, including, in particular, scarce involvement in land consolidation initiatives [19]. Hudecová et al., made analogous observations in presenting a self-designed indicator to efficiently monitor the degree of land fragmentation in the regions of Slovakia. The tool is an alternative to previous solutions described as inflexible and too complicated [20]. Land fragmentation in Lithuania is the subject of consideration by Pašakarnis and Maliene. The authors see the unordered privatisation of land during the political transformation after the collapse of the Soviet Union as one of the main reasons behind the poor spatial structure of rural areas. A substantive diagnosis of the identified problem supports the claim regarding the necessity to intensify land consolidation works [21]. Deininger et al., presenting the analysis results carried out in Albania [22] and Martyn et al., describing Ukrainian reality, also share the view on the special significance of land fragmentation in post-Socialist countries. The study's authors concerning the agriculture of Ukraine put particular emphasis on the observed insufficient coordination of land consolidation works due to a lack of adequate regulatory solutions [23]. Dudzińska and Kocur-Bera undertake the issue of land fragmentation in the context of the requirement for land consolidation works in Poland, presenting the results of thorough research based on several selected indicators [24]. By contrast, Wang et al., evaluate the reasons for and consequences of land fragmentation in China. They deem repeated land divisions, typical of conventional agriculture, to be the main source of the problem [25]. Despite the geographical differentiation of reasons behind land fragmentation, researchers worldwide commonly believe that this is an adverse phenomenon and that land consolidation is a necessary procedure. Thus, the methods of the land consolidation procedure optimisation, which are the main subject of this research, are studied by the researchers as a particularly important issue.

A predominant part of the world literature on improvements in the tools used for the land consolidation procedure refers to surveys conducted in Central and Eastern Europe and in selected Asian countries. Drawing on their experience acquired during the study in Slovenia, Lisec et al., point to the need for maximising the benefits of land consolidation to satisfy the participants and increase the society's support of land consolidation [26]. Janus and Markuszewska highlighted the necessity to boost the economic efficiency of land consolidation in Poland and mentioned that the efficiency of works is low compared to the considerable time and financial expenditure involved in their performance [27]. Other authors to discuss the issue of limited resources are Janus and Taszakowski, who emphasise the necessity to prioritise the urgency of land consolidation for projects in waiting to ensure the optimum benefits of the utilised resources [28]. Delimitation of potential consolidation objects according to consolidation works urgency is also the subject of studies conducted by Marinković et al. The proposed solution comprises an integration of selected methods for evaluating the agrarian structure to maximise the reliability of outcomes and make it possible to reject those standing out as non-representative [29]. Stręk et al., see a possibility to improve the efficiency of land consolidation by eliminating the so-called external plot patchwork upon the assumption of possible expansion of the nominal area of land exchange onto adjacent localities [30]. In contrast, Harasimowicz et al., suggest that farmstead design procedures should be automated to improve land consolidation works and their outcomes. As an example of desired solutions, they describe their self-designed heuristic algorithm for reallocating land, taking the economic criterion of potential transport costs for farms into account [31]. Hakli et al., also write about the automated parcel design process, highlighting the low effectiveness of available solutions. The authors present an algorithm using the Delaunay triangulation as an efficient tool [32]. Cay and Uyan outline the consolidation of land in Turkey and analyse options to increase the fulfilment of the expectations of land consolidation participants. The presented self-designed algorithms, based on the prioritisation of needs and automated parcel design, are highly-efficient and ensure a relatively high level of landowners' satisfaction [33,34]. Demetriou, relying on his observations in Cyprus and self-designed algorithms for spatial analyses, recommends innovative methods to parametrise the characteristics of consolidated land at the task scheduling stage. An objective outline of the existing needs and available options for land reallocation, integrated with an algorithm ensuring an automated sequence of design activities, makes it possible to work out solutions that would be difficult to achieve using conventional methods [35]. Zou and Li propose a tool for evaluating land consolidation that supports the identification of directions for their potential optimisation. The proposed solution, tested under a consolidation project in China, was recommended for common use [36]. Consolidation of land in other regions of the world, including Western Europe and Africa, is a less popular topic yet undertaken by some authors. Hartvigsen tackles the decline in the number of land consolidation proceedings in Denmark. In his opinion, social interest in land consolidation can increase again on the condition that new programmes are adapted to local needs and include attractive public financing [37]. In turn, Asiama et al. describe attempts at propagating the idea of land consolidation in African countries such as Rwanda, Ethiopia and Ghana. For them, the maximum performance of agriculture is of special importance to the urgency of measures to improve food security in a considerable part of Sub-Saharan Africa. However, implementing land consolidation mechanisms in the analysed countries is a highly complex process at risk of failure due to, among other reasons, the risk of protests among the local community and limited options available to the local authorities. The authors deem the potential development of land consolidation in Sub-Saharan countries viable, but it requires intensified measures of governing authorities and planning the works having the local cultural conditions in mind [38]. Gedefaw et al. share this view and point to a clear interest in land consolidation among Ethiopian farmers, emphasising the legitimacy of informational and promotional campaigns held among the communities of various regions of Ethiopia [39]. A common element of land consolidation methodology is designing farmsteads with optimised geometry and location parameters based on the value of existing land held by landowners [40]. The procedure for determining the relative value of the land for farmsteads to be consolidated, referred to as the comparative estimation of land value, is a current and popular research subject [41]. The directions of the search for new solutions include substantive rules for land valuation. Among the proposed methods, those worth special attention are based on the market value of land estimated from time to time, use predefined land value maps agreed upon during general appraisal and assume the so-called comparative estimation determining relative values for assigning priorities to particular types of land making up the currently consolidated project [42]. The technical aspect of land value estimation, particularly the search for potential solutions to standardise and automate necessary steps, remains equally important [43]. Demetriou refers to the estimation of land value as a ‘critical’ issue noting that the process is time-consuming and costly and that empirical valuation is not adequately accurate, and suggesting employment of automated valuation models, for instance, algorithms combined with geographical information systems (GIS) [44], or using neural networks trained based on a representative sample of conventional valuation [45]. Ertunç and Uyan also demonstrate that land valuation is of key importance to land consolidation and recommend their self-designed multi-criteria model as a tool for efficient and objective valuation of farmsteads [46]. The belief of the fundamental significance and necessity of undertaking measures to develop land valuation methods is also shared by Tezcan et al., authors of a model based on fourteen interdisciplinary land quality index factors [47]. Also, Branković et al., prefer the multi-criteria approach and recommend their self-designed tool relying on GIS technology. They underline the necessity for aligning the present regulatory framework with modern land valuation methods, which is a prerequisite for potential innovation [48]. Peráček et al., also discussed the legal aspect of land value estimation in the land consolidation process, thoroughly analysing and evaluating the legislation of Slovakia governing land valuation for public purposes. They state the legitimacy of thorough reconstruction of the existing legislative framework and introducing dedicated solutions for efficient and equitable land value estimation during land consolidation works [49].

Despite the observed diversity of the concepts of optimising land value estimation techniques to the extent of their tools and input data, the common belief that land valuation is a key stage in the whole land consolidation process remains noticeable. A significant conclusion drawn from the analysis of world literature is the legitimacy of measures optimising the estimation procedure to ensure the maximum efficiency of calculations and provide objective land valuation criteria. However, despite the availability of outcomes of many studies tackling with the development of land value estimation methods, a deficiency of practical, technical solutions that could be implemented in land consolidation projects using generally acceptable methods based on the legal framework is explicit. A considerable part of the proposed innovative solutions requires that the test phase be continued and regulations facilitating their implementation be in place. Despite documented potential benefits, many concepts are refuted due to the excessive cost of their implementation and the necessity to maintain the methodological continuity of land consolidation proceedings. Thus, developing tools to maximise the performance of strictly specified land valuation procedures in land consolidation practice, which is the subject of this study, remains valid and essential.

2. Materials and Methods

This paper deals with a self-designed tool for automating the technical aspect of comparative estimation of land value based on processed cadastral data and guidelines agreed upon with the participants of the land consolidation project. The presented solution was developed in response to the needs stemming from the specificity of land consolidation projects in Poland, but due to its concise and clear structure, the algorithm can be adapted to the needs of other cadastral systems. The algorithms, embedded in an intuitive QGIS interface, allow us to efficiently assign adequate values to each polygon representing a land use/soil valuation class. This object is an elementary unit of the area formed at the intersection of vector layers representing soil class contours as well as land use contours stored in the numerical cadastral database to represent the areas delimited according to soil type and intended use of land and its actual use [50]. The mechanisms used are a good alternative to manual operations and can significantly optimise the working time and minimise the risk of error, if any.

The algorithm was thoroughly evaluated for eleven real consolidation projects extending over a total area of ca. 119.13 km^2 in the Subcarpathian voivodeship, southeastern Poland. The study area consisted of villages displaying different spatial characteristics of land, depending on, among other features, geographical situation, and, notably, on terrain relief. An essential factor in the context of the study is the specification of diverse forms of land use and soil quality classes in the examined villages. For villages situated in the north of the Subcarpathian voivodeship, where the terrain relief is relatively low, various classes of arable land were the predominant land use type. By contrast, the mountainous landscape sites in the south showed predominant grassland, forestland and afforested areas. The availability of land advantageous to agricultural production was a key determinant of the value of agricultural holdings established during the analyses. Figure 1 illustrates the location of the study area.

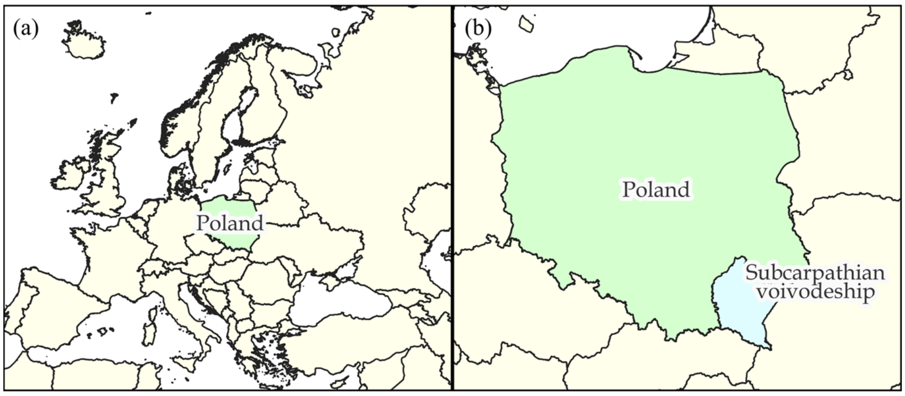

Figure 1. (**a**) Location of Poland on the map of Europe; (**b**) Location of the Subcarpathian voivodeship on the map of Poland. Source: own elaboration.

After the solutions had been verified to work correctly and the postulates regarding the intuitive interface and data processing capacity had been fulfilled, the tool was implemented for comparative estimation of land value at the Subcarpathian Office of Land Surveying and Agricultural Areas in Rzeszów in charge of land consolidation and exchange in the Subcarpathian voivodeship, an unquestionable leader in Poland in terms of the number of land consolidation projects.

For the needs of the adopted purpose, that is, developing a tool to automate the operations of comparative land value estimation procedure, we created a dedicated algorithm to process spatial data and tabular input into geometric objects representing land use/soil valuation classes supplemented with corresponding estimates. These objects constitute necessary input to calculate the land value for respective farmsteads. Figure 2 is an overview of the general flow chart of the algorithm.

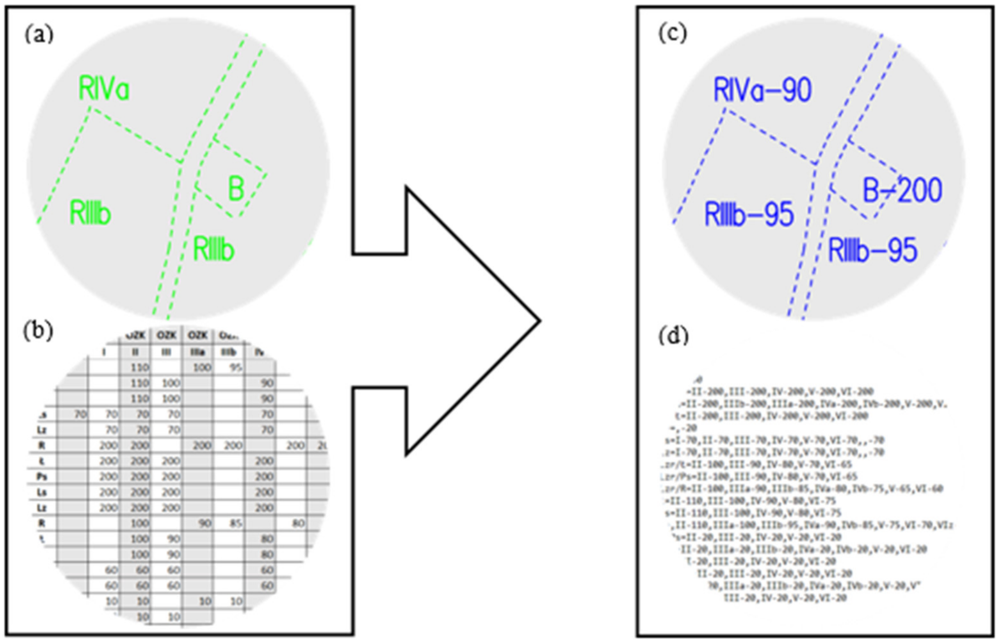

Figure 2. The concept of calculating the value of estimated land use/soil valuation classes: (**a**) layer of land use/soil valuation classes; (**b**) table of values; (**c**) output layer of estimated land use contours; (**d**) EWMAPA configuration file. Source: own elaboration.

This algorithm was designed using solutions available in common access open QGIS, providing, among other things, a user-friendly tool, the possibility of visual interpretation of outcomes, and a tool for converting data into various formats. The default data exchange standard was SHP, compatible with the popular EWMAPA programme by Geobid sp. z o.o., supporting the geometrical portion of the cadastral database and used in land consolidation projects. Table 1 presents the scope and a brief description of input data used.

Table 1. Description of data in use. Source: own elaboration.

Type of Data	Source	Use
vector layer of land use/soil valuation classes	authority maintaining the district land and buildings register database	defining the spatial range of the calculated land value; allowing the calculation of the land value of agricultural holding
comparative land value estimation table	resolution of the land consolidation project participants	assigning correct contractual value to particular types of land

In order to initiate the requested estimated value calculation, a correct two-element set of input files is required. The first type of necessary data is the vector layer of land use/soil valuation classes constituting a combination of land use and soil class contours existing in the cadastral database. These land use/soil valuation classes have no geometrical representation in the cadastral database; however, their geometries can be generated by the geospatial intersection of polygon layers. The key attribute describing the type of land use, according to legal regulations in force, is a combination of OFU (land use type), OZU (soil classification contour type) and OZK (soil class designation)—the legacy attributes of land use layers and land use contours. In a separate paper, we write about the automated procedure for generating correct land use/soil valuation classes. However, assuming that the topology of land use and soil class contours is correct, the layer of land use/soil valuation classes can be generated directly in the software supporting the graphical cadastral database.

Another element of input data is information on the estimated values of respective land use/soil valuation classes. Due to variations in the specificity of the relative value of land depending on the geographical location and social factors, the legal regulations on land consolidation in Poland do not provide for a uniform valuation system. A default solution is the estimated value rates determined by the participants of a land consolidation project and finalised by way of a resolution [51]. This document, processed into spreadsheet tables with a specific format (Figure 3), is the algorithm's input file.

OFU	OZK / OZU	-	I	II	III	IIIa	IIIb	IV	IVa	IVb	V	VI	VIz
R	R			110		100	95		90	85	75	70	
Ł	Ł			110	100			90			80	75	
Ps	Ps			110	100			90			80	75	
Ls	Ls	70	70	70	70			70			70	70	
Lz	Lz		70	70	70			70			70	70	
Br	R		200	200		200	200		200	200	200	200	200
Br	Ł		200	200	200			200			200	200	200
Br	Ps		200	200	200			200			200	200	200
Br	Ls		200	200	200			200			200	200	200
Br	Lz		200	200	200			200			200	200	200
Lzr	R			100		90	85		80	75	65	60	
Lzr	Ł			100	90			80			70	65	
Lzr	Ps			100	90			80			70	65	
Lzr	Ls		60	60	60			60			60	60	
Lzr	Lz		60	60	60			60			60	60	
W	R		10	10		10	10		10	10	10	10	10
W	Ł		10	10	10			10			10	10	10
W	Ps		10	10	10			10			10	10	10
W	Ls		10	10	10			10			10	10	10
W	Lz		10	10	10			10			10	10	10

Figure 3. Example of a comparative land value estimation table. Source: own elaboration.

The table lists all types of land use/soil valuation classes in the appraised area. Types of land use/soil valuation classes were defined based on a unique combination of attributes: OFU—land use type (first column), OZU—soil classification contour type (second column) and OZK—soil class designation (first line). Other fields in the table denote unit values of respective land use/soil valuation classes expressed in points/ha. Empty fields mean the specific land use/soil valuation class is absent in the study area.

The detailed workflow of the algorithm, comprising the operations involved in linking geometric and tabular data and generating a configuration file for the software supporting the graphical part of the cadastral database, is presented as a flowchart in Figure 4.

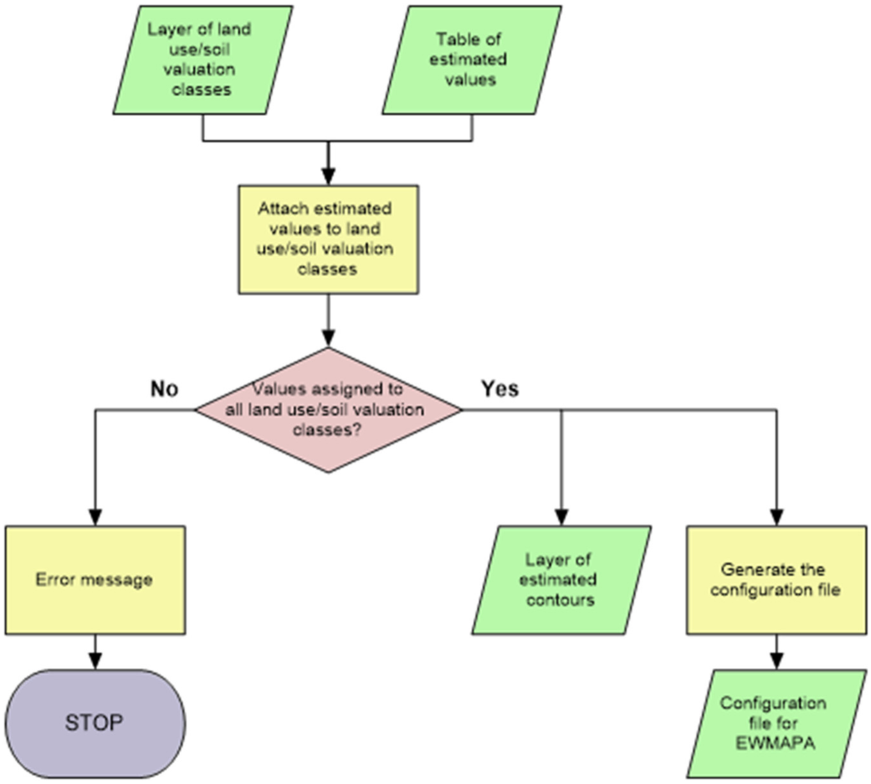

Figure 4. A general flowchart of the procedure for calculating estimated land value. Source: own elaboration.

This algorithm's core module involves assigning the corresponding estimated values to the relevant land use/soil valuation classes. The mechanism for retrieving and joining data from the table is based on an SQL query. Due to the technical difference between the simplified form of data collection in the input table and the method of designating land use/soil valuation classes stemming from the regulatory framework (Regulation, 2021), it was necessary to identify the conditions for converting attribute values.

The operation of the estimated values module should result in assigning an attribute containing a positive integer to every object of the land use/soil valuation class. This was a criterion for verifying the correctness of the assignment. Failure to meet this condition is equivalent to one of the following errors related to the input data:

- incorrect designations in the layer of land use/soil valuation classes
- failure to include at least one land use/soil valuation class in the resolution on the comparative estimation of land value (applicable to the type of land use/soil valuation classes present in the layer representing the consolidated object in question).

An error, signalled by an appropriate message, results in an emergency interruption of the procedure. Should this be the case, it is suggested that the unique attribute values of the designations of land use/soil valuation classes in the input layer be verified and compared with the provisions of the adopted resolution, after which the tool should be restarted. In special cases, if justified, the control mechanism can be modified, and the procedure can be allowed to continue despite an incomplete assignment.

The land use/soil valuation class layer with the attached attribute of estimated value is exported as the outcome of the procedure after successful validation. However, for the correct implementation of the output in EWMAPA, the algorithm also generates an additional text file containing the definitions of possible designations and values of land use/soil valuation classes in the database. The need to declare a limited dictionary of land use/soil valuation class types prevents the subsequent accidental creation of undesirable objects, which can lead to serious errors due to miscalculation of the value of land for farmsteads. The procedure for generating the configuration file involves the creation of appropriately coded rows containing all the types of land use/soil valuation classes present in the layer, including their possible estimated values.

3. Results

The result of the adopted assumptions, described in detail in Section 2, is a model algorithm, providing the possibility of automated calculation of estimated land values based on a vector layer of land use/soil valuation classes and a table containing their values. The target interface of the tool, supported by QGIS, is shown in Figure 5.

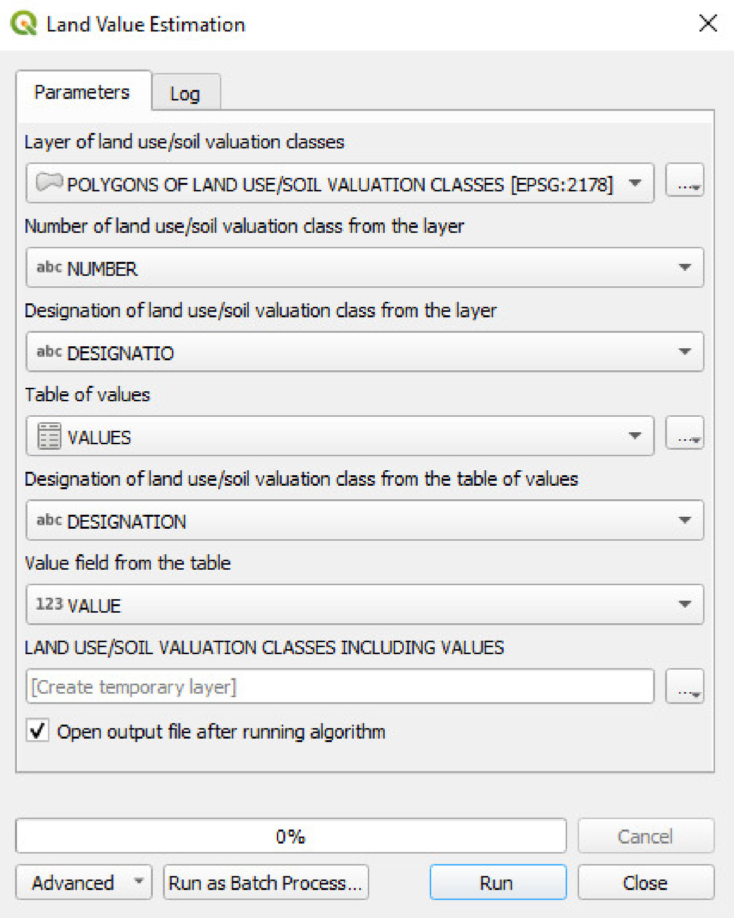

Figure 5. Interface of the self-designed tool supporting the comparative land value estimation. Source: own elaboration.

The correct and efficient operation of the tool was verified based on cadastral data of real consolidation projects. The following analysis describes a representative case of the precinct (village) of Wólka Grodziska, in the Leżajsk district, in Subcarpathian voivodeship (Poland). The entered input data are based on the cadastral database of the land and buildings register updated to the extent of soil class and land use contours. Another essential component of the procedure was a table listing the criteria for comparative valuation of land, compiled based on the resolution of the local land consolidation team.

First, the input data was entered using the tool's interface and the calculation procedure was launched. The result in the form of geometric and use/soil valuation classes with an additional attribute representing the point value per unit of the area [ha] was presented on the map in Figure 6.

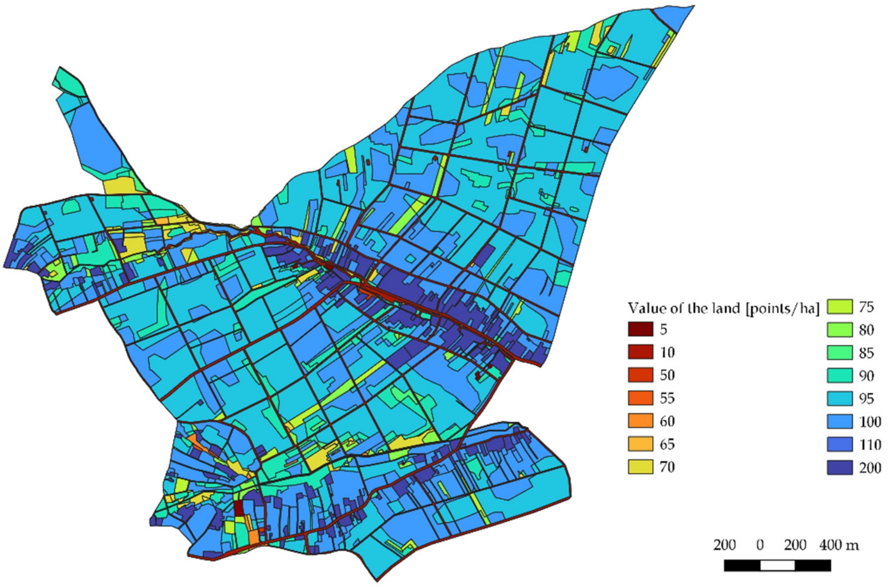

Figure 6. Unit values of land within the village of Wólka Grodziska. Source: own elaboration.

In several seconds' a continuous and complete map of land value for the study area is ready, which can be used as the basis for calculating the land value of existing agricultural holdings and designing new ones based on the value criterion. The explicit spatial differentiation of the unit value of land corresponds with the arbitrary methods of valuation. The highest score (200 points) was recorded, particularly in the central and southern parts of the village in the built-up areas. By contrast, areas with the minimum score (5 or 10 points) are roads and other transport areas. Intermediate scores (50–110 points) in particular refer to agricultural land (arable land, meadows and pastures) with different soil quality classes.

To illustrate the practical applications of the outcomes, the scores were also calculated for particular plots, taking into account their surface area and unit value of respective types of land use/soil valuation classes. Figure 7 contains a graphic representation of the calculated result

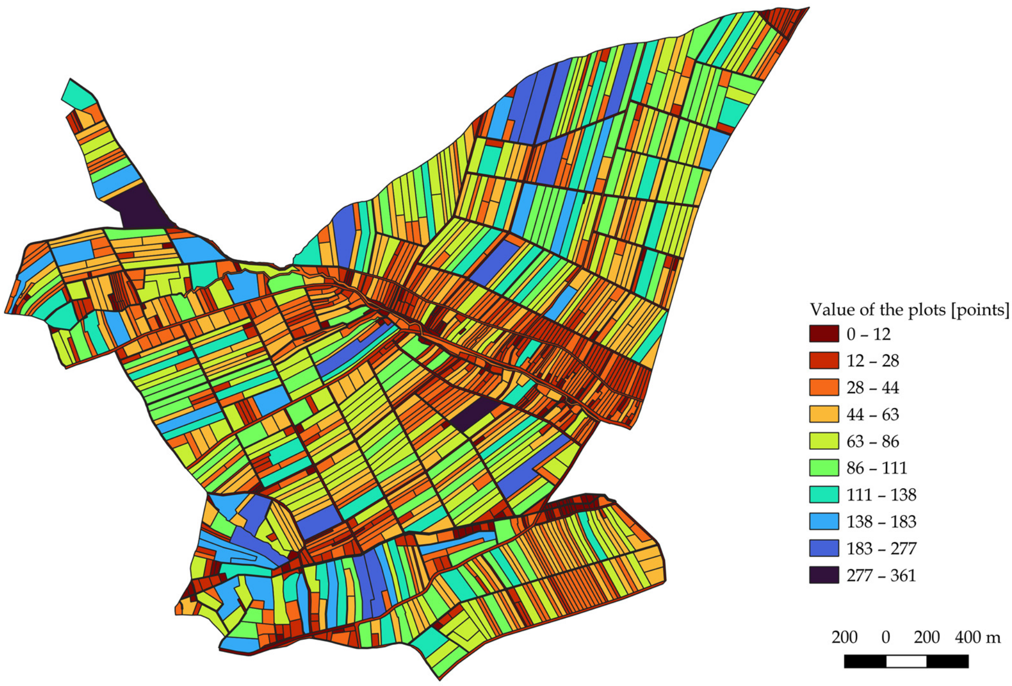

Figure 7. Scores were calculated for plots in the village of Wólka Grodziska. Source: own elaboration.

The calculated value of plots, aggregated by agricultural holdings, is essential for developing the concept of substantively correct and equitable delimitation of land for the respective participants of the land consolidation project.

4. Discussion

The tool, owing to its graphical interface, is user-friendly. The operator selects the files containing source data and indicates attributes describing the numbers and designations of the objects of the vector layer of land use/soil valuation classes and the fields in the table of values containing the types of land use/soil valuation classes and their corresponding estimated values. Running the algorithm initiates an immediate computing process resulting in a set of files compatible with the software used in the land consolidation procedure.

The tool will operate correctly if the input data is technically and substantively correct. In order to eliminate the risk of error, special care is recommended when transferring information on land value from the body of the resolution into the predefined table template. A recommended step before running the algorithm is also to verify the geometric correctness of the layer of land use/soil valuation classes for the presence of undesirable gaps and empty spaces.

An important issue related to the application of the presented tool is how land value is calculated for sites containing areas not subject to the standard comparative value estimation procedure. For such sites, some land can be excluded from the calculation using available algorithms for computing logical differences, or the vector layer can be trimmed. Linking the core algorithm to the GIS environment ensures that datasets and computing procedures can be efficiently adapted to a variety of needs.

Particular strengths of the proposed solution also include an effective error control procedure to eliminate the risk of perpetuating irregularities. The computing module design makes it impossible to skip assigning an estimated unit value to the area of any land use/soil valuation class. It is also impossible to assign different values to objects representing land use/soil valuation classes identical in terms of soil class and land use type by mistake. The mechanism for verifying the correctness of the calculations is simultaneously a tool for controlling the completeness of the provisions of the resolution on the comparative estimation of land value, which is a document with a significant impact on the overall land consolidation works.

The tool evaluation procedure, necessary for its potential implementation, demonstrated the correctness of the technical solutions applied. In the course of testing on eleven sites included in the land consolidation procedure, located in different districts of the Subcarpathian voivodeship, no errors due to faulty operation of the algorithm were recorded. In addition, the pilot application of the algorithm allowed us to detect and correct any inaccuracies early at the stage of interpreting the content of the resolution on the comparative estimation of land value.

After the successful testing phase, the final version of the algorithm was implemented at the Subcarpathian Office of Land Surveying and Agricultural Areas in Rzeszów. The solutions that replaced manual operations significantly accelerated the work at the stage of comparative estimation of land value. The automated procedure also contributed to avoiding potential irregularities, ensuring the superior quality of output data, which is significant to the entire land consolidation and exchange process.

However, for the correct application of the present tool, its limitations, which are mostly due to the specificity of input data and land valuation practice, should be taken into account. The algorithm makes calculations for comparative estimation of land value based only on land use types and soil quality classes. For an extended scope of valuation criteria, it will be necessary to develop supplementary modules or design an alternative tool.

The presented tool is a practical realisation of the demands indicated in the literature, concerning the development of the efficient and unified land valuation method for the purposes of the land consolidation proceeding. The current legal standards determine the general assumptions of the land valuation, however a comprehensive procedure, describing the particular stages of the operations, does not exist. This observation has been supported by Paciorek and Witkowski, who emphasise that the applied method of the land valuation depends on the preferences of the experts performing the works, especially, of the land surveying designer, whose knowledge and experience determinate the assumed strategy of the task realization [52]. In the authors' opinion, the aforementioned state is a phenomenon implying potentially negative consequences. A just land valuation, based on the objective and standarised criteria, is the necessary condition of the proper realization of the land consolidation purposes. Within the presented research, the implementation of the method basing on the current cadastral data in the range of the soil quality and land use form information, has been justified. This method has been suggested by Dudzińska [53]. The authors' tool is a development of the aforementioned concept, providing the unified standard of the data processing and verification and enabling the automatization of the potentially problematic operations.

5. Conclusions

The complex and diverse factors associated with respective operations determine the broadly understood land consolidation efficiency. Solutions that meet contemporary and projected needs should be applied to ensure the desired results in terms of minimising work time while maximising the quality of the outcomes. Latest technological developments and regularly updated know-how make it possible to design solutions for improving the measures undertaken at every stage of the operations.

Estimation of land value, as an element of the complex land consolidation project, is one of the most essential processes during the implementation of such tasks. The substantive correctness of the valuation depends on a reliable and rational determination of the value of particular soil classes, which translates directly into an equitable division of land, conditioning the satisfaction of participants to the land consolidation procedure and the legitimacy of all work undertaken. The proposed tool for calculations necessary in the comparative estimation of land value makes it possible to significantly reduce the duration of work and eliminate potential errors. Modern GIS techniques facilitate calculations directly on geometric data without the need to convert them into numerical data or manually assign values via the interface of the cadastral database management software. The solution, therefore, significantly reduces the number of operations required for the process. Introducing a tool fully automating the operations, and simultaneously checking the correctness of data derived from previous stages of work, is an element of innovative actions with a measurable, practical significance to the rate of work and the quality of deliverables. Analogous solutions implemented at other work stages would allow us to reduce the duration of land surveying and design activities many times, and provide the basis for developing a complex, smart consolidation project management system. We believe that the development and integration of computer-aided tools for land surveying support should be the object of further scientific research in collaboration with potential users of the proposed technologies—institutions in charge of land consolidation and exchange projects. Technological progress to this extent can be created, among other things, by collaboration between local administrative units and research centres, this paper being an example of its deliverables. Coordinated actions oriented toward systematic improvement of the quality of work methods, make a permanent and explicit contribution to sustainable rural development.

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