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SECTION

GEODESY AND MINE SURVEYING

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PRE AND POST LAND CONSOLIDATION LAND FRAGMENTATION ASSESSMENT

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ABSTRACT

Paper describes the usage of fragmentation indexes in condition of Slovak Republic. The aim of this paper is to objectively evaluate the success of new territorial organization after land consolidation (LC) process. Four indexes of fragmentation are methodically evaluated (Shape - SI, Simmons - FI, Januszewski - K and Reduction index - RI) and endurance distance of one owner to its plots is determined in initial and new state. Thus established approaches are unique in Slovak conditions and mentioned parameters are not used in process of LC and other documentation. The comparison of situation before and after proposal of LC uses calculation of consolidation coefficient – KK and the numbers of plots per one owner – N. Calculation and comparison of fragmentation before and after LC project is realized in Veľké Vozokany area (988 hectares) for purposes of this article. The results indicated that new situation after LC project has brought significant decrease of land fragmentation. FI index has increased from the original to the new state by 178 % and the K index by 0.012 %. The average land area has increased by 2 ha. Average number of plots per owner was reduced from 100 to 4. Endurance distance from the municipality center to individual plots and back per one owner was reduced by 347 km. Authors of this article state that these slightly modified measurement procedures of spatial ownership fragmentation are suitable and could help in an objective assessment of the quality of the proposals presented in the LC projects.

Keywords: index, land fragmentation, ownership, shape index, new territorial plot organization

INTRODUCTION

Land fragmentation is according to [1] defined as situation, when the owner owns many plots scattered in the whole cadastral area. Experts [2], [3] consider land fragmentation as serious obstacle to agricultural development, which decreases land productivity by many forms. According to [4] land fragmentation increases transportation costs, decreases infrastructure development, irrigation and drainage development. According to [3] land fragmentation is closely linked to the size of holdings of soil, amount of land belonging to the state economy, plot size, shape of the plot, spatial distribution and the distribution of plots. [2] distinguishes fragmentation of land ownership, land use and the separation of ownership and usage. The degree of land fragmentation can be determined by fragmentation indexes. Fragmentation indexes can be divided into the indexes describing the external and internal fragmentation. Calculations of external fragmentation are based on the principle of calculation ratio of land area to the

perimeter, so called shape metrics indexes. E.g. [5] states this theory in own works. Indexes based on internal land fragmentation (e.g. the percentage of land, which own one owner in one cadastral area, the ratio of the number of parcels before and after the project in relation to the number of owners) define e.g. [6]. Other authors e.g. [7, 8] dealt with setting indexes, which are able to define the degree of fragmentation of land depending on the input parameters defining individual relations (e.g. dispersion of productivity, cultivation benefit, planning costs etc.).

In this article is compared land fragmentation before and after land consolidation project, according to selected indexes of land fragmentation using abroad. The aim of article is to use these indexes in model area of Slovak republic (SR) and to verify results of our work. After that the impact of the effectiveness of land consolidation on the example of a specific owner will be presented.

MATERIAL AND METHODS

Model area of our article is municipality of Veľké Vozokany (Fig. 1). Cadastral area belongs to the administrative-territorial division in the Nitra region, district Zlaté Moravce. Cadastral area has 987 ha (project area has 895 ha), with 536 inhabitants. Area of the interest lies in the catchment area of Žitava river.

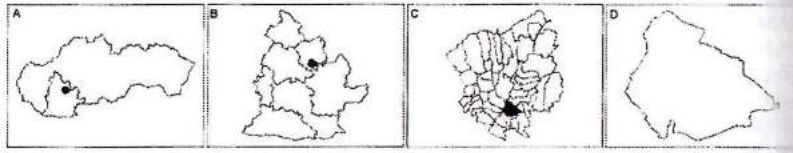

Fig. 1 Study area (position in A) SR and region, B) region and district, C) district and cadastral area, D) border of cadastral area)

Project of land consolidation was conducted in years 2005-2011. Figure 2 displays the arrangement of land ownership before and after land consolidation project. The basic parameters are used by the evaluation the land consolidation project: A) the number of plots per owner, which is determined as common ratio of the number of parcels and the number of landowners. It can be decreased via land reallocation activities during the course of land consolidation and is likely to be the most significant effect of LC implementation. Theoretically, maximum consolidation is achieved when each household had just one plot (= 1). Other indicator of consolidation of fragmented plots is the calculation of B) average number of ownership relations per one owner, which is determined as common ratio of ownership relations and the numbers of landowners. Maximum consolidation is achieved when one owner owns one plot (= 1/1 share, exclusive property). Successful LC is based on the number of ownership relations recalculated to one owner. This procedure is more complex and appropriate.

Short basic information overview of LC project in Veľké Vozokany: Number of ownership relations before LC project was 16 581 and after LC 3 000. The number of owners wasn't changed after LC project. The number of parcels was 4 140 before LC

project and 2 340 after LC project. The average area of one plot was 0.22 ha before LC project and 0.38 ha after LC project.

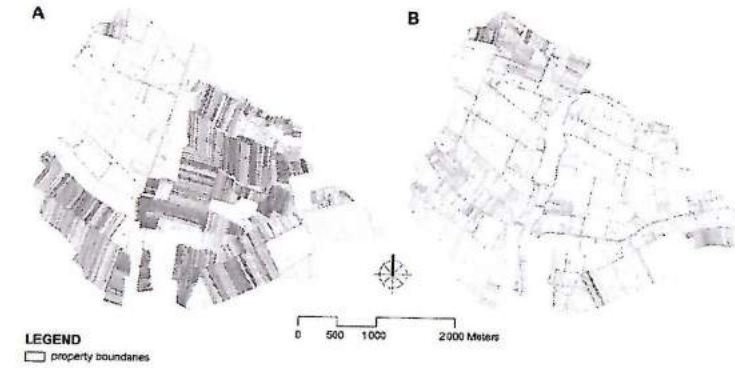

Fig. 2 The comparison of plot fragmentation A) ownership before LC project, B) ownership after LC project

Model area was analyzed by indexes (determination of ownership fragmentation and the success rate of the LC project) used in foreign countries. These indexes are not used in Slovakia by the evaluation of LC success rate. Area was analyzed using complex formulas and based on evaluation of the middle distance.

Fragmentation index (FI) proposed by [11], takes into consideration number of plots in a proportion to the relative size of each plot (1). Values of FI indexes are in the range of 0 to 1. If the index FI equals to 1, it means that the area consists of only one plot. If FI index decreases towards 0, the fragmentation of the territory increases.

$$FI = \frac{\sum_{i=1}^{n} a_i^2}{A^2} \qquad (1)$$

FI – fragmentation index, n –number of plots, a – area of one plot [m^2], A – the whole area [m^2].

Januszewski [11] fragmentation index (K) is based on three basic characteristics: degree of fragmentation is increased in proportion to the number of plots, the degree of fragmentation increases if the proportion of small plots is increased and vice versa and if a number of large plots increases, the degree of fragmentation is reduced along with the quantity of fragmented plots (2).

$$K = \frac{\sqrt{\sum_{i=1}^{n} a_i}}{\sum_{i=1}^{n} \sqrt{a_i}} \qquad (2)$$

K – fragmentation index, n – number of plots, a – area of one plot [m^2].

Reduction index (RI) (3) and LC coefficient (CC) (4) represents the impact of effectiveness of the implemented LC [11]. Reduction index RI (3) is used for simple statistical evaluation of the success of LC projects in Slovakia also as Joying of land plots coefficient (KKV) (5).

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$$RI = \frac{P}{Pc} \quad (3)$$

$$CC = RI \frac{\frac{100}{P}}{\frac{}{O}} \quad (4)$$

$$KKV = \frac{LO}{LOc} \quad (5)$$

RI – reduction index, P – number of plots pre-consolidation, Pc – number of plots post-consolidation, O – number of landowners, KKV – Joying of land plots coefficient, LO – number of ownership relations pre-consolidation, LOc – number of ownership relations post-consolidation

The need of smart endurance distance to plots is closely linked to fragmentation and spatial dispersion. Distance from center of municipality to individual plots (the nearest point of land borders and back with using road network) means spatial dispersion. The value of middle distance has been treated for the state before and after LC project per one selected owner. Selected indexes were processed in geographic information systems.

RESULTS AND DISCUSION

Short ownership relations overview of LC project in Veľké Vozokany: the average number of co-ownership relations per one plot before LC project was 4.01 and after LC 1.28. The average number of owner relations per one owner before LC project was 13.81 and after LC 2.50. The number of parcels per one owner was 3.44 before LC project and 1.95 after LC project. This information refers that number of ownership relations has decreased from initial 15 762 to 3 131 (i.e. about 503 %). These results are interesting: the average number of co-ownership relations per one plot has decreased about 313 %, the average number of parcels of initial state per one owner has decreased about 176 %, the average number of owner relations per one owner has decreased about 552 %. The average area of plot in new state (0.38 ha) shows, that LC project has positive impact to land fragmentation compared with initial state with average area of 0.22 ha. Calculations were processed based on formulas (table 1).

Table 1 Overview of the individual indexes of ownership fragmentation

Indexes	Factors	Pre-consolidation	Post-consolidation
FI	number of plots, area of plots, total area	0.028	0.036
K	number of plots, area of plots	0.00236	0.00243
RI	number of plots, number of owners	1.77	
CC	number of plots, number of owners	3.44	
KKV	number of ownership relations	5.33	

Calculation of fragmentation using indexes FI and K is presented by number format in the range of 0 - 1. Resulting value defines the degree of ownership relation fragmentation. The value of initial state is 0.028 and new state 0.036 (+0.008) according to FI. The value of fragmentation of initial state is 0.00236 and new state 0.00243 (+0.00007) according to K. The resulting decimal differences in calculating the degree of fragmentation by fragmentation indexes are not so clear. These differences are calculated for all plots within the cadastral area. Coefficients are more appropriate to use for specific owners and evaluate the quality of proposals with an impact on the individual.

RI has reaches the value 1.77. The declining trend of this coefficient is expected, although we would have expected a greater reduction in the number of plots after land consolidation. Shown state can be justified by high number of owners with small plots and these owners are willing to keep plots despite small areas.

KKV say about the ratio of number of ownership relations in initial and new state. KKV has reaches the value 5.33. The present result is expected. More than 500 % decrease in ownership relations is very significant.

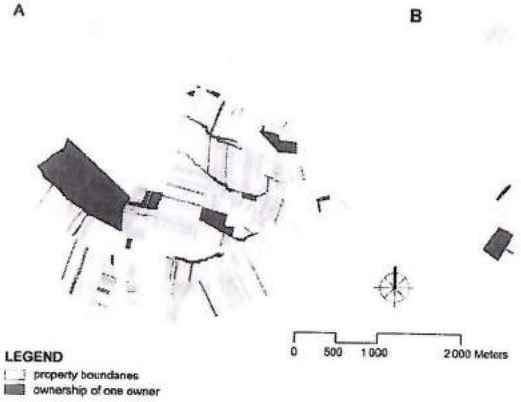

Fig. 3 Comparison of spatial and ownership fragmentation of one owner A) the ownership before LC project – generally in shares, B) the ownership after LC project – generally in exclusive ownership

An example of land fragmentation of one owner states fig. 3A. One owner has own ownership spread in shares in 100 plots in the whole cadastral area in this case. Owner of plots could not farm on own plots in the case of interest in initial state before realization of LC project. He could not farm because plots are not available by mechanisms and he shares ownership with 14 other co-owners (some of them are unknown). This leads to a situation where it is not technically possible to limit ownership share on plot, make geometric plan and record property in C cadaster. These types of plots are usually given to rent of agricultural cooperatives or are sold as whole with financial settlement of individual unit holders (with the agreement of all co-owners). Fig. 3B displays situation after LC project. Owner has exclusive ownership in all newly created plots (share 1/1). The number of plots decreased from 100 to 4 against initial state. This and other characteristic defines table 2.

Table 2 Basic parameters of fragmentation of one owner

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	initial state before LC project	new state after LC project
Number of polygons	100	4
Min. area of plot [m²]	4	91
Max. area of plot [m²]	131 895	74 998
Average area of plot [m²]	9 011	21 265
Average perimeter of plot polygon [m²]	615.43	481.64

The degree of fragmentation per one owner has the value in initial state 0.1567 and in new state 0.7045 (an increase of 0.5478) according to index K. Similar results were recorded by the calculation FI. Difference between initial (0.0838) and new (0.7876) state represents a value of 0.7038. Both methods of this calculation confirm the effectiveness of the LC projects. Effectiveness is confirmed by the decrease in the number of plots in ownership, thereby the anticipated reduction in the degree of fragmentation is confirmed. This is the main benefit of LC that the owner after land consolidation project expects.

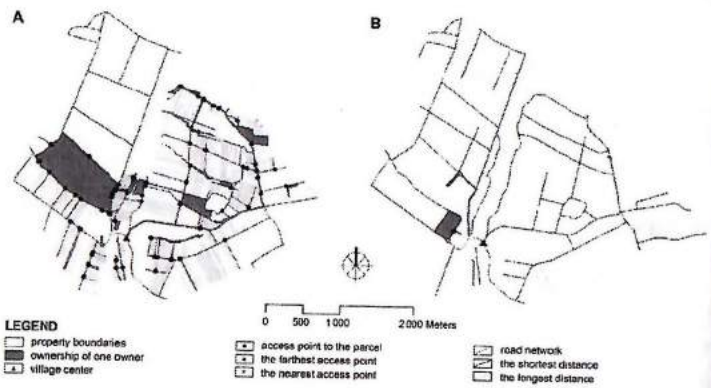

Fig. 4 Endurance distance of one owner A) ownership before LC project, B) ownership after LC project

Fragmentation and spatial dispersion is represented by the calculation of the endurance distance need of owner to plots. Distance of plots, from center of municipality (municipality residential area), is represented by the situation of one owner and illustrated by the significant difference in distance in initial and new state. From fig. 4A is apparent that the high fragmentation of plots has resulted in the rising cost of transport and it is not always possible to use traffic roads. Points represents nearest possible access to plots from the road network. The average distance that must be overcome is 1 771 m (one way). The total distance to be covered to all plots (100) in initial state is 354 199 m (return journey). No road leads to two plots in the northeastern part of cadastral area and the owner of plots is forced to pass through the plots of other owners. Fig. 4 presents maximal transport distance (red point) of 4 263 m from the center of municipality and vice versa the shortest distance (green point) of 432 m from the center of municipality.

The whole return endurance distance is 6 806 m compared with new state (fig. 4B). The closest plot is distant 631 m (one way) and vice versa furthest plot is distant 1 192 m (one way). All plots are accessible by road network in new state after LC project. The difference in endurance distance between the initial and the new state is 347 km in favor of the new state.

As states e.g. [12], measurement of spatial or ownership fragmentation is interesting mainly because of increase and control proposals from land consolidations. New approaches are developed abroad, which solve optimization and quality new proposals using indexes making provision for size combination, shape of plot and quality plot distribution. Similar indexes have not been still developed in process of LC in Slovakia. Verification of selected indexes presented in this paper pointed out to their applicable character also in cases where a large number of small plots enter to the calculation. Applied formula, with using geographic information systems, can be used in the evaluation of parameters of new plots. And thus it is possible to objectively assess whether consolidated process is successful also with large number of inputs.

CONCLUSION

Paper deals with the calculation of land fragmentation in cadastral area Veľké Vozokany pre and post land consolidation project. Calculation of fragmentation by the SI index reached a maximum value of 0.82 in initial state and maximum value of 0.99 in new state. Results of work show that new plots were occurred after land consolidation project. These new plots are more ideal in terms of shape and area, as they were in initial state, as shows SI, which is almost equal to 1. Land fragmentation was particularly reduced after land consolidation project by the indexes FI and K. This fact also document results of FI (initial state – 0.00236; new state – 0.00243) and K (initial state – 0.028; new state – 0.036). Differences in both indexes are more clearly visible on the example of a specific owner. FI (initial state – 0.0838; new state – 0.7876) and K (initial state – 0.1567; new state – 0.7045). Fragmentation situation is also characterized by total endurance distance from the center of municipality to individual plots and back for one owner. Difference in endurance distance between initial and new state is 347 km in favour of a new state.

From outputs of the work resulted, that the measurement of spatial or proprietary fragmentation before and after realization of LC project is particularly interesting because of the strict drafts controls.

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PROCEDURES FOR CHECKING THE GNSS EQUIPMENT

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ABSTRACT

At the moment in Romania there are a total of more than 7000 individuals and legal entities authorized by ANCPI (National Agency for Cadastre and Land Registration) for geodetic, photogrammetric, cartographic, cadastre and land registration works [4]. According to ANCPI standards there are regulated minimum technical conditions necessary for authorization including types and performances for geodetic and topographic equipments. At the national level the State Legal Office of Legal Metrology (BRML), which is in charge of the National Institute of Metrology (NIM) acts as a representative institution for metrology and ensures the accuracy and consistency of measurements performed in different public activity areas. NIM it is the official institution dealing with the realization, preservation and dissemination of units in Romania, in accordance with the requirements of Mutual Recognition Arrangement of National Measurement Standards and National Calibration Certificates issued by national institutes of metrology [6]. BRML includes in its structure the Market Supervision Inspection Service and has primary responsibility for ensuring the realization of national market surveillance activities [5]. BRML activity it is based on government decisions No. 711/2015 establishing the conditions for placing on the market of measuring instruments and No. 1660/2005 regarding the approval of legal metrology instructions. One of the most spreaded geodetic technology it is the GNSS technology including GNSS receivers and antennas. Recognizing the need for specifications on best practices for GNSS positioning more countries have developed a number of standards for geodetic and surveying control, including GNSS equipment working in static or kinematic mode. An example of procedure for checking GNSS RTK equipment it is the ISO (International Organization for Standardization) - "Optical instruments and mechanical - procedures for testing geodetic and terrain of the instruments" - ISO-17123- (1-8), 2012. The ISO 17123 part 8 standard refers to the GNSS RTK measurements and data analysis procedure for verification of such equipment. At present in Romania this procedure it is not yet implemented and a case study was performed at Faculty of Geodesy from Technical University of Civil Engineering Bucharest and the results are presented.

Keywords: GNSS, equipment check, procedure, ISO

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