University of West Hungary

Theses of doctoral (PhD) dissertation

# GEOINFORMATICAL METHODS IN LAND CONSOLIDATION

János Katona


Sopron
2016

**Doctoral School:** Pál Kitaibel Doctoral School of Environmental Sciences
**Head of the Doctoral School:** Prof. Dr. Kolláth Zoltán

**Program:** K4 Geoinformatika
**Head of the program:** Dr. Czimber Kornél

**Supervisors:** Dr. Pődör Andrea, Dr. Czimber Kornél

**Scientific Background and Objectives**

Although, the agricultural suitability in Hungary is prominently favourable, the present land fragmentation structure - due to the distribution of compensational and proportionality ownership happened in the 90s'- does not favour the competitive agricultural production. Therefore it is essential to consolidate land on the basis of a complex approach that can be carried out with the help of Geoinformatics.

In Hungary land consolidation lacks a plenty of preconditions. The information based decision-making model belongs to these preconditions. This model would be able to optimize the present land structure based on objective aspects. The goal of general land consolidation is to create competitive producing units by changing the relation between land tenure and land use in such a way that it takes account of factors influencing production and suits to long term land development conceptions.

The objective of the present research is to develop a land consolidation methodology with a geoinformatical solution that can be applied in all areas of the country and takes into account land quality, arability, location, relief conditions, environmental sensibility, infrastructural capability and the owners' demands.

**Data and Methods**

The sample area of the research was the periphery of Mesterszállás. The graphical and descriptive data necessary to the research were given by the Ministry of Agriculture and Regional Development with the contribution of the Institution of Geodesy, Cartography and Remote Sensing.

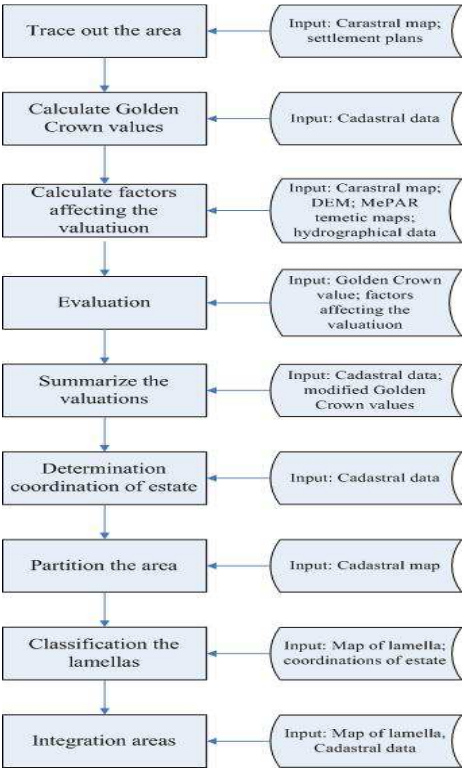
During the research, the following spatial and nonspatial data were used: decoded owner and user data, land registry map, orthophoto, relief model, land cover database and thematic coverage of the Agricultural Land Parcel System

DigiTerra Map software 15.3 toolkit 3.14.2.21 was used for planning.

During the research, internationally accepted statistical data were utilised. Correlation examination supports the parameters of land consolidation based on cluster analysis. Factors affecting the valuation of parcels were determined on the basis of topology of spatial data. The independence of the above-mentioned factors is proven by hypothesis testing. Increasing production efficiency developing from the planning is proven by the indices of the literature (e. parcel index) and the evaluation procedure of the research.

**Results of the dissertation - Theses**

1) The author has analysed the geoinformatical relations of the land consolidation procedure. He has made a proposal for a GIS-Based Decision Support System that aims at the formation of competitive producing units in view of the agricultural and environmental capabilities. He has also summarized the data of the planning.




Publication(s):

KATONA J. (2014): Land Consolidation Based on GIS, 9th International Symposium on Applied Informatics and Related Areas - AIS2014, Óbudai Egyetem Alba Regia Műszaki Kar, Székesfehérvár, 2014. november12., , pp. 49-52.

2) He has analysed the factors affecting the valuation of the soil that are the essential elements of land consolidation. With the help of these factors, he has worked out a soil valuation procedure that is based on spatial data and that matches the environment. The result of the procedure was a kind of value in exchange that means the elemental part of land consolidation. The sigmoid fuzzy function illustrates the factors affecting the valuation:

$$mSig(x, a, c) = (1-)\frac{1}{1 + \exp\left(-\frac{5}{a} * (x - c)\right)}$$

where: c: centre, where gradation is 0,5
a: gradient

| Corrective factors | Parameters | | Bases of evaluation |
|---|---|---|---|
| | a | c | |
| Shape, area, sizet | 2,5 | 0,5 | Area,Perimeter |
| Locations | 27 | 4 | distance from inner belt area |
| accessibility, road conditions | 150 | 25 | categories of connecting roads |
| Relief and gradient conditions | 90 | 0 | category of gradient |
| Irrigation conditions | 5,9 | 1 | distance from irrigational canal |

$$Cummulative\ Correction = \sum_{i=1}^{n} k_i - n * 0{,}5$$

Publication(s):

KATONA J. (2015): The Application of Fuzzy Logic in the Field of Land Consolidation, 10th International Symposium on Applied Informatics and Related Areas (ISBN:978-615-5460-49-4), 2015. Paper P15. 4 p.

3) The independence of factors affecting the valuatiuon has ensured the correctness of valuation method. This independence has been proven by cluster analysis and hypothesis testing.

| Correlation coefficient (r) | Shape, area, size | Location | Accessibility and road conditions | Melioration | Conditions of irrigation | Natural protection |
|---|---|---|---|---|---|---|
| Shape, area, size | 1.0000 | -0.1607 | 0.0276 | 0.1118 | 0.0700 | 0.0788 |
| Location | -0.1607 | 1.0000 | 0.0986 | -0.0288 | 0.0584 | 0.0055 |
| Accessibility and road conditions | 0.0276 | 0.0986 | 1.0000 | 0.0368 | -0.0859 | 0.0324 |
| Melioration | 0.1118 | -0.0288 | 0.0368 | 1.0000 | 0.0914 | -0.0136 |
| Conditions of irrigation | 0.0700 | 0.0584 | -0.0859 | 0.0914 | 1.0000 | -0.0561 |
| Natural protection | 0.0788 | 0.0055 | 0.0324 | -0.0136 | -0.0561 | 1.0000 |

Hypothesis testing: $H_0$: r = 0 ; $H_1$: $\rho \neq 0$

The t- statistics are > t0.05, $\infty$ in all cases, therefor the alternative hypothesis can be rejected. Verifiable, that the correlation between the variables significantly differently on level 0-95 %.

Publication(s):

KATONA J. (2015): Fuzzy logika alkalmazása a birtokrendezés területén, Országos Geoinformatikai Szakmai Továbbképzés összefoglalója, ISBN: 978-615-5460-54-8, pp. 21-30.

4) He has analysed the function of DigiTerra Map Land Consolidation algorithm and he has also made a proposal for a more effective solution that would match better the owners' demands (determination of coordination, establishment)

He has found a consequence among weighting parameters, the number of iteration, the number of parcels and owners and the accuracy of distribution. Therefore he has stated that it is not practical to carry out a large number of iteration for the optimal planning. The reason for this is that a large number of iteration can reduce the accuracy of distribution but it does not considerably raise fragmentation and the shape factor of the parcels.

5) The author has illustrated the integration of spatial data, a novel valuation of parcels and the applicability of land planning modul with the help of a sample area. Internationally accepted statistical indices and complex indices have been introduced to prove the effectiveness of land planning modul.

| | Starting point | Planning on the basis of parcel | | Planning on the basis of lamella | |
|---|---|---|---|---|---|
| | | with centre of gravity | with coord. of estate | with centre of gravity | with coord. of estate |
| Number of parcels | 508 | 309 | 243 | 497 | 325 |
| Parcel per capita | 6.120 | 3.723 | 2.928 | 5.988 | 3.916 |
| Index according to Simmons | 0.678 | 0.720 | 0.750 | 0.725 | 0.756 |
| Index according to Januszewski | 0.749 | 0.785 | 0.814 | 0.764 | 0.791 |
| Index according to Igozurike | 1.081 | 0.600 | 0.299 | 0.942 | 0.531 |
| Accuracy of distribution | | 0.994 | 0.919 | 0.999 | 0.996 |

The research shows that planning on the basis of lamella does not per se provide a real solution for optimal planning, it is necessary to give the sufficient distribution coordinations of premises and land.

**The practical applicability of the results**

The results can be applied in both direct and indirect ways to carry out land consolidation. A direct way can be the value in exchange based on spatial data, the algorithm that implements the planning, and the change management of land cadastral. The analysis on the sample area (e. the independence testing of factors affecting the value) the results of the planning (e. thematic maps, fragmentation indices) can contribute to the social acceptability of land consolidation

**Publications**

*Printed or electronic notes:*

KATONA J. (2010): A mezőgazdasági úthálózat birtokrendezési vonatkozásai,. Új Magyarország Fejlesztési Terv, Társadalmi Megújulás Operatív Program (TÁMOP) 4.1.2-08/1/A-2009-0027, Nyugat-magyarországi Egyetem Geoinformatikai Kar, „Tananyagfejlesztéssel a GEO-ért", BRTI16, 14 p.

KATONA J. (2010): Birtokrendezési tervek adatbázisának kiépítése, Új Magyarország Fejlesztési Terv, Társadalmi Megújulás Operatív Program (TÁMOP) 4.1.2-08/1/A-2009-0027, Nyugat-magyarországi Egyetem Geoinformatikai Kar, „Tananyagfejlesztéssel a GEO-ért", BRTI17, 21 p.

*Degree thesis*:

KATONA J. (2009): Ingatlan forgalmi értékének megállapítása, Szakdolgozat, NymE-GEO, Székesfehérvár, 55 p.

KATONA J. (2011): Térinformatikai szemléletű birtokrendezés, Diplomaterv, NymE-GEO, Székesfehérvár, 73 p.

KATONA J. (2014): Korszerű földhasználat tervezése különleges rendeltetésű területeken, Szigorlati dolgozat, Nyugat-magyarországi Egyetem Erdőmérnöki, Kar Kitaibel Pál Környezettudományi Doktori Iskola, 23p.

*Proceedings of international conferences in foreign language:*

HOROSZNÉ G. M. – KATONA J. (2010): The methods of landscape ecology researches, Corvinus Regional Studies, 2010. I. volume/2-3. issue

MANSBERGER R.- SEHER W.- GOMBÁS K.- KATONA J - NYIRI J.- PŐDÖR A. (2011): Geoinformation in der Össterreichischen Ländlichen Neuordnung, In: Erwin Hepperle; Robert W Dixon Ghough; Thomas Kalbro; Reinfried Mansberger; Kim Meyer-Cheh (szerk.), Core-Themes of land Use Politics: Sustainability and balance Interests: Im Auftrag der. 400 p. Zürich: ETH, 2011. pp. 321-331.

MIZSEINÉ Ny. J., HOROSZNÉ G. M., UDVARDY P., KATONÁNÉ G. K., KATONA J. (2012): Complex eco-environmental study on urban area of Székesfehérvár. International Scientific Conference on Sustainable Development & Ecological Footprint (NymE TÁMOP 4.2.1/B), Proceedings, ISBN 978-963-334-047-9, 8 p.

KATONA J. (2014): Land Consolidation Based on GIS, 9th International Symposium on Applied Informatics and Related Areas - AIS2014, Óbudai Egyetem Alba Regia Műszaki Kar, Székesfehérvár, 2014. november12., , pp. 49-52.

UDVARDY P., MIZSEINÉ Ny. J., HOROSZNÉ G. M., KATONÁNÉ G. K., KATONA J. (2014): Complex eco-environmental study on urban area of Szekesfehervar, JOURNAL OF GEODESY AND CADASTRE (ISSN: 1583-2279) Nr.17.: pp. 153-160

KATONA J.(2015): Land Cover Systems as Effective Means of Decision–making Process, Integration Geo-spatial Information Technology and its Application to Resource and Environmental management towards GEOSS, Székesfehérvár, Hungary, January 19-17, 2015, ISBN 978-963-334-211-4, pp. 143-146.

KATONA J. (2015): The Application of Fuzzy Logic in the Field of Land Consolidation, 10th International Symposium on Applied Informatics and Related Areas (ISBN:978-615-5460-49-4), 2015. Paper P15. 4 p.

*Publication in Hungarian periodicals:*

MANSBERGER R., SEHER W., MIZSEINÉ Ny. J., PŐDÖR A., KATONA J., KATONÁNÉ G. K. (2010): A térbeli adatok és a korszerű kommunikációs technológia a birtokrendezés szolgálatában, Acta Agraria Kaposváriensis, ISBN 1418-1789. pp. 241-258.

HOROSZNÉ G. M. – KATONA J. (2010): Tájökológiai kutatások módszerei, Corvinus Regionális Kutatások, 2010. I. évf., 2-3.szám, pp. 43-50.

KATONA J. – HOROSZNÉ G. M. (2011): Térinformatikai szemléletű birtokrendezés, Az elmélet és a gyakorlat találkozása a térinformatikában II., Térinformatikai konferencia és szakkiállítás, Debrecen 2011, ISBN: 978-963-318-116-4, pp. 251-258.

UDVARDY P., MIZSEINÉ Ny. J., HOROSZNÉ G. M., KATONÁNÉ G. K., KATONA J. (2012): Városok öko-környezetének vizsgálata, Városok öko-környezetének komplex vizsgálata a Nyugat dunántúli Régióban, Nyugat-magyarországi Egyetem Kiadó, Sopron pp. 37-57.

KATONÁNÉ, G. K. –KATONA, J. (2013): Földhasználat változások összehasonlító vizsgálata választott modell területeken Kínai Népköztársaságban és Magyarországon. IGIT project (PIRSES –GA-2009-247608). Tájtudomány-Tájtervezés. V. Magyar Tájökológiai Konferencia. Konferencia kiadvány. Nyugat-magyarországi Egyetem, Erdőmérnöki Kar, Erdővagyon-gazdálkodási és Vidékfejlesztési Intézet, Tájtudományi és Vidékfejlesztési Intézeti Tanszék. Sopron. ISBN 978-963-334-102-5.

UDVARDY P.- KATONA J. (2014): Nemzeti vidékstratégia és a birtokrendezés, Térinformatika 2014, Óbudai Egyetem Alba Regia Műszaki Kar, Geoinformatikai Intézet, Székesfehérvár, ISBN 978-615-5460-27-2, pp. 155-164.

KATONA J. (2015): Fuzzy logika alkalmazása a birtokrendezés területén, Országos Geoinformatikai Szakmai Továbbképzés összefoglalója, ISBN: 978-615-5460-54-8, pp. 21-30.

*Conference lectures in foreign language:*

UDVARDY P. –KATONA J (2008): Land use changes and land consolidation in Hungary, 2008. november 28., Fuzhou

KATONA J.- MIZSEINÉ Ny. J.- PŐDÖR A. (2014): Computer-aided land consolidation in Hungary, Cultural Landscapes in Rural and Urban Areas, European Academy of Land Use and Development 4th International and Interdisciplinary Symposium, 2014. szeptember 3-5., Krakow

KATONA J. (2014): Land Consolidation Based on GIS, 9th International Symposium on Applied Informatics and Related Areas - AIS2014, Óbudai Egyetem Alba Regia Műszaki Kar, 2014. november12., Székesfehérvár

KATONA J. (2015): The Application of Fuzzy Logic in the Field of Land Consolidation, 10th International Symposium on Applied Informatics and Related Areas

*Conference lectures in Hungarian language:*

HOROSZNÉ G. M. – KATONA J. (2011): Térinformatika a hidrológia és a földhasználat területén, GIS OPEN konferencia, Székesfehérvár 2011. március 16-18.

KATONA J. (2012): Térbeli döntéstámogatás lehetőségei a birtokrendezésben, GIS Open Konferencia Székesfehérvár, 2012. március 12-14.

KATONA J. (2013): Térinformatika a birtokrendezésben, MFTTT Workshop, Székesfehérvár, 2013. november 20.

MIZSEINÉ Ny. J., HOROSZNÉ G. M., UDVARDY P., KATONÁNÉ G. K., KATONA J. (2014): Adatspecifikáció, adatgyűjtés és elemzés társadalmasítási célokra a TÁMOP- 4.2.2C-11/1/KONV-2012-0015 projektben, MFTTT Workshop, Székesfehérvár, 2014. március 19.

KATONA J. (2014): A birtokszerkezet-fejlesztés lehetőségei hazánkban, GIS Open Konferencia Székesfehérvár, 2014. április 15-17.

KATONA J. (2015): Fuzzy logika alkalmazása a birtokrendezés területén, Országos Geoinformatikai Szakmai Továbbképzés összefoglalója