

Parcel analysis for the general application of remote sensing monitoring

János Katona
Óbuda University Alba Regia
Technical Faculty
Székesfehérvár, Hungary
katona.janos@amk.uni-obuda.hu

Abstract— The control of agricultural subsidies in the EU is strictly regulated. The satellites provide relevant and complete free and open data which allows monitoring of all agricultural areas in the Member States. However, narrow parcels are not suitable for inspection. Areas smaller than 0.3 ha and narrower than 10 meters should be excluded from monitoring, as recommended by the EU. The article explains how to determine the shape factors of parcels for accurate analysis.

Keywords— *shape factor, remote sensing monitoring, geoinformatics*

I. INTRODUCTION (HEADING I)

Monitoring of agricultural subsidies were traditionally carried out at the place in question. However, GIS-based analysis of satellite imagery has allowed remote sensing of support. The goal is to fully automate the monitoring of all parcels while reducing the rate of on-the-spot checks. Member states can voluntarily introduce the new system, which is going to take 3 years. All advanced techniques can be used, but Sentinel satellite imagery is recommended. Sentinel-2 can be used to separate soil and vegetation, to determine the characteristics and phenological status of vegetation, and to delimit non-agricultural areas. Sentinel-1 can be used successfully to determine the structure, volume and moisture content of vegetation and to examine the structure of the soil. Only aspects that cannot be controlled by monitoring require classic on-the-spot verification. Areas smaller than 0.3 ha and narrower than 10 meters should be excluded from monitoring, as recommended by the EU. Due to the fragmented ownership structure in Hungary, thousands of parcels do not fulfill this condition. [1][2]

According to the 2010 land use registry, on the average [3]:

- the number of land parcels used by a private person is 4.44 pieces
- the size of land parcels used by a private person is 9.54 hectares
- the number of land parcels used by professional farmers is 39.42 pieces
- the size of land parcels used by professional farmers is 296.38 hectares

Bipolar land structure can be found in Hungary: there are either small land holdings or large land holdings; there are no medium sized agricultural holdings (See Table I). In the last few years it has become better and better and more and more farms over 50 hectares have been made. The rate of large land holdings belongs to the lowest in the European Union. With its 3,9 % Hungary is behind the average of 11 %. Nowadays

there are about 3,3 million landowners who have 2 hectare agricultural field and 1 million acquire incomings from land renting.

Although Hungary is below the EU average in terms of average farm size (Fig. 1.), screening of non-controllable parcels may be necessary in other Member States.

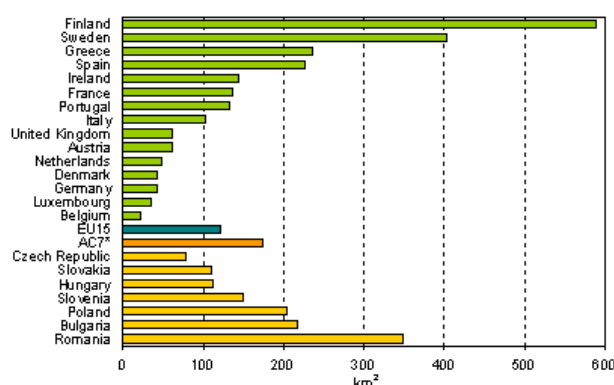


Fig.1. Average size of non-fragmented land parcels [4]

II. METHODOLOGY

A. Shape factor

The size and shape of the parcel also play an important role in evaluating the land. On the basis of experience, the shape and size factor influence the market value of a parcel by $\pm 10\%$. Area is an objective, well-defined attribute. However, width is no longer a clear category, as most of the land is not regular rectangular. A study [5] gives the following definition of the parcel shape:

$$\text{Shape factor} = (\sqrt{\text{area}}/\text{perimeter}) * \text{area}^{0.1} \quad (1)$$

B. Limit calculation

Considering the average Hungarian land structure, both area and form influence the final score in the equation. This dimensionless number can be used to filter out parcels that are unsuitable for monitoring. If the shape factor of a parcel is less than 0.21, the parcel is 87.6% likely to be unsuitable for remote sensing monitoring. This threshold is based on a set of 1000 data series. The area is between 0.2 and 0.4 hectares, with a trunk of no width between 7 and 12 meters from the randomly issued mark.

If the shape or area is incorrect, the metrics in the table will have "1". If the area index or the width index is set to "1", the complex index is also set to "1". The shape factor index takes on "1" if it is less than 0.21. The parity between the shape and the complex index is shown by "Parity". Its average value after analysis of 25 different datasets is 72.44%.

TABLE I. EXCERPT FROM THE 1000-PATTERN DATASET.

Nr.	Area [hectar]	Width [m]	Shape factor	Index of area	Index of width	Komplex index	Index of shape factor	Parity
534	0.22	10	0.22	1	1	1	0	0
535	0.32	12	0.23	0	0	0	0	1
536	0.39	9	0.16	0	1	1	1	1
537	0.29	11	0.22	1	0	1	0	0
538	0.37	9	0.16	0	1	1	1	1
539	0.20	7	0.16	1	1	1	1	1
540	0.21	11	0.25	1	0	1	0	0
541	0.22	11	0.24	1	0	1	0	0
542	0.36	7	0.13	0	1	1	1	1
543	0.25	8	0.17	1	1	1	1	1
544	0.25	8	0.17	1	1	1	1	1
545	0.36	11	0.20	0	0	0	1	0
546	0.40	10	0.18	0	1	1	1	1
547	0.23	9	0.20	1	1	1	1	1
548	0.23	9	0.20	1	1	1	1	1
549	0.38	8	0.15	0	1	1	1	1
550	0.36	7	0.13	0	1	1	1	1
551	0.26	10	0.21	1	1	1	1	1
552	0.21	10	0.22	1	1	1	0	0
553	0.24	12	0.25	1	0	1	0	0
554	0.38	10	0.18	0	1	1	1	1
555	0.36	12	0.22	0	0	0	0	1
556	0.24	9	0.19	1	1	1	1	1
557	0.21	10	0.22	1	1	1	0	0
558	0.30	11	0.21	0	0	0	0	1
559	0.28	10	0.20	1	1	1	1	1
560	0.30	11	0.21	0	0	0	0	1

III. ANALYSIS IN THE SAMPLE AREA

Hungarian Ministry of Agriculture has merely provided the data of Mesterszállás for the analysis. This village is on the Great Hungarian Plain. It is 42.92 km² and its population is 702 people. 508 land parcels have been involved in the planning.

Shape factors were calculated for all plots of the sample area (Fig. 3.). As a result of the analysis, 25 of the 508 plots are not suitable for remote sensing monitoring based on the index. Therefore 4.92% of the parcels require field inspections. This is also confirmed by the separate inspection of the parcels (Fig. 2.).

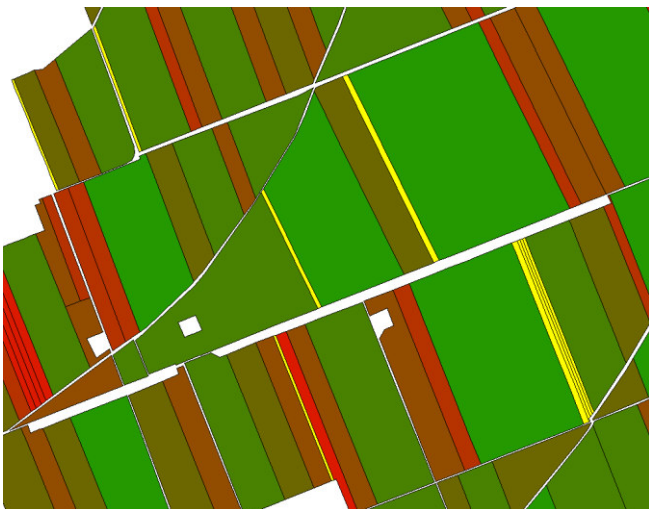


Fig. 2. Selection of parcels with a shape factor of less than 0.21

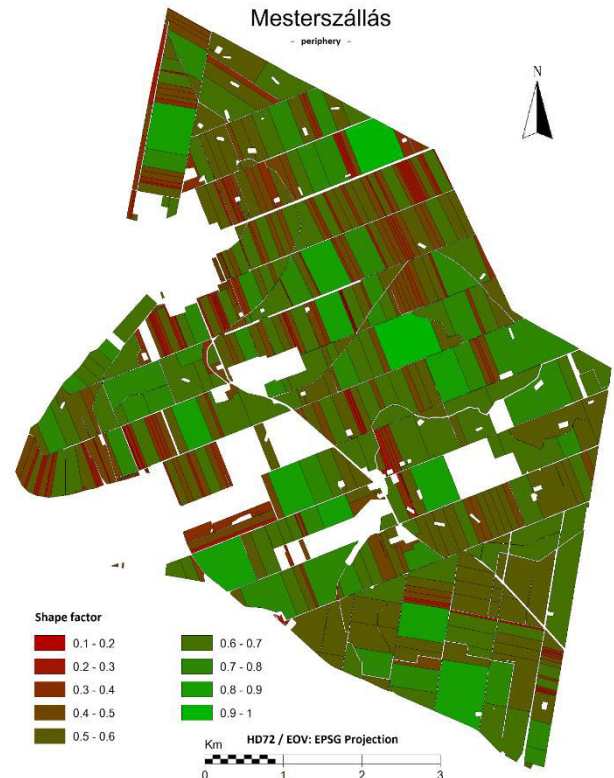


Fig. 3. Shape factor of parcels in the sample area

IV. CONCLUSIONS

There is a tendency to automatically check agricultural subsidies based on satellite imagery. However, not all parcels are capable of remote sensing control. The objective and fast method of GIS based shape factor calculation helps decision making. Based on the results presented in this paper, the shape factor, which is used to evaluate parcels, can be used to filter out parcels unsuitable for remote sensing monitoring.

REFERENCES

- [1] COMMISSION IMPLEMENTING REGULATION (EU) 2018/746 of 18 May 2018 amending Implementing Regulation (EU) No 809/2014 as regards modification of single applications and payment claims and checks
- [2] Dorgai L. et al.: A Magyarországi Birtokstruktúra, A Birtokrendezési Stratégia Megalapozása, Agrárgazdasági tanulmányok 2004. 6. Szám, Agrárgazdasági Kutató Intézet, Budapest, p.199., 2004.
- [3] Ripka J.: Az agrártárca hosszú távú földbirtok-politikája, Háttéranyag, Vidékfejlesztési minisztérium Földügyi Főosztály, FF/1744/2011.
- [4] European Environment Agency: Average size of non-fragmented land parcels, AC-7 refers to the ACs shown in the graph, 29 Nov 2012.
- [5] Katona, J; Gulyas, Margit Horoszne: Determination of factors modifying land value based on spatial data, In: Drótos, Dániel; Vásárhelyi, József; Czap, László; Ivo, Petrás (szerk.) Proceedings of the 19th International Carpathian Control Conference (ICCC 2018) Piscataway, Amerikai Egyesült Államok : IEEE, pp. 625-628. , 4 p. 2018.