ASSESSMENT OF CHANGES IN USING THE AGRICULTURAL LAND RESOURCES BASED ON DIGITAL SATELLITE SCENES AND AERIAL IMAGES

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ABSTRACT

The presented thesis deals with detection of changes in using the agricultural land resources in the area of Oravská Polhora village cadaster based on aerial images and digital satellite scenes. A part of the thesis presents description of the area, period of mapped years, their changes, on going influences and current possibilities of utilization. In this part we focus mainly on the development of agriculturally used area and its influence on the surrounding environment. Having compared the current economic possibilities in the country on the basis of grant controlled data with the first mapped period, we got an image of agricultural land resources development. The next part describes approaches to data classification of distance earth research based on multispectral image scenes with a very high resolution.

Key words: Remote sensing, changes detection, object-oriented classification

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INTRODUCTION

The availability of aerial measure images and their alternative digital satellite data with very high resolutions (VHR) enables to gain information in regular intervals. Wide database generation about the monitored areas, mainly e.g. in the areas with agricultural land resources (ALR) extensibility brings possibilities of monitoring the development of these changes, specific characteristics and their possible utilization.

Quantitative and qualitative information about objects and phenomena from the image recordings remote sensing are evaluated by different photo - interpreting procedures. These changed very quickly according to data availability and evaluation necessity. The traditional methods of photo-interpreting based on pixels (i.e. pixel - based or per - pixel) are categorized into particular image elements on the basis of their spectral characteristics (Sviček M., Mišková M. 2012). However, the objects in the images with a high resolution are characterized not only by spectral pattern, specific texture but also by mutual coherence which is possible to utilize by processing the images using the method of object oriented classification (Tuček J. 2003). Detection of changes of land cover focused on agricultural land in the part c. a. (cadastral area) of village Oravská Polhora represents the period of last 64 years. The choice of the area and time horizons represent breakthrough periods in the agricultural land development determined by social and economic changes.

MATERIAL AND METHODS

The methods are based on monitoring the changes in intensity of ALR utilization in the example of a part of Oravská Polhora village in chosen time intervals (table 1). The main part of the thesis lies in mapping the landscape structures - it means biotope special identification. The disposition of groups of elements depended from processing the individual time horizons in the model area. The elements of current landscape were divided into five basic groups. Within these there are elements of historical landscape and the number of identified ones was thirty - one. Secondary landscape structure elements are characterized according to Bedrna Z., et al. (1992), modified by Miklós Z., Izakovičová L. (1997).

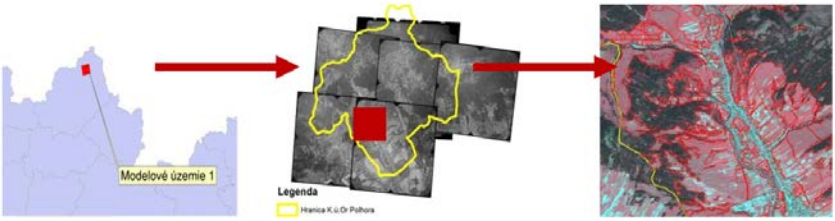
Tab. 1 *Basic data of model areas*

Name of Location	District	I.time zone	II. time zone	III.time zone	IV.time zone	V. time zone	Area in ha
Oravská Polhora	NM	1949	1970	1992	2002	2013	1378.22

The individual groups of landscape elements within 1949 until 1992 were divided into smaller subgroups that contain specific types of landscape elements. Landscape elements within 2004 and 2013 were set beforehand and taken from the LPIS project and divided into groups in a way that they comply with the legend. The statistic and source step was processing the aerial images from 1949. Satellite scenes from 2013 show the overall change in the period of 64 years (fig. 1). The landscape structure elements in aerial images were identified by visual interpretation using interpreting characters (shape, size, tone of grey, sample).

Methods of remote sensing recorded a significant move when classifying data mainly in the availability of digital VHR. The satellite scene in the thesis was used while evaluating the last time horizon using a method of semi - automatic classification. This method enables to create linked hierarchy of segments in different resolution levels which is the same as in visual classification (Stanková H., Čerňanský J. 2004). On the basis of the set procedures, the image was processed in chosen programmes (Erdas Imagine, ESRI ArcMap and eCognition) in a way that the evaluation

meets criteria of selecting the chosen elements. Review of methods and procedures for each type of classification can we found for example, in Schiewe J.2002, Jensen J. 2005, and others.



Source: VUPOP

Fig. 1 The procedure of processing steps from left to right: (area localization, aerial images, satellite scene)

The process of object-oriented classification was run in the eCognition software where the process was formed in five steps:

- Import of input image and other secondary layers
- Creation of image objects by multilevel segmentation
- Creation of classification classes hierarchy
- Own classification process
- Export of output vector layers

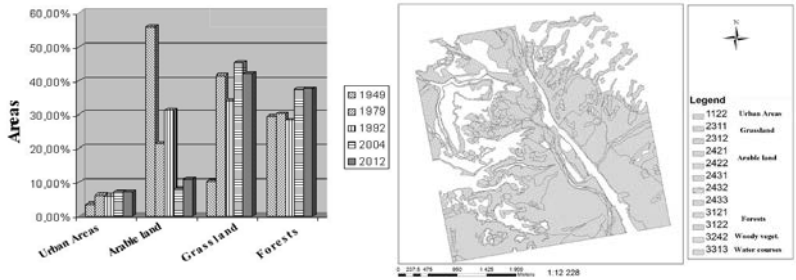
At first it was necessary to divide the image into "homogenic" parts representing objects and then apply the classifying model. Obtaining the objects, i.e. dividing the image data in geographic and marked space is based on segmentary algorithms (Sviček M., Mišková M. 2012). There exist some approaches and they are based on different homogeneity definition approach. By using the resultant classifying method multilevel segmentation was used where the model was modified by so called hard or soft classifiers. The resultant groups were exported in the .shp format and completed with the recent data.

After having obtained the particular landscape element areas and after their fusion in a way they create coherent and compact image, the measures were set and they showed their overall representation within the modeled area. Digitalization outputs, i.e. maps regarding the area representation and development of landscape elements changes were covered by maps of morphometric analysis that show the cause of changes in this location.

RESULT AND DISCUSSION

The village Oravská Polhora belongs to districts with very small agricultural production. In the structure of agricultural land area, there are mainly meadows and grazing grounds that form up to 57.11 %, while the arable soil only 15.64 %. The modeled area with 1378.22 ha is one of few areas where in 1949 the majority was the arable soil 55.47 % and the area of permanent grass vegetation decreased under 10 %. From 1949 until 1970 the majority of agriculture area was formed by fragments of small line fields especially in flat and suburb areas. During 1949 until 1992 arable soil formed 30 % out of the overall area. From 1992 until 2004 the proportion of these areas

significantly decreased to 10%. The area of permanent grass vegetation has not changed within the last 4 monitored years. At present, these areas form more than 40 % especially in mountain areas and in the areas with a high terrain gradient.



Source: VUPOP

Fig. 2 Processing procedure from left to right: (graph of results in changes, map of overall changes)

An interesting finding was the change of country landscape between 1949 and 1979. The mosaic of small fields (41.34 %) which dominated during the first time period before collectivization during the second time period almost vanished (0.55 %). The process of change in mosaic fields into multiareal parts of arable soil (8.35 %) and permanent grass vegetation (41.53 %) was formed by a change in proprietaries after the Second World War when bigger agricultural units were created. Recent changes, e.g. in 2004 and 2013 had no such significance. The landscape image has been kept up to the present with only some small changes. Landscape elements of permanent grass vegetation represent similar percentage over 40 % and form a significant dominant of the particular area.

The results of the object - oriented classification are, in comparison with the results of classic classifying methods, less "broken", i.e. they can be interpreted more easily although they would require further generalization for different applications. However, in some cases sensitive recording of small areals (Fig. 3) and difficult border formation could be an advantage, e.g. when using classification results for ecological landscape assessment (Stanková H., Čerňanský J. 2004).

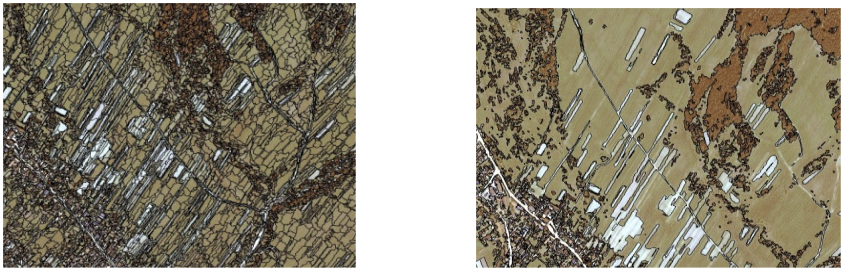


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Fig. 3 Examples of image without classification (from left) and with classification

On the basis of the last satellite image from the part of village Oravská Polhora for 2013, out of the overall number 113 of cultural parts with the area of 590.23 ha there were mostly abandoned 22 cultural parts with the area of 29.44 ha. These parts with the majority of cultures of arable soil and permanent green vegetation were deleted from the LPIS register based on their long - term

unutilization. Extensibility of the agriculture landscape, mainly in the suburb areas near forests is caused mainly by variability of the mountain terrain, steep slopes and inaccessibility.

CONCLUSIONS

In the end, it is possible to assume that black and white aerial images are almost as precise in obtaining information about landscape as the satellite scene. In the thesis, different interpreting methods are presented using the example of digital satellite scenes from the campaign of grant control of agriculture for 2013. The data results from object - oriented classification were successfully used while identifying the agriculture land in the model area. Classification was done in eCognition software. In general, the procedure can be considered as semi - automatic. It was necessary to add visual interpretation to some of the classification steps. The supposed utilization of the full automatic classification can be used only in limited form. The main procedure was the sequence one using hierarchic classification model. Solving the set problematics, it is possible to obtain better results by combining the object - oriented classification and visual interpretation than using only automatic or visual interpretation.

It is clear from the obtained results that since 1949 the landscape has significantly changed. The overall area of changed element groups represents 89 % of the area. The researched area can be included into areas of limited potential of economic utilization although its picturesqueness. There are only limited possibilities for agricultural production and on the other hand, there are good conditions for forest industry. The character of the area partially limits urbanization and building possibilities. Currently, only one fourth of the agriculture soil (10.85 %) is formed by arable soil, mainly in the centre of the area. The majority of the area is covered by productively permanent grass vegetation - meadows and grazing grounds (40.98 %). Forest industry is a significant and most natural form of resource utilization of the nature here, with the percentage up to 38 %.

REFERENCES

BEDRNA, Z., MIKLÓSZ, L., IZAKOVIČOVÁ, Z., ŠTEFEK, J. et al., 1992: Analysis and synthesis of sub - components of landscape structure. Slovak Technical Library, Bratislava, 95 pp.

JENSEN, J.R., 2005: Introductory Digital Image Processing: A Remote Sensing Perspective. New Jersey, Prentice Hall, 526 s.

MIKLÓSZ, L., IZAKOVIČOVÁ, Z., 1997: Country as a geosystem, SAV Bratislava, 152 pp.

SCHIEWE, J., 2002. Segmentation of high-resolution remotely sensed data - concepts, applications and problems. Geospatial Theory, Processing and Applications: Proceedings of ISPRS Symposium in Ottawa.

STANKOVÁ, H., ČERNANSKÝ, J., 2004: Object - oriented classification of land cover in Chopok - Jasna. Cartographic leaves 12.

SVIČEK, M., MIŠKOVÁ, M., 2012: Options spatial identification of abandoned agricultural land in the pilot areas of object - oriented automatic classification of remote sensing. Scientific work 34, ISBN 978-80-89128-98-3.

TUČEK, J., 2003: Specific methods of digital processing of remote sensing materials with high spatial resolution capability for forestry, In.: Geoinformatizácia cartography, Proceedings of the 15. cartographic Conference, Zvolen .280 - 293 pp.