HAL open science

Monitoring changes in agricultural landscapes of Central Europe, Hungary: application of ILWIS GIS for image processing

Polina Lemenkova

To cite this version:

Polina Lemenkova. Monitoring changes in agricultural landscapes of Central Europe, Hungary: application of ILWIS GIS for image processing. XII th International Conference on Geoinformatics - Theoretical and Applied Aspects, National Academy of Sciences of Ukraine, May 2013, Kiev, Ukraine. 10.6084/m9.figshare.7434197.v1 . hal-02021978

HAL Id: hal-02021978

https://hal.science/hal-02021978v1

Submitted on 22 Mar 2019

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Distributed under a Creative Commons CC0 - Public Domain Dedication 4.0 International License

Polina Lemenkova

Monitoring changes in agricultural landscapes of Central Europe, Hungary: application of ILWIS GIS for image processing

Введение (Introduction)

The research aim is application of GIS and spatial analysis of satellite images for agricultural mapping. The study area is located in Mecsek Hills, Hungary. These landscapes represent unique part of Hungarian environment in the Carpathian Basin. Diverse landscape structure with complex biogeographic composition characterizes this region. However, this region is intensely used in agriculture, which causes high land heterogeneity.

The research method consists in using ILWIS GIS and Landsat TM satellite imagery (1992, 1999 and 2006). The methodology includes clustering, spatial analysis, interpretation and classification. Clustering algorithm is based on the analysis of the similarity of the spectral signatures of pixels, and grouping pixels into thematic categories of classes of the land cover types in study area.

This paper contributes to the development of the agricultural monitoring in region of central Europe. The distribution of the landscapes in the Mecsek Hills area was analyzed. Land cover types were interpreted by association of pixels on the image to different thematic classes: vegetation, categories of agricultural land and other areas (in total, 12 classes). The results consists in thematic land cover maps of the study area in 1992, 1999, 2006 showing landscape dynamics.

Метод и/или Теория (Research Problem)

The study area is located in Mecsek Hills, a low mountain range in the south western part of Hungary, encompassing area of 46°6′0″N, 18°5′0″E. Geographically, the region is located to the north of Pécs city and surrounded by the Transdanubian Hills, Hungary

The Mecsek Hills is a unique region of the Hungarian environment. Its central European location specifies distribution of diverse landscape types, formed under conditions of transitional climatic settings, mixed from sub-atlantic to sub-mediterranean ones. However, recent climate changes and anthropogenic influence (intensive agricultural activities) affect local land cover patterns. Thus, in the past decades there is considerable increase in the extreme hazardous climatic events the Carpathian Basin, which includes droughts and water shortage. At the same time, Hungary is highly exposed to flood hazards. The vegetation coverage is the most vulnerable and least resisting landscape element with the most rapid response to external changes. For instance, in the period of 1961-2005, the aboveground net primary production dropped from 67% to 49% (Kohlheb and Krausmann, 2009). A new hydrological and climatic conditions trigger evolution of landscapes and cause landscape dynamics (Huszar *et al*., 1998).

Besides natural and climate factors leading to the environmental landscape changes, there are human-caused impacts mostly of socioeconomic character, that largely influence Hungarian land use system. Thus, changes in landscape structure were caused by the industrialization of agriculture in the period of 1961–1989, and restructuring of a new economy in the late 1990s to 2000s.

Примеры (Methods)

The data used in the current research is the Landsat TM imagery. The data for the current research have been downloaded from the Global Land Cover Facility, Earth Science Data Interface website. In the current work we used orthorectified Landsat TM data files in Geographic Tagged Image-File Format (GeoTIFF) acquired over the area of Mecsek region, Hungary. While downloading, the mask for selected region has been defined by a box with coordinate 45º00'N – 47º00'N; 17º00'– 19º00' E. The captured images have a time span of 14 years: 1992, 1999 and 2006. The acquisition time of the image scene is important characteristics, since diverse agricultural areas, vegetation and other land cover types are distinguishable by their unique spectral signatures that vary according to the growth season. The images were stored as raster file in .img format, then imported into raster map format (ASCII). After converting, each image contained collection of 7 Landsat raster bands. The pre-processing of the imagery included data import and visual settings of colors and contrast

enhancement, in order to improve quality of image and visibility of lines. To sharpen the image and improve color contrast, stretching filter was applied to the bands. Various compositions of Landsat band channels were applied (false color, pseudo natural and true colors composite), in order to find out the best visualization for the images, and the optimal one has been chosed for images processing.

The classification method used in the current work is based on general remote sensing principle: each pixel on a multichannel image, such as Landsat TM, has a spectral signature defined by the reflectance of the DN of this pixel in each spectral band. Multispectral clustering is an iteration process of unsupervised classification which extracts information about values of the pixels DNs, by analyzing their spectral signatures. The method is named "clustering" since it assigns pixels on the image to clusters, i.e. natural small- to media sized groups of pixels with similar value of DNs (Jensen, 2007). During the classification process the digital cells are measured according to their similarity and assigned into a small number of categories, or clusters.

For the land cover classification the thematic classes were applied, which were initially developed and accepted by Csorna*i et* al. (2008). The pixels were identified for each of the categories and grouped into following land cover categories: 1) Winter wheat 2) Spring barley 3) Maize 4) Maize for ensilage 5) Sunflower 6) Sugar beet 7) 8) Other crops 9) Potatoes 10) Water bodies 11) Not agricultural areas 12) Grassland. After the clusters were grouped, the mapping was performed based on the assignation of each cluster to appropriate land cover class.

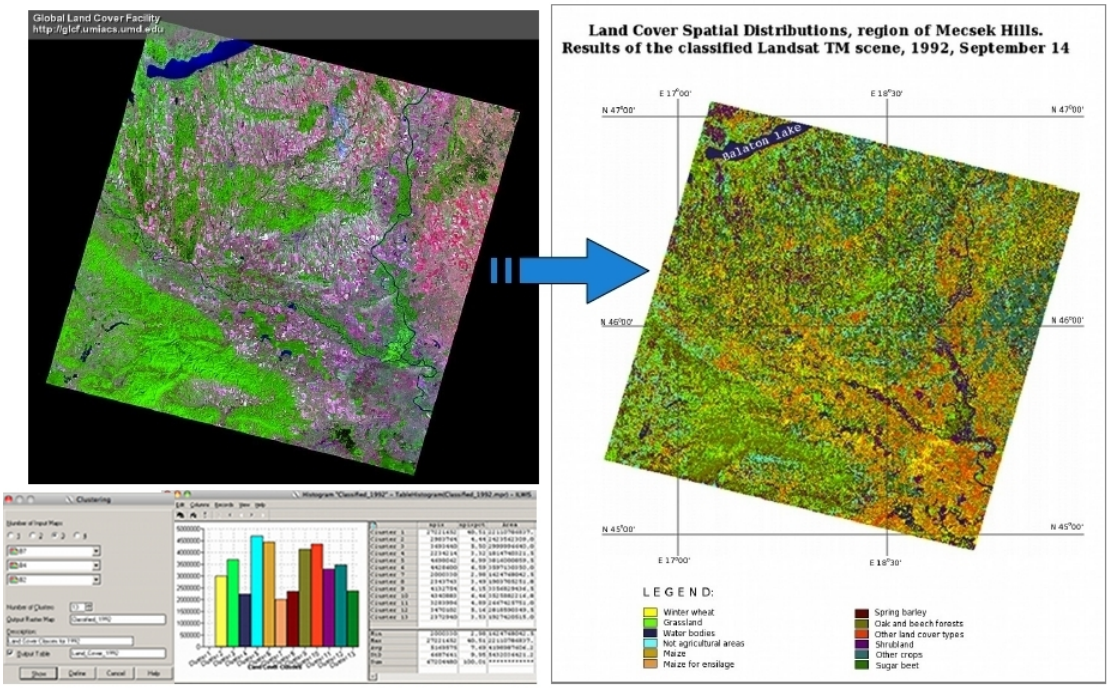


Рисунок 1 *Original image Landsat TM scene taken on 1992, September 14 (left, above), and the map showing classification results (right), performed using Cluster method in ILWIS: land cover classes in Mecsek area. Below: Clustering techniques in ILWIS GIS; Histogram of land cover classes (1992).*

Примеры (Results)

The final results consist in created thematic maps on agricultural land cover types in the study area. The cartographic mapping included creating a legend and layouts. The mapping was performed using results of the cluster classification. After all clusters were defined to a representation class of land cover type, the image of clusters was colored using palette which best represents thematic classes.

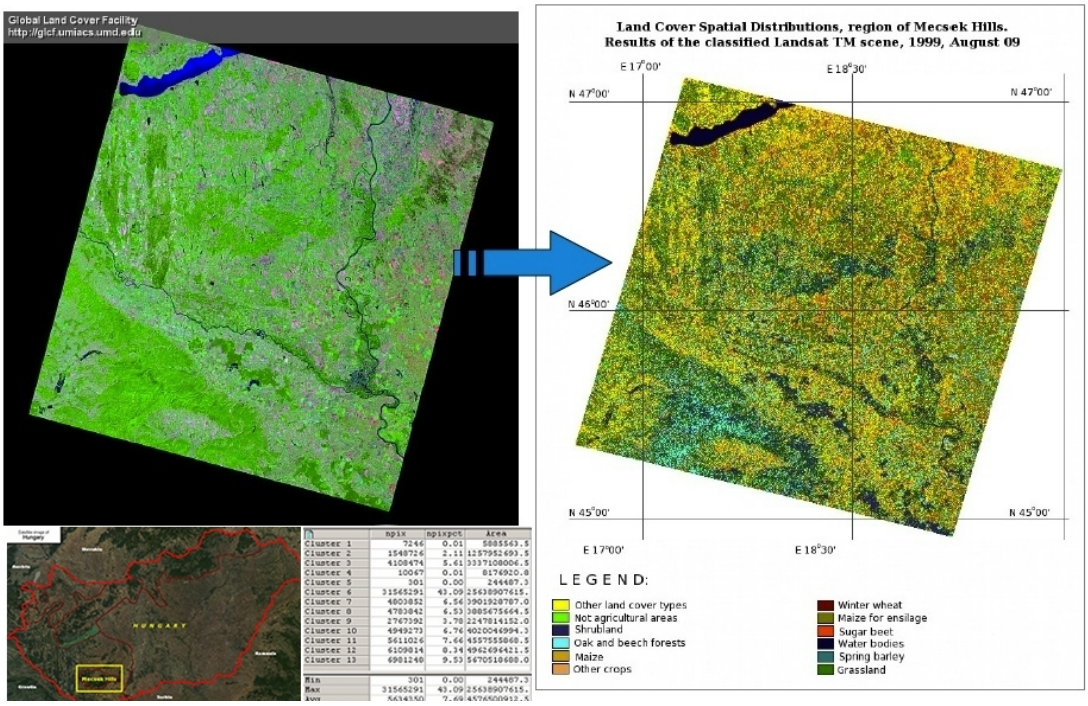
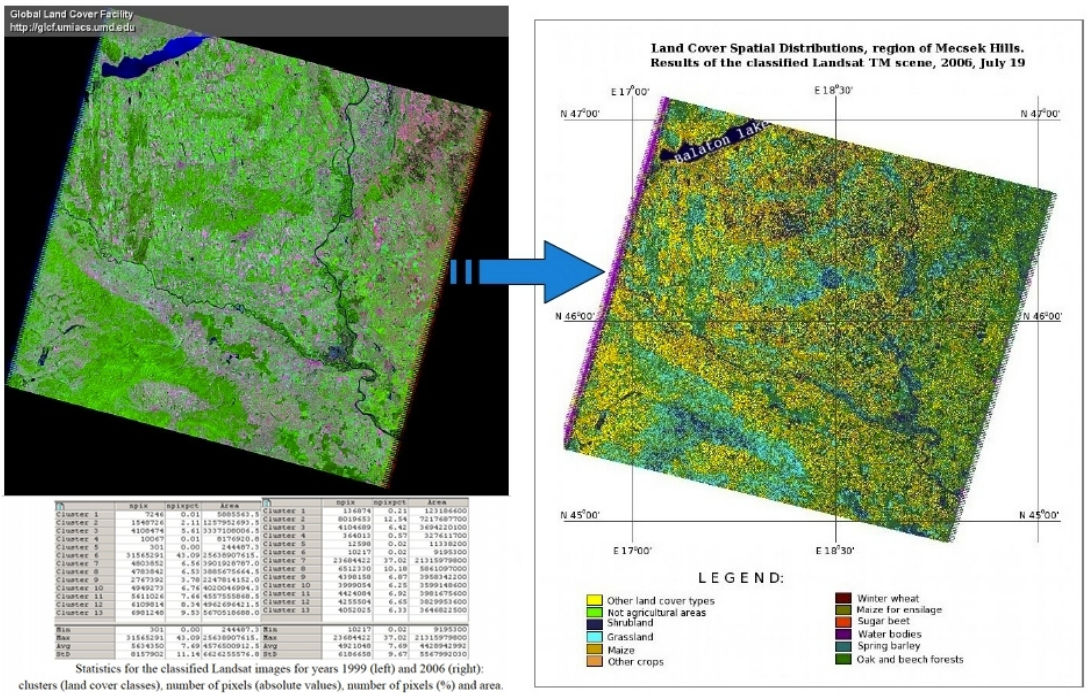


Рисунок 2 *Landsat TM scene (09 August 1999), left, above, and the agricultural map (right). Below: the research area of Mecsek Hills, south-western Hungary; Clustering statistics for scene 1999.*



Statistics for the classified Landsat images for years 1999 (left) and 2006 (right): clusters (land cover classes), number of pixels (absolute values), number of pixels (%) and area.

Рисунок 3 *Landsat TM scene (19.07.2006), left; agricultural map of land cover classes (right). Below: Statistics on pixels classification received in clustering of images dated 1999 and 2006.*

Выводы (Conclusions)

Mapping land surface carried out by means of the GIS analysis of the satellite images, is a right solution for the agricultural areas, located in hilly areas where land cover pattern is highly diversified and complex, as it is in Mecsek Hills surroundings. Spatial analysis of land cover types in agricultural areas for diverse periods may assist to identify environmental changes in the landscape structure.

Using remote sensing data, e.g. Landsat TM imagery or other scenes with higher resolution, has great potential for the land cover studies and environmental mapping in agriculture (Wulder *et al.* 2008). Practically it has possibility of application towards such thematic fields as landscape mapping, desertification assessment, agricultural monitoring and disaster detection (e.g., deforestation).

In this paper an ILWIS GIS approach towards land cover analysis and mapping is presented. The research methodology is based on the clustering classification technique. The Landsat TM images were visualized and classified, and actual land cover types were defined. As a result, three independently agricultural thematic maps covering the same spatial region of south-western Hungary have been created based on the classified images, for years 1992, 1999 and 2006, respectively. The experience of the application of ILWIS GIS and Landsat TM scenes, described in the current work, is a contribution towards agricultural mapping. This work also reports selected technical cartographic functions of the ILWIS GIS. The open source ILWIS GIS software, a program for GIS and remote sensing spatial analysis, is a convenient open source tool with free availability, especially useful for agricultural mapping due to its functionality and logical graphical user interface. Practically, the methodology used in this paper can be tested in other agricultural areas and regions.

Благодарности

The financial support of this research was generously provided by the Balassi Institute, HSB (Hungarian Scholarship Border), Budapest Hungary. Reference No. MÖB/154-2/2011.

Ссылки (References)

Csornai G, Wirnhardt Cs., Suba Zs., Nádor G., Tikász L., Martinovich L., Kocsis A., Zelei Gy., László I., Bognárornai E. [2008]. Cropmon: Hungarian Crop Production Forecast by Remote Sensing. *ISPRS Archives XXXVI-8/W48 Workshop proceedings: Remote sensing support to crop yield forecast and area estimates.*

Huszar, T, Mika J., D. Loczy, D., Molnar, K., and A. Kertész A. [1998]. Climate Change and Soil Moisture: A Case Study. *Physics and Chemistry of the Earth* **24**, 905–912.

Jensen, J.R. [2007]. Remote Sensing of the Environment: An Earth Resource Perspective, 2nd Edition. ISBN-10: 0131889508. Prentice-Hall, Inc.: Upper Saddle River, NJ.

Kohlheb, N., and Krausmann, F. [2009]. Land use change, biomass production and HANPP: The case of Hungary 1961–2005. *Ecological Economics* **69**, 292–300.

Wulder M., White J.C., Goward S.N., Masek J.G. , Irons J.R., Herold M., Cohen W.B. , Loveland T.R., Woodcock C.E. [2008]. Landsat continuity: Issues and opportunities for land cover monitoring. *Remote Sensing of Environment* **112**, 955–969.