Universitatea *Transilvania* din Braşov

HABILITATION THESIS
SUMMARY

**IDENTIFICATION, ASSESSMENT AND MONITORING OF
ENVIRONMENTAL CHANGES USING REMOTE SENSING METHODS**

Domeniul: SILVICULTURE

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BRASOV, 2015

Summary

The Habilitation Thesis synthetically presents the results of research carried out after defending the PhD thesis entitled *The Possibilities of Using Satellite Images in Forest Planning Works*, in 2005 at Transilvania University of Brasov. This thesis is comprised of an abstract, scientific and professional achievements, plans for further career and research development and references.

The increasingly significant changes that occurred in Romanian society after 1989 led to changes in land use/land cover, forest management, and property rights, due to the transition from socialist property to private property, as well as changes in all economic and social fields. Against this background, the purpose of our research was to identify, assess, and monitor these environmental changes, which were determined by various natural and/or anthropogenic causes, using remote sensing methods. In this context, the research focused on land use/land cover changes, those caused by desertification risk, forest changes and those caused by surface utilisation. In order to conduct this research, we used times series satellite images, in which, for comparison purposes, the first year was taken from before 1989 in almost all the periods. The studies were carried out based on *Landsat TM* and *Landsat ETM+* satellite images, and we used as reference data *Ikonos* satellite images, photograms, digital aerial images, and cartographic materials at certain scales (1:5000, 1:2000, 1:1000, 1:500) found in different databases.

Methods for monitoring change employed in our research were: images difference, vegetation indices difference or difference between components of *TC* transformation, *CVA*, *PCC*, and *PCA*. We also resorted to the *DTC* method, the method of correlation between *NDVI* and *LST*, the spectral profile method, and the method of comparison of vegetation indices. Beside the metods specific to remote sensing, the following were used: knowledge of digital photogrammetry, *GNSS*, topography and the information systems specific to the field of activity.

Identification, assessment and monitoring of changes in land use/land cover were performed in Brasov metropolitan area. The research resulted in a study for the period, 1993–2009, covering a smaller surface area and in two studies drawn up with different objectives for the period, 1987–2009, covering the entire metropolitan area. In this area, we analysed the dynamics of changes in land use/land cover by obtaining „from – to" information, as well as the impact of these changes on land surface temperature determined, in turn, on the basis of the thermal band of *Landsat* images. Results showed that after 1989 a significant surface area of agricultural land remained uncultivated or was turned into pasture, and that the surface area covered by constructions increased. Research also showed that there is a negative correlation between *NDVI* and *LST* indicator.

Research into the identification, assessment and monitoring of land cover was carried out between 1987–2011 also within Medias Forest Division, with Copsa Mica town at its centre. Results show that changes in land cover led to a significant reduction of surface areas affected by carbon black pollution and, to a lower degree, by heavy metal pollution.

The assessment and monitoring of desertification risk were studied in Dobrogea using *Landsat TM* satellite images and *MSAVI1*, *MSDI* indicators and the albedo, connected with vegetation conditions, landscape pattern and micrometeorology. As a result of this research, maps displaying six grades of desertification risk were obtained: *non, very low, low, medium, high*, and *severe.* Results show that in Dobrogea, according to rules established for the period, 1987–2011, two grades of desertification risk have an ascending trend, namely *very low* and *medium*. Analysing the causes of the occurrence of desertification risk, we found that the main factor is high temperature that combines with the destruction of forest belts and of the irrigation system, and to a smaller extent, with fragmentation of agricultural land and deforestation in the study area.

Identification, assessment and monitoring of forest changes were carried out concerning windthrows in spruce stands, uncontrolled forest logging, illegal logging and vegetation regeneration. The monitoring of windthrows was performed using two satellite images, *pre-* and *post-event*, both from 2001, when massive windthrows occurred in Sanmartin Forest Division within the Miercurea Ciuc Forest District. Research results showed that, among the used methods, the univariate image differencing (UID) applied to the *TCW* component allowed the identification of windthrows with high precision, while the application of the first principal component on the basis of the *SAVI* index yielded the lowest precision.

Another area where research into forest disturbances was carried out for the period, 1987–2009, was Vlahita in Harghita County. Images were processed using *TC* transformation on the basis of which the disturbance index *DI* was calculated and forest disturbance index maps were drawn up for 1993, 2002, and 2009 as well as for each period. Research into forest disturbances was also performed in Giurgeului Mountains, using a similar methodology. After calculating the *DI* index, the method of difference between *DI* images was applied, and, on the basis of resulting thresholds, disturbance class maps were finally obtained, including three classes: *fragmented*, *nonforest*, and *forest*. Based on those, *10* metrics that characterise landscape and are related to area, edge, shape, and core area were analysed at class level and for each period. Results showed that during 1987–2009, a strong forest fragmentation in the study area took place as a result of uncontrolled forest logging and illegal logging, which eventually led to the loss of the specific forest environment, of connectivity, of the habitat of different species, and to the emergence of bare slopes and surface erosion phenomenon.

In Trotusului Valley, research into vegetation monitoring for the period, 1986–2009, was conducted using the *CVA* method applied to *TCB* and *TCG* components derived from *TC* transformation. Following the processing of satellite images, we obtained maps that show the magnitude and direction of changes in deforestation, regeneration, and persistence of vegetation. Research results show that changes, caused by deforestation and also by regeneration, occurred in the analysed period.

Identification, assessment and monitoring of surface utilisation changes were carried out for two limestone quarries, located on the outskirts of Brasov city, using satellite images acquired in 1984, 1989, and 2009. The results obtained show that the most adequate *RGB* combination for differentiation of limestone quarries from other surfaces with a similar spectral profile, such as asphalt and concrete surfaces, is the combination that includes *NDVI*. Following the analysis of regression, we found that, for the study area, *NDVI, SAVI* and *TSAVI* indices yield approximately the same results.

The evolution of professional and research activity, and the plans for further career and research development are presented in a synthesis that complements this thesis.