

**IMPACTS OF CLIMATE CHANGE ON LANDSCAPES IN CENTRAL EUROPE, HUNGARY\***

The study area is located in Central Europe and focusing on Mecsek Hills, a low mountain range in the south western part of Hungary. The region of central Europe includes complex mix of elements from mediterranean and continental climate, since the area is located in transitional zone of sub-atlantic and sub-mediterranean climate types. 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. The distribution of ecosystems in the region illustrate adaptation of soil properties to actual climate conditions. As determined by the present-day climatic and geomorphological settings, soils in the Mecsek region are rich in nutrients, and landscapes are characterized by various mixed soil types. Brown forest soils predominate on hilltops of Mecsek, while alluvial soils on floodplains [1]. According to the underlying soil types, the landscapes are characterized by mixed vegetation types. The most typical is Pannonian mixed forests of temperate broadleaf and mixed forests, common in Euro-Siberian region. There are also forests of Turkey and hornbeam oak in the catchment area of Mecsek region. The dominating vegetation coverage types on the slopes of Mecsek Hills include beech forests, ravine forests and oaks. Some regions of the Mecsek Hills include unique biogeographic areas with endemic species, not founded elsewhere in Carpathian Basin.

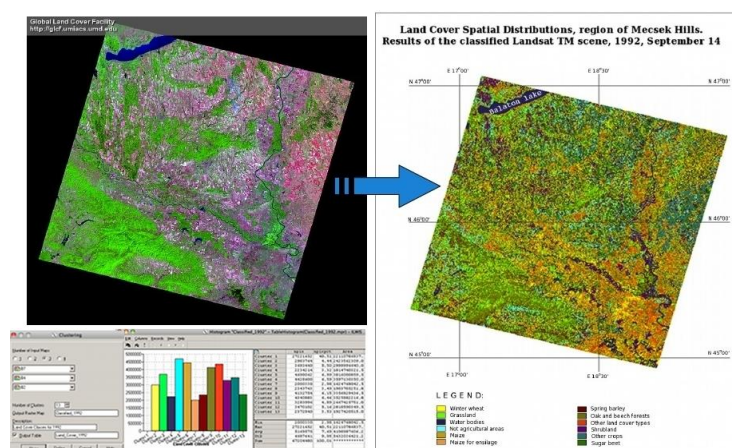
The overall climate change, especially the global temperature increase, controls balance of heat and water budget on the Hungarian landscapes, and has considerable impact on the agricultural landscapes. In the past decades there were changes in climate, detected in the Carpathian Basin region, which illustrate general fluctuations in the climatic settings in Hungary and change of overall average air temperatures [2]. Recently, considerable increase in the occurrence of hazards is detected in Carpathian Basin: rainfalls, drought and heat periods in summer. Climate change makes impact on local soil properties, which affects ecosystem structure. Various ecological factors have impact on ecosystems with different impact factor, according to vulnerability and sensitivity: the main impact have temperatures and precipitation, affecting soil water regime, evaporation and water runoff. The overall impact of various factors make a joint effect on ecosystems structure. Recent climate changes mostly influence regional hydrological regime, e.g. increased temperature warming, regime and intensity of precipitation [3, 4]. Hydrology strongly affect soil properties (texture, moisture), nutrient regime (organic matter content) and fertility. The main environmental problems nowadays in Hungary are aridification and desertification. It is reflected in increased annual temperatures and decreased precipitation [5]. A new hydrological and meteorological balance triggers evolution of landscapes and cause landscape dynamics [6]. Reduced availability of water affects ecosystems. Vegetation coverage is the most vulnerable and least resisting elements of landscapes, with the most rapid response to external changes, like water shortage. Hence, since 1961, the net primary production dropped from 67% to 49% [7]. Recently in the Carpathian Basin there is considerable increase in extreme hazardous events: droughts, water shortage and floods. Driving factor is changes in precipitation distribution in the past decades. The local flood hazard risk can be assessed as moderate to high [8]. Thus, lowlands are potentially exposed to floods, since the majority of river discharge is collected by the runoff from the hills [9], which is intensified by the hazards, and lead to floods. Cumulative effects of environmental, climate and anthropogenic factors (intensive agricultural activities) affect Hungarian landscapes.

Combination of the satellite images with GIS techniques is a key method for land patterns identification and classification of ecosystems. Research methodology is based on the GIS spatial analysis tools and classification of Landsat TM image, which was used for visualizing landscapes. An ILWIS GIS was applied to perform spatial analysis and mapping. The research algorithm is clustering, which classifies pixels with similar value of Digital Numbers (DNs) to thematic classes. As a result, spatial analysis on distribution of land cover patterns was performed. Data processing include image pre-processing, enhancement, classification, spatial analysis and interpretation. A land cover map was created by classifying study area into land categories. The core method used in the current work for the interpretation of imagery is clustering algorithm. This method is based on the remote sensing general principle that each unique pixel on a multichannel image has spectral signature defined by the reflectance of its DN in each spectral band. The DNs of pixels create unique signatures for various objects, distinguishable from other objects. Multispectral cluster classification was applied for the Landsat TM image, by extracting information about values of the pixels DNs, analyzing their spectral signatures. During classification, digital cells are measured according to the similarity of their

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\* Издаётся в авторской редакции.

DNs and assigned into a small number of categories, or clusters. The image was taken in autumn harvest season, to enable best distinguishability of spectral signatures in diverse land areas and vegetation types. The pixels were identified to land cover classes and assigned into thematic categories. As a result, following land types were classified: 1) wheat; 2) spring barley; 3) maize; 4) maize for ensilage; 5) oak and beech forests; 6) sugar beet; 7) other crops; 8) shrubland; 9) waters; 10) not agricultural areas; 11) grassland; 12) other land cover types.



**Figure 1 – Landsat TM image (left) and final thematic map (right) showing land use in Mecsek area. Below: Clustering in ILWIS GIS; Histogram of land cover classes**

Current work demonstrated analysis of climate factors affecting ecological settings of Mecsek Hills, and local landscapes visualized by means of ILWIS GIS and remote sensing data (Landsat TM). The results consist in recognized distribution of land use patterns. ILWIS GIS is a convenient open source GIS, useful for spatial analysis and land use monitoring. Clustering method is useful for ecological mapping, since it enables objective identification of the land types in regions characterized by high land heterogeneity and complex structure, such as agricultural fields mixed with natural land cover types. The experience of Landsat TM imagery processing by means of ILWIS GIS, described in the current work, is a contribution towards agricultural mapping.

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This paper focuses on the environmental monitoring by technical methods of GIS and spatial analysis. The study area is located in south-western Hungary: Mecsek Hills. Study reports ecological aspects of climate change impacts on landscapes. The ecosystems of Mecsek region represent unique part of Hungarian ecology. Located in central Europe, the surroundings of Mecsek have mixed climatic and environmental settings, characterized by diverse landscape structure and complex ecological composition.

At the same time, this region is intensely used in agriculture, which results in complex landscape structure and high land heterogeneity, representing a mix of the agricultural fields with natural ecosystems. Maintaining sustainable ecology of Mecsek area is a priority of the environmental monitoring. The research method is based on application of ILWIS GIS and Landsat TM image for mapping ecosystems and land use types. The image was processed using methods of spatial analysis, interpretation and clustering. The landscapes of Mecsek area were classified to several land cover types. The result is presented by thematic land use map visualizing Mecsek Hills ecosystems.

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# **BIOGEOCHEMICAL CONSEQUENCES OF HABITAT DESTRUCTION AFTER HYDROLOGICAL CHANGES IN POST AGRICULTURAL LANDSCAPE\***

Our goal was to gain a better understanding of the environmental behavior, fate and impact of nutrients, and metals in terrestrial and aquatic systems. These studies contribute to decision support tools (models) for environmental management.

The study sites (the meadows) are in north-eastern Poland, in The Masurian Landscapes Park in the close vicinity of Łuknajno Biosphere Reserve (N53° 48', E21° 34'), within the area of agricultural and forest mosaic comprising the following habitats: a belt of alderwood along the lakeshore, arable fields, fallowed since 1991 and an extensive stretch of forest. In the field sized approximately 120 ha, cereal (wheat, oats, rye, maize) and potatoes were intensively cultivated. In 1991 the land was fallowed and the process of secondary succession has started.

Our main objectives were to (1) assess soil-habitat changes in post agricultural areas (hydrological balance, ground- and surface-water chemistry, physical and chemical features of soil and other habitat features), (2) describe and comprehend successional change in vegetation of new wetland habitats and ponds created by excavation and damming as a result of local ground-water-level raise caused by implementation of small-scale impoundments in different areas of Piska Forest (Natura 2000 Network).

A water quality study was carried out on 20 new created ponds located within post agricultural landscapes. Data obtained from the two years investigations indicated significant differentiation between 20 investigated ponds in water level during a two years. Chemical properties of total N; C; Fe  $\text{PO}_4^{3-}$ ; N- $\text{NH}_4^+$ ; N- $\text{NO}_3$ ) classified the ponds from poor to rich of trophical status level. For example: the average values of P varied from 0.99-2.34  $\text{mg/dm}^3$   $\text{PO}_4^{3-}$ ; the mean average values of Fe varied between 0.34-2.77  $\text{mg/dm}^3$ ; – the mean of N varied between 0.23-0.45  $\text{mg/dm}^3$  N- $\text{NH}_4^+$  and 0.53-1.84  $\text{mg/dm}^3$  N- $\text{NO}_3$ .

Globally, our results suggest that open ponds, with macrophytes concentrated in the deeper layer, can be an effective and sustainable management method of successional changes in post-agricultural landscapes.

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# **ДЕГРАДАЦИЯ ЗЕМЕЛЬ СЕМИПАЛАТИНСКОГО ПОЛИГОНА ВБЛИЗИ НАСЕЛЕННЫХ ПУНКТОВ**

Агробиозологические проблемы на территории Семипалатинского испытательного полигона (СИП) усугубляются в связи с активной хозяйственной деятельностью. Для хозяйствующих субъектов на полигоне нет

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\* Издается в авторской редакции.