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# ASSESSMENT OF THE LAND COVER CHANGES IN THE PLOVDIV REGION FOR THE PERIOD 1990 – 2000 BASED ON CORINE LAND COVER DATA

**Rumiana Vatseva*, Anton Stoimenov** Nevena Borisova****

**Institute of Geography – BAS, **Space Research Institute – BAS*
*Acad. G. Bonchev Street, Bl. 3, Sofia 1113, Bulgaria*
*e-mail: rvatzeva@bas.bg; astoimenov@space.bas.bg*

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***Abstract:*** The CORINE Land Cover 2000 database represents a compatible tool applicable to the assessment of short-term development in land cover changes for the substantial part of Europe. This study is part of the research held in the framework of the joint project between the Slovak and the Bulgarian Academies of Sciences "Changes of the rural landscape in Slovakia and Bulgaria in 1990-2000 identified by application of the CORINE Land Cover data". The aim of the project is to demonstrate land cover changes on case studies, to compare essential differences in the landscape dynamics and to explain regional specific features in development of the rural landscape as determined by different natural and positional conditions and traditions of the social and economic development of both countries. The Plovdiv region is one of the selected administrative units in this study being representative for the lowland and mountainous landscape in Bulgaria. CORINE Land Cover changes are transformed into three class groups: artificial surfaces; agricultural areas; forest and semi-natural areas, wetlands, and water bodies. Quantitative assessment of the short-term changes identified for these three land cover classes is presented with special emphasis on changes caused by human activities.

## 1. Introduction

Satellite image data are nowadays a substantial source of information for spatially distributed land cover and land use data. Land cover/land use maps are an essential inputs to different applications, such as landscape management, natural resources assessment, and, more generally to support economic, social, and environmental policies. A series of studies (Feranec et al., 1997, 1999, 2000 and 2002) and others documented the theoretical-methodological aspects of the application of remote sensing and land cover data to landscape change identification. In this context the CORINE Land Cover (CLC) database (Heymann et al., 1994, Perdigao and Annoni, 1997, Bossard et al., 2000) from various time horizons can be considered as one of the new and important information sources on landscape changes. Definitions of categories of landscape changes based on land cover changes are presented by Stott and Haines-Young (1998) and by Feranec et al. (1999). The direct observation of land cover changes using multispectral satellite data provides the possibility of detecting the main processes of the changes and by inference – of characterizing landscape dynamics (Martens and Lambin, 1999).

In 2005 a joint research project between the Slovak and Bulgarian Academies of Sciences was started focused on assessment of regional differences in the rural landscape changes on selected representative territories. The obtained results about the state and changes of the land cover for the years 1990 and 2000 following the CLC90, CLC2000 and CLC Changes data will be documented in cartographic outputs and statistical tables. Specific features of the ten-year development will be evaluated in the context of social and economic conditions and used as a source material for prediction of trends in the development of the rural landscape for the decision-making and planning bodies in both countries.

During the first stage of the project representative example territories that are characteristic from the point of view of natural conditions and specific socio-economic features of the regional development in Bulgaria and Slovakia are selected. The aim of this paper is to present the results of the spatial statistical analysis of CLCChange database for one of the selected regions for Bulgaria – part of the Plovdiv district.

## 2. Study Area and Data

A part of the Plovdiv administrative region has been selected for the purposes of the investigation as a representative area with lowland and mountainous landscapes and various types of land use. The study area is located in South-Central Bulgaria and includes 15 municipalities of the Plovdiv district: Asenovgrad, Brezovo, Kaloyanovo, Karlovo, Krichim, Kuklen, Maritsa, Parvomai, Perushtitsa, Plovdiv, Rakovski, Rodopi, Sadovo, Saedinenie and Stamboliiski (Figure 1) with total area of 5 133 $km^2$ (513 276 ha).

The central part of the region is fragment of the Gornotrakiyska lowland (Upper Thracian lowland) and it is characterized by plain relief and mainly by agricultural and urban areas. The mountainous landscapes and forests are predominant at the North and the South section of the region, which are occupied respectively by Stara planina (Balkan mountain) and Sredna gora (to the Noth), and Rhodope mountain (to the South).

The land cover changes have been detected using satellite images from Landsat 5 TM acquired on September 27$^{th}$, 1992 (path/row: 183/030) and August 10$^{th}$, 1992 (path/row: 183/031), as well as satellite images from Landsat 7 ETM+ acquired on June 5$^{th}$, 2000 (path/row: 183/030) and June 21$^{st}$, 2000 (path/row: 183/031).

The ancillary data used include: topographic maps (scale 1:25 000 and 1:100 000), thematic maps (Map of the Vegetation of Bulgaria in scale 1:600 000 and city maps in scale 1:5 000) and field work.

## 3. Methodology

The methodology used in the project is developed in the Institute of Geography at the Slovak Academy of Sciences based on the investigations of Feranec et al. (2002) and Otahel et al. (2004). The first methodological step is a selection of comparatively large administrative units of the lowland and mountainous landscape in Slovakia and Bulgaria with similar landscape characteristics. For these territories assessment of the long-term changes is performed according to the natural landscape types. Natural landscape is reconstructed as the hypothetical state of the landscape that existed before human intervention but related to the present climatic conditions. Natural landscape types represent homogeneous bioclimatic and soil/substrate areas with conditions similar to the original forest or forest-steppe landscape. In this sense, their potential for land use is also relatively homogeneous.

The use of natural potential and the character of the present land use are assessed based on CORINE land cover classes in scale 1:100 000. Additional detailed characteristics will be added according to socio-economic functions.

*Figure 1. Study area and Land Cover Classes 2000 in Selected Municipalities of the Plovdiv District.*

Shares of areas of three CLC class groups:

- artificial surfaces
- agricultural areas and
- forest and semi-natural areas, wetlands, and water bodies

are expressed in per cent of the natural landscape. Character of land use (type of cultural landscape): urbanized, recreational and tourist, agricultural, forest and seminatural and

their combinations are determined according to the share of area of the basic CLC classes.

The assessment of short-term landscape changes is based on the land cover changes identified (Feranec et al., 1999, Otahel et al., 2004):

- urbanization (industrialization) - changes of classes of agricultural, forest, semi-natural and wetland polygons (211, ...412) – to classes of artificial surfaces (111, ...142);
- intensification of agriculture (intensive use of agricultural land) - changes of classes 231 and 243 into classes 211, 221, 222, 223 and 242;
- extensification of agriculture - changes of class 211 into classes 231 and 243 and classes 221, 222, 223 into 211, 231 and 243;
- deforestation after felling or calamities - changes of class 311, 312, 313 into classes 211, 231 and 324;
- afforestation (natural overgrowing and cultivation of forest) - changes of classes 211, 231, 321 into classes 324 and classes 324 into 311, 312, 313;

All these data are received by overlay procedures in the CLC databases and processing in the GIS environment. Statistical analysis of the landscape change types is performed according to their areas and number of polygons.

### *4. Results and Discussion*

As a result of this study, a land cover and landscape changes databases are created for the territory of the selected 15 municipalities of the Plovdiv district. The map created in scale 1:100 000 illustrates the spatial distribution of the identified CLC changes reclassified into landscape changes (Figure 2). The CLC level one classes are transformed into three basic class groups for the quantitative assessment of these changes. In 2000 agricultural areas comprise 56.2 %, forest and semi-natural areas, wetlands, and water bodies - 38.1 % and artificial surfaces - 5.8 % of the region (Figure 1).

The land cover changes area for the period 1990 – 2000 amounts to 13 942.9 ha or 2.72 % of the studied surface (Table 1). The number of the “change” polygons (area ≥ 5 ha and width ≥ 100 m) is 107. The obtained data show that the changes of the agricultural areas occupy 2.22 % and the changes of the forest and semi-natural areas include 0.5 % of the investigated part of the Plovdiv region.

*Table 1. Landscape Changes in Selected Municipalities of the Plovdiv District (1990-2000).*

| Type of Landscape Change 1990-2000 | Number of Polygons | Area (ha) | % of changed area | % of studied area |
|---|---|---|---|---|
| Intensification of agriculture | 10 | 570.7 | 4.09 | 0.11 |
| Extensification of agriculture | 43 | 10 826.1 | 77.65 | 2.11 |
| Afforestation | 24 | 805.5 | 5.78 | 0.16 |
| Deforestation | 30 | 1 740.7 | 12.48 | 0.34 |
| **Landscape changes** | **107** | **13 942.9** | **100.0** | **2.72** |
| **Study area** | | **513 276.0** | | **100.0** |

The changes of the agricultural areas comprise 11 396.8 ha or 81.7 % of the total changed area. They are distributed mainly in the Maritsa, Rakovski and Saedinenie municipalities (Figure 2). Two types of changes are observed – extensification and intensification of agriculture (Table 1). The extensification of agriculture includes 10 826.1 ha (77.6 % of the total area of change). This is the largest change compared to all other changes in the studied region. The extensification of agriculture (Table 2) includes mainly the

transformation of rice fields (class 213) into arable land (211), as well as fruit tree plantations (222) and vineyards (221) into arable land (211). The intensification of

*Figure 2. Landscape Changes in Selected Municipalities of the Plovdiv District in 1990 - 2000.*

agriculture spreads on 570.7 ha (4.1 %) and includes the transformation of pastures (231) into arable land (211), as well as arable land (211) into vineyards (221) and fruit tree plantations (222) (Table 2).

Table 2. Changes of the Rural Landscapes in Selected Municipalities of the Plovdiv District (1990-2000).

| Type of Rural Landscape Changes | CORINE Land Cover Changes 1990-2000 | Number of Polygons | Area (ha) |
|---|---|---|---|
| Intensification of agriculture | 211-221 | 2 | 168.3 |
| | 211-222 | 1 | 52.0 |
| | 211-242 | 1 | 82.5 |
| | 231-211 | 6 | 267.9 |
| | **TOTAL:** | **10** | **570.7** |
| Extensification of agriculture | 211-231 | 1 | 40.5 |
| | 213-211 | 15 | 8 767.4 |
| | 221-211 | 6 | 205.4 |
| | 222-211 | 20 | 1 812.6 |
| | 222-242 | 1 | 0.2 |
| | **TOTAL:** | **43** | **10 826.1** |

The changes of forest and semi-natural areas cover 2 546.2 ha (18.3 % of the total changed area), occupying the biggest areas in the Karlovo and Asenovgrad municipalities (Figure 2). Two types of changes are recognized – afforestation and deforestation. The deforestation is the second largest change in the studied region (Table 1). The deforestation area is 1 740.7 ha (12.5 % of the total changed area) and includes the transformation of broad leaved (311), mixed (313) and coniferous (312) forests into transitional woodland scrub (324) (Table 3).

Table 3. Changes of the Forest in Selected Municipalities of the Plovdiv District (1990-2000).

| Type of Forest Landscape Changes | CORINE Land Cover Changes 1990-2000 | Number of Polygons | Area (ha) |
|---|---|---|---|
| Afforestation | 321-324 | 1 | 50.9 |
| | 324-311 | 18 | 606.2 |
| | 324-313 | 5 | 148.3 |
| | **TOTAL:** | **24** | **805.5** |
| Deforestation | 311-324 | 22 | 1 498.4 |
| | 312-324 | 2 | 89.3 |
| | 313-324 | 6 | 153.0 |
| | **TOTAL:** | **30** | **1 740.7** |

The afforestation area is 805.5 ha (5.8 % of the total area of change) and includes the transformation of transitional woodland scrub (324) into broad leaved (311) and mixed (313) forestsq as well as natural grassland (321) into transitional woodland scrub (324) (Table 3). The afforestation and deforestation (natural and human-induced) are determined mainly by the forest management practices (regulated logging and planting).

## 5. Conclusions

The investigation of the land cover/land use in the selected 15 municipalities of the Plovdiv district indicates that in year 2000 the agricultural areas occupy 56.2 %, forest and semi-natural areas, wetlands, and water bodies - 38.1 % and artificial surfaces - 5.8 %.

All land cover changes for the period 1990 – 2000 include 13 942.9 ha or 2.72 % of the studied area. Most of them are changes in the agricultural areas - 81.7 % of the total area changed. The extensification (77.6 %) predominates over the intensification (4.1%) of agriculture almost twenty times during this 10-year period of transformations in the

ownership and use of the agricultural land. The changes of forest and semi-natural areas show that the deforested territories are almost twice bigger than the afforested ones. The afforestation and deforestation (natural and human-induced) are determined mainly by the forest management practices (regulated logging and planting).

The future investigations will be directed to the cause analysis of the detected changes and landscape diversity assessment. The landscape changes will be examined taking into account the changes of population number in the district, the sum of financial means provided (incl. EU funds, PHARE, SAPARD, ISPA), analysis of legal provisions, mortgages, etc. The rural landscape changes will be analysed based on relevant demographic and economic data in time horizons, economic indices, the changes in legislation that might have influenced the land use and land management changes.

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