

LAND USE AND LAND COVER CHANGE IN THE CHEPINSKA VALLEY FOR 30 YEARS PERIOD

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Abstract

The study aimed to identify land cover and land use transformations in the Chepinska River valley over the last 30 years. The total area of the considered territory is 976.86 km². For the main aim of the article, applied methodology is based on Geographic Information Systems (GIS) analysis and assessment. The area is characterized by Artificial surfaces (26.17 km²), Agricultural areas (159.73 km²), Forest and semi-natural areas (770.21 km²), and Water bodies (20.75 km²). Forest and semi-natural areas predominated over the other three classes and occupied over 79% of the study area. This class is represented by the following classes at level 3: Broad-leaved Forest (CLC 311), Coniferous forest (CLC 312), Mixed forest (CLC 313), Natural grasslands (CLC 321), Transitional woodland-shrub (CLC 324), and Sparsely vegetated areas (CLC 333). At the beginning of the considered period, the Forest and semi-natural areas of the total area was 80.74% (788.71 km²), and today it is 78.84% (770.20 km²).

INTRODUCTION

Globally, land cover and land use have been changing very rapidly in recent decades. The main reason is the high rate of population growth, the development of the economy, etc. This, in turn, is the basis for the emergence of several environmental problems: soil and water pollution, increasing the number of landfills, and many others.

Based on the results of that activities, land cover change and land use is an important research topic. Many scientists today use this problem as a basis for their research. Here we will present some of them. Meryem Koncak Doğruer et al. (2023) studied the spatial variation of agricultural land in Turkey by using CORINE data. Malavipathriana et al. (2024) present monitoring and forecasting land use and land cover changes in paddy cultivation. Zhang et al. (2023) analyzed which land cover product provides the most accurate land use land cover map of the Yellow River Basin. Aslan and Koc-San present in their research the relation between the land cover and land surface temperatures and their changes in time. Blay and Abunuyuwah (2024) study the implications of land use and land cover change in Mampong municipality, Ghana. Halder et al. (2024) study the impacts of land use/land cover changes on groundwater resources.

There are also many publications on land cover and land use in Bulgaria (Nikolova et al., 2010; Vatsava, 2012; Stoyanova, 2013; Vatsava, 2015; Petrova, 2016; Gartsyanova, 2016; Gikov et al., 2016; Gartsyanova, 2017; Genchev and Vatsava, 2017; Assenov and Grigorov, 2018; Temelkova, 2018; Petrov and Prodanova, 2019; Vatsava et al., 2020; Temelkova, 2020; Stoyanova, 2020; Vatsava et al., 2020; Belev, 2020; Prodanova, 2020a; Prodanova, 2020b; Temelkova and Varbanov, 2021; Belev, 2021; Temelkova and Varbanov, 2022; Stoyanova, et al., 2022; Temelkova, 2023).

Today, remote sensing and GIS technologies provide new opportunities for studying land cover and land use (Zheng et al, 2012; Vatsava et al., 2016; Mare and Mihai, 2016).

The study aimed to identify land cover and land use transformations in the Chepinska River Valley over the last 30 years (1990-2020), by using the CORINE Land Cover (CLC) database. The research area is poorly studied and publications are few (Gartsyanova et al., 2023; Kolcheva et al., 2023; Varbanov et al., 2023; Tcherkezova et al., 2023a; Tcherkezova et al., 2023b).

MATERIALS AND METHODS

Study area

The Chepinska River Valley is a part of South-Western Bulgaria (Figure 1), where the river runs for 81.7 km from its springs in the Batak Mountain (Western Rhodope Mountain Range) to the confluence into the Maritsa River. The study area covers around 97756.16 ha (976.86 km²).

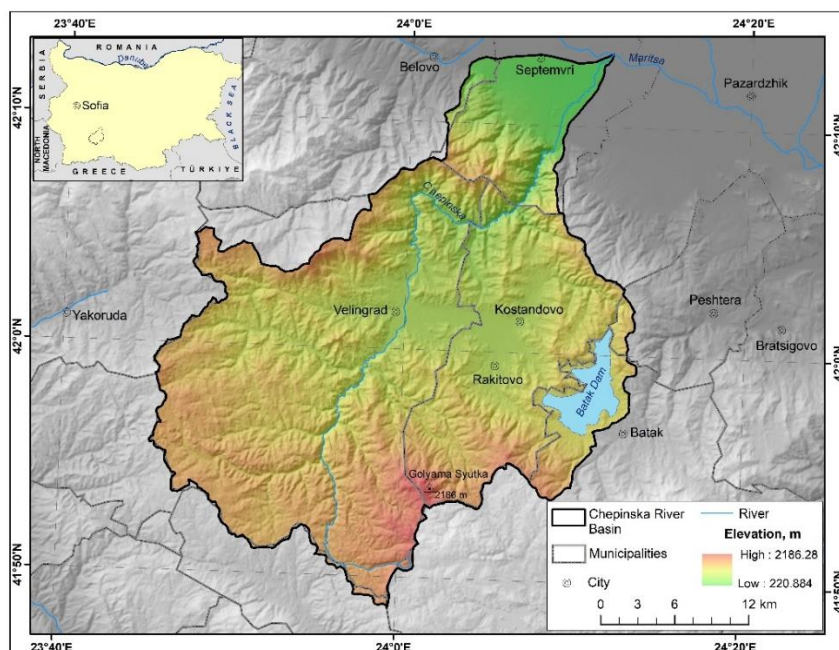


Figure 1. Study area

The climate in the study area is transitional-continental with a mild winter. The annual air temperature amplitude is small. Precipitation has two maximums (July and November) and two minimums (August and February) (Velev, 2002). The area is characterized by a diverse soil cover, represented by dystric (CMd), rendzins (rendzic, LP), rankers (umbric, LPu), lithosols (lithic, LPq), and alluvials soils along the rivers (FAO, 2006).

According to the administrative division of Bulgaria, the study area is divided between the municipalities of Rakitovo, Velingrad, and Septemvri, all within the Pazardzhik District. Leading in the economy of Rakitovo municipality is the secondary sector (industry and construction), followed by the primary sector (agriculture and forestry). In recent years, the tertiary sector (the sphere of services) has also been developing (PIRO Municipality Rakitovo, 2021-2027). For the municipality of Velingrad, the leading economic sector is the tertiary sector (services) 77.6%, 45.2% of which is the trade and repair of cars and motorcycles and 18.7% is the hotel and restaurant industry. In second place is the industry sector with 19.5%, the largest share of which has the processing industry. Agriculture and forestry takes the last place, with a share of 2.8% (PIRO municipality of Velingrad, 2021-2027). The main sectors in the economy of Septemvri municipality are the processing industry, trade, and agriculture. The primary (agrarian) sector is important for the development of the municipality. It provides about 10% of employment in the local economy (PIRO Municipality Septemvri, 2021-2027).

Data and Methods

The changes in the land cover are presented at the third level of the CORINE Land Cover nomenclature. The data used for land use and land cover analysis are vector data from the European program CORINE Land Cover (CLC1990, CLC2000, CLC2006, CLC2012, and CLC2018) for Bulgaria.

The ESRI ArcGIS, ArcMap 10.6.1 software is applied and GCS_WGS_1984 is used as the Geographic Coordinate System and projected to WGS_1984_UTM_Zone_35N in compilation of all of the maps in this survey.

RESULTS AND DISCUSSION

The results of mapping the land cover (level 3) are shown in Figures 2-6, and the names of the classes of the land cover together with their areas are presented in Table 1.

Table 1. Land use and Land cover classes in 1990, 2000, 2006, 2012, and 2018

<i>CORINE Land Cover</i>	Class Code Level 3	1990	2000	2006	2012	2018
		ha	Ha	ha	ha	ha
1. ARTIFICIAL SURFACES						
1.1 Urban fabric						
<i>Discontinuous urban fabric</i>	112	1651.32	1651.32	1808.13	1832.35	1832.35
1.2 Industrial, commercial, and transport units						
<i>Industrial or commercial units</i>	121	420.96	420.96	296.51	302.94	302.94
<i>Road and rail networks and associated land</i>	122	65.42	65.42	62.48	62.80	62.80
1.3 Mine, dump, and construction sites						
<i>Mineral extraction sites</i>	131	34.44	34.44	32.96	26.0	26.0
1.4 Artificial, non-agricultural vegetated areas						
<i>Sport and leisure areas</i>	142	394.13	394.13	393.00	392.99	392.98
2. AGRICULTURAL AREAS						
2.1 Arable land						
<i>Non - irrigated arable land</i>	211	5140.69	5140.69	4868.54	4575.30	4588.71
2.2 Permanent crops						

<i>Vineyards</i>	221	296.49	296.49	189.01	83.48	83.48
<i>Fruit trees and berry plantations</i>	222	304.09	304.09	408.21	251.43	251.42
2.3 Pastures						
<i>Pastures</i>	231	501.97	501.97	280.47	123.05	99.50
2.4 Heterogeneous agricultural areas						
<i>Complex cultivation patterns</i>	242	466.75	466.75	787.12	905.45	915.59
<i>Land principally occupied by agriculture, with significant areas of natural vegetation</i>	243	7463.06	7463.09	9538.22	10034.76	10034.76
3. FOREST AND SEMI-NATURAL AREAS						
3.1 Forests						
<i>Broad-leaved forest</i>	311	17524.23	17479.53	17141.17	17076.71	17076.71
<i>Coniferous forest</i>	312	31396.70	31373.31	34934.67	35009.27	35009.27
<i>Mixed forest</i>	313	21064.31	21004.82	18052.52	18059.51	18059.51
3.2. Scrub and/or herbaceous vegetation associations						
<i>Natural grasslands</i>	321	1734.80	1702.74	1427.34	1422.90	1422.90
<i>Transitional woodland-shrub</i>	324	7151.75	7311.35	5363.88	5425.27	5425.27
3.3. Open spaces with little or no vegetation						
<i>Sparsely vegetated areas</i>	333	0	0	27.22	27.25	27.25
5. WATER BODIES						
5.1. Inland waters						
<i>Watercourses</i>	511	0	0	0.02	0.02	0.02
<i>Water bodies</i>	512	2074.94	2074.94	2074.94	2074.94	2074.94

Land cover in 1990

Four classes of land cover are identified at the first level of the CLC nomenclature in the study area at the beginning of the investigated period. These were Artificial surfaces (class 1), Agricultural areas (class 2), Forest and semi-natural areas (class 3), and Water bodies (class 5).

Forest and semi-natural areas (class 3) strongly predominated over the other three classes and occupied 81% of the study area. They were represented mainly by coniferous forest (CLC 312), which took 32% (31396.70 ha), followed by mixed forest (CLC 313) with 22% (21064.31 ha), and broad-leaved forest (CLC 311) with 18% (17524.23 ha) (Table 1 and Figure 2).

Agricultural lands (class 2) covered over 15% (14173.05 ha). In class 2 the share of land principally occupied by agriculture, with significant areas of natural vegetation at 8% (CLC 243) followed by non-irrigated arable land at 5% (CLC 211), pastures (CLC 231), complex cultivation patterns (CLC 242), and vineyards (CLC 221).

Artificial surfaces (class 1) covered over 3% of the investigated section of the valley and were identified mostly within the settlements of Velingrad, Septemvri, Kostandovo, and Rakitovo.

Class 5 – Water bodies occupied more than 1%, including the Batak Dam. The area and spatial structure of class 1 and class 5 changed slightly until 2020 and therefore will not be specifically considered in the next four sub-periods.

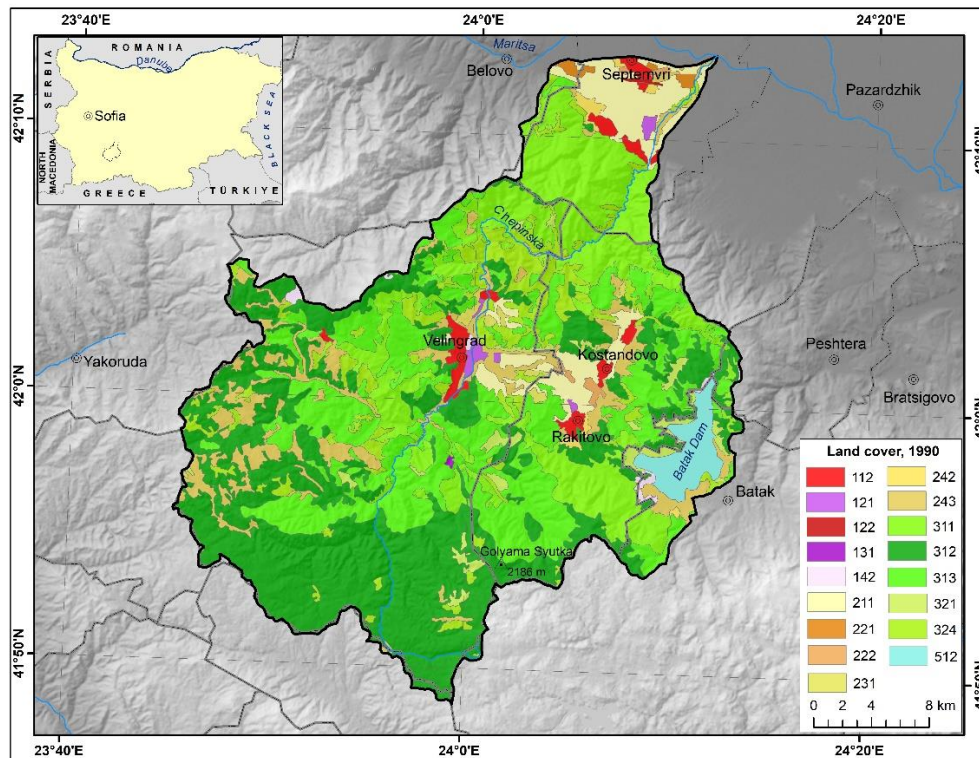


Figure 2. Maps of the land use and land cover (level 3) in 1990. The names of the classes are given in Table 1.

Land cover in 2000

The spatial structure of the land cover did not show significant changes for the period 1990-2000 (Table 1 and Figure 2). Forest and semi-natural areas (class 3) remain with 81% (78871,75 ha) of the territory of the studied area.

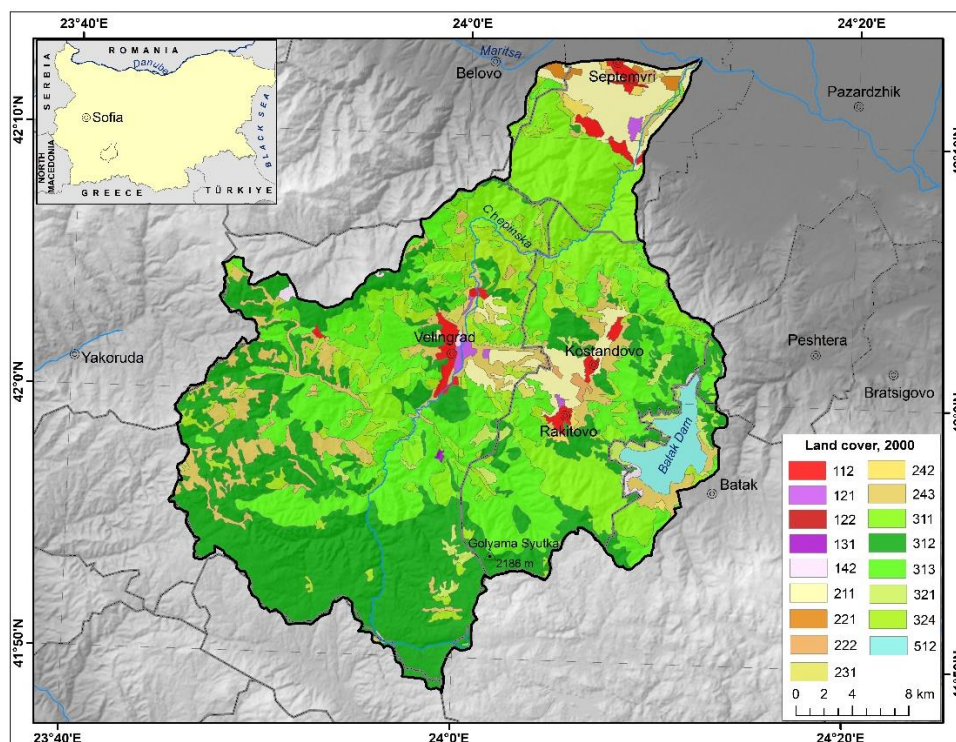


Figure 3. Maps of the land use and land cover (level 3) in 2000. The names of the classes are given in Table 1.

Land cover in 2006

The spatial structure of land cover at the highest level of the CLC nomenclature again shows no significant changes for the period 2000-2006. The changes in the lower nomenclature levels of the land cover were much more significant. The structure of forests and semi-natural areas (class 3) are the most affected. The areas of class 3 decreased by 2%. Coniferous forests (CLC 312) remain the largest share, which increased by 4% compared to the previous two periods. However, the share of mixed forests (CLC 313) decreased by 4%. During the period under review, a new class appeared in the forests and semi-natural areas structure, sparsely vegetated areas (CLC 333) (Table 1 and Figure 4).

During the period 2000-2006, the share of agricultural land increased by 1%. There has also been a change in the structure of class 2. In first place remains Land principally occupied by agriculture, with significant areas of natural vegetation (CLC 243) with 10%, at second place remains non-irrigated arable land (CLC 211). During the period third place is presented by complex cultivation patterns (CLC 242) with 1%. The area of class 242 increased by 320.37 ha. The area of pastures (CLC 231) decreased by 221.5 ha, and of vineyards (CLC 221) by 107.48 ha.

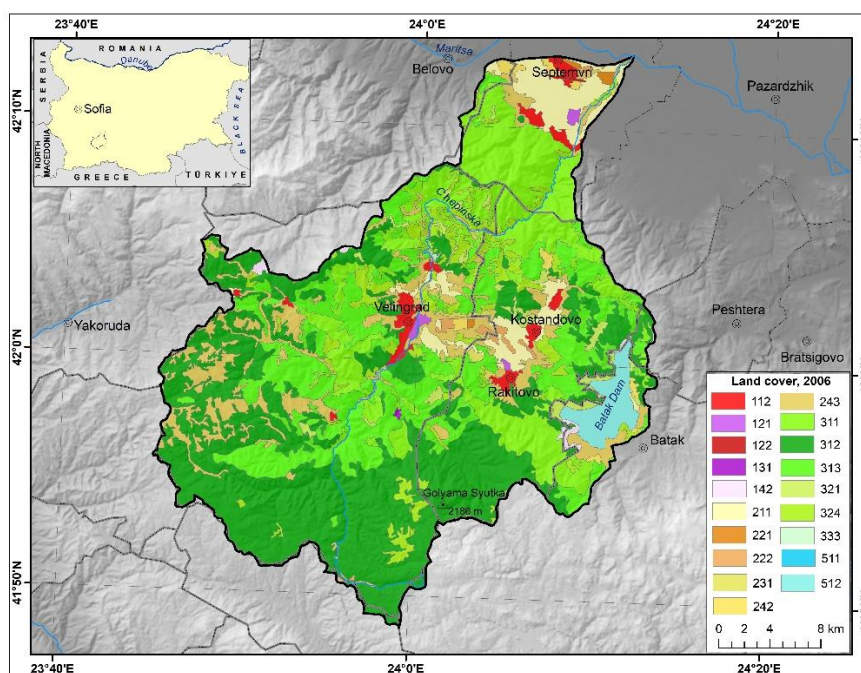


Figure 4. Maps of the land use and land cover (level 3) in 2006. The names of the classes are given in Table 1.

Land cover in 2012

In the period 2006-2012 again no significant changes were observed. The area of land principally occupied by agriculture, with significant areas of natural vegetation (CLC 243) has increased by 496.58 ha, complex cultivation patterns (CLC 242) by 118.33 ha, and coniferous forest (CLC 312) by 74.6 ha. It should be noted that the areas of broad-leaved forest (CLC 311) with 64.5 ha, vineyards (CLC 221) with 105.53 ha, fruit trees, berry plantations (CLC 222) with 156.78 ha, and pastures (CLC 231) with 157.42 ha (Table 1).



CLC 311



CLC 312



CLC 313

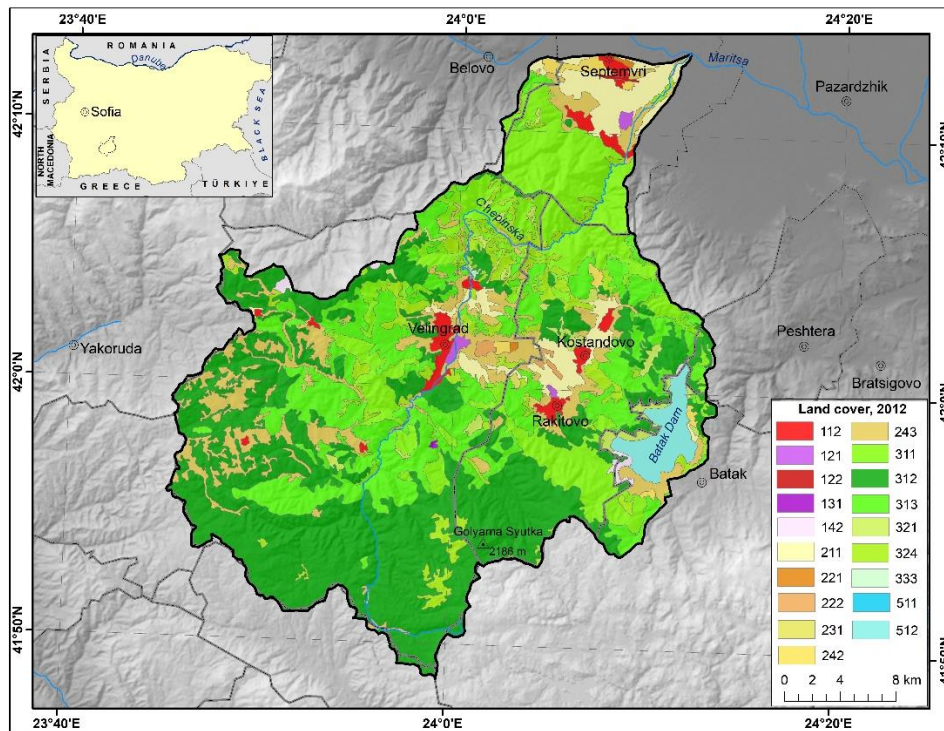


Figure 5. Maps of the land use and land cover (level 3) in 2012. The names of the classes are given in Table 1.

Land cover in 2018

The spatial structure of the land cover did not show significant changes for the period 2012-2018 (Table 1 and Figure 6). Forest and semi-natural areas (class 3) remain with 79% (77020,01 ha), followed by agricultural lands (class 2) with 16%, artificial surfaces (class 1) with 3%, and water bodies with 2% of the territory of the studied area.

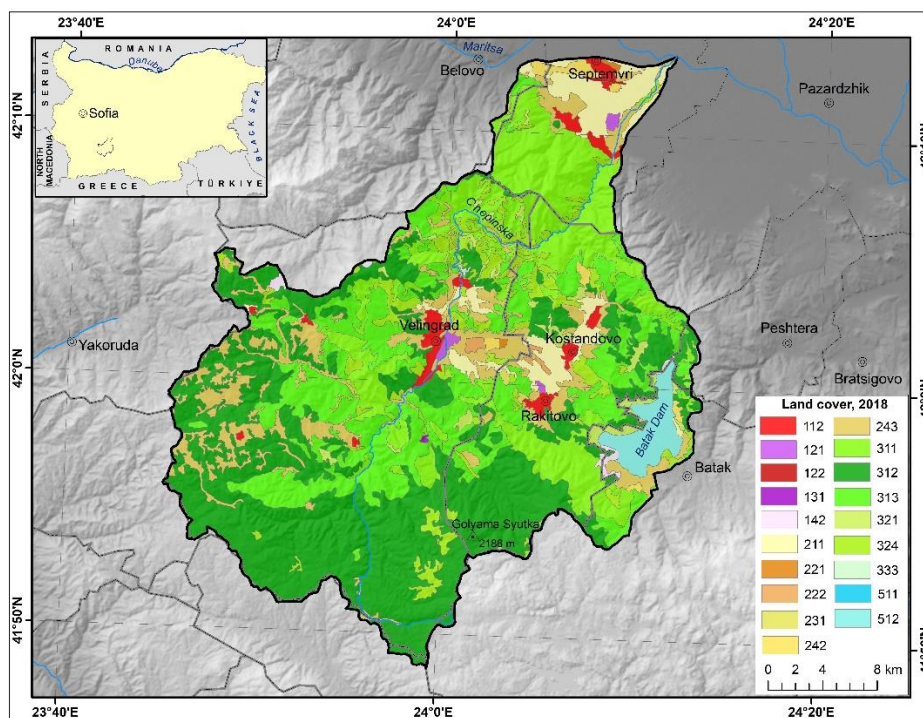


Figure 6. Maps of the land use and land cover (level 3) in 2018. The names of the classes are given in Table 1.

CONCLUSION

The land cover in the Chepinska River Valley study area is dominated by forest areas, followed by agricultural lands, artificial surfaces, and water bodies. This basic structure has undergone minor changes since 1990 due to its strong dependence on valley environmental conditions such as topography and soil cover.

However, the deep economic and political transformations of Bulgaria between 1990 and 2020 affected the lower classes of the CORINE Landcover nomenclature. The biggest changes were recorded during the 2000-2006 period. As a result, class 221 - Vineyards, class 222 - Fruit trees and berry plantations, and class 231 Pasture have significantly reduced their areas due to the crises of agriculture and the decline of animal husbandry.

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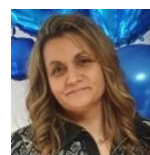
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