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Investigation of land cover change with GIS using CORINE data

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Abstract

Population growth leads to the growth of cities and the destruction of natural areas. Urban growth triggers changes in land cover. Determining the change effects in land cover is essential for sustainable policies. The temporal data were produced from the CORINE data for the years 1990, 2000, 2006, 2012 and 2018 for evaluating and understanding the land cover change. When the land cover change data of the study area were examined, an increase of 251.75% with +13.290 km^2 was detected in the artificial surfaces class. It is seen that from the results, The results the study area is under intense urbanization pressure.

1. Introduction

Land cover change, which affects the natural resource value, is accepted as one of the most important environmental problems globally (Guan et al. 2011; Veldkamp and Lambin 2001; Arslan and Örücü 2019). With the increasing population and developing technology, the pressure on natural resources is increasing day by day. Identifying and interpreting the problems that arise with urban sprawl and taking the necessary precautions are important in terms of effective management and planning. Therefore, investigating the degree, causes and consequences of urban sprawl is very important for human life (Uyar and Ozturk 2019).

Urban growth is a complex socio-economic process that transforms the built environment and rural areas into urban settlements with the increasing population, and also shifts the spatial distribution of the population from rural areas to urban areas (BM 2019). Land cover, on the other hand, refers to the soil layer, including the natural vegetation covering the surface of the land, agricultural products and human structures (Verburg et al. 2009; Başara and Şişman 2022). The occurrence of urban growth triggers land use as cover changes.

In this study, temporal land cover changing in Atakum district of Samsun (Turkey) were investigated. Atakum district is located at 41°19'48.4176'' North and 36°17'32.9172'' East coordinates. Atakum district is 7 kilometers away from Samsun city center and located in border Black Sea (Fig. 1). Atakum district has a population of 238,732 people. Atakum district has undergone a great change in residential areas due to its long coastline, university potential and important transportation networks such as the tram line, which has an important place in urban transportation in recent years.

The study area, consisting of the central areas of Atakum district along the coast, was select as of 70,937 km^2. The study area map is given in Figure 1.

Figure 1. Location Map

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2. Material and Method

While the land use/cover does not change for many years in rural areas, on the contrary, in urban areas, significant changes can be seen about it due to the pressure created by rapid population growth. The regions where this change is most rapid and evident are urban development areas (Ozturk et al. 2010).

CORINE (Coordination of Information on the Environment) data was used to determine the land cover change. CORINE Land Cover (CLC) is a 1:100,000 scale land cover map for European Union (EU) member states and all partner countries. The project was initiated by the European Union Commission in 1985 and carried out by the Commission until 1990, during which an environmental information system was established (Bruttner et al. 2000). Source attributes of CORINE data is given in Table 1.

Table 1. CORINE Data Sources (Falťan et al. 2020)

Dataset	Spatial Resolution	Source	Format
CLC1990	$\leq 50m$	Landsat-5 MSS/TM	Vector
CLC2000	$\leq 25m$	Landsat-7 ETM	Vector
CLC2006	$\leq 25m$	SPOT-4/5, IRS P6 LISS III	Vector
CLC2012	$\leq 25m$	IRS P6 LISS III, RapidEye	Vector
CLC2018	$\leq 10m$	Sentinel-2, Landsat-8	Vector

The standard European CLC nomenclature is hierarchical, including three levels of thematic detail in five major groups (Heymann et al. 1993): artificial surfaces, agricultural areas, forests and semi-natural areas, wetlands, water bodies.

Level-1 and Level-2 classes of CORINE land cover classes are given in Table 2.

Table 2. CORINE Land Classes (Uyuk et al. 2020)

Level-1	Level-2
1.Artificial Surfaces	1.1. Urban Fabric 1.2. Industrial, commercial and transport units 1.3. Mine, dump and construction sites 1.4. Artificial, non-agricultural vegetated areas
2.Agricultural Areas	2.1. Arable land 2.2. Permanent crops 2.3. Pastures 2.4. Heterogeneous agricultural areas
3.Forest and Semi Natural Areas	3.1. Forest 3.2. Scrub and/or herbaceous associations 3.3. Open spaces with little or no vegetation
4.Wetlands	4.1. Inland wetlands 4.2. Marine wetlands
5.Water Bodies	5.1. Inland waters 5.2. Marine waters

The aim of CLC-Change creating is to produce a map of real land cover changes describing an evolution process taking place in the environment (e.g., urban sprawl, forest clearcut). Changes should be interpreted regardless of their position (Fig. 2). Change polygons should: have size at least 5 ha, have width at least 100 m, describe a real evolution process that occurred between year old and year new, and be detectable on satellite images.

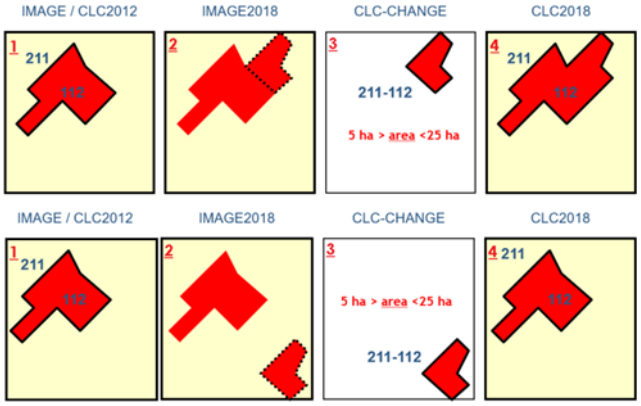

Figure 2. Consistent mapping of CLC Change

Upper row: growth of an existing settlement. Lower row: birth of a new (isolated) settlement

- First boxes in both rows show the land cover status visible on IMAGE2012 and the polygon outlines in CLC2012 database.
- Second boxes show the land cover status visible on IMAGE2018 without polygon boundaries. Dashed outline marks patches that have changed.
- Third boxes show polygons to be drawn in the CLC-Change database.
- Fourth boxes show the polygons as present in CLC2018 database (as the results of GIS addition of CLC2012 and CLC-Change 2012-2018 (CORINE 2021).

Geographic Information System is important for collecting and processing geographic data of objects. Transforming data into geographic information with geographic analysis and viewing geographic data helps to plan activities (Başara et al. 2021). GIS software was used as a method in examining the land cover change. "Zonal toolset" and "Tabulate Area" analysis was performed from the "Spatial Analyst toolbox" menu of ArcGIS software. Calculates cross-tabulated areas between two datasets and outputs a table (Fig. 3). Land cover maps of the years 1990, 2000, 2006, 2012, 2018 were processed in accordance with the study area.

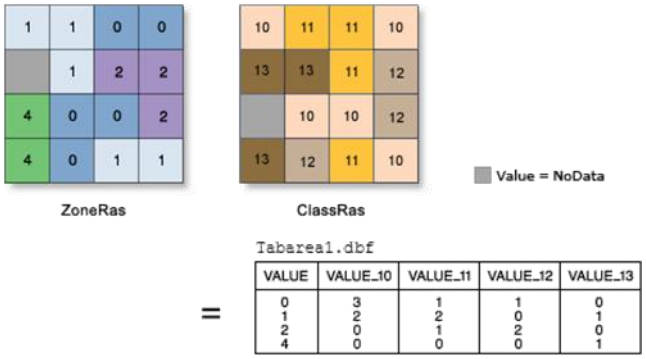

Figure 3. Tabulate Area Illustration

3. Results

Artificial surfaces, agricultural areas, forest and semi natural areas, wetlands and water bodies classes are mapped using Level-1. The produced maps were analyzed as areal and percentage. Land cover maps Fig. 4-8 and their areal distributions are given in Table 3-7.

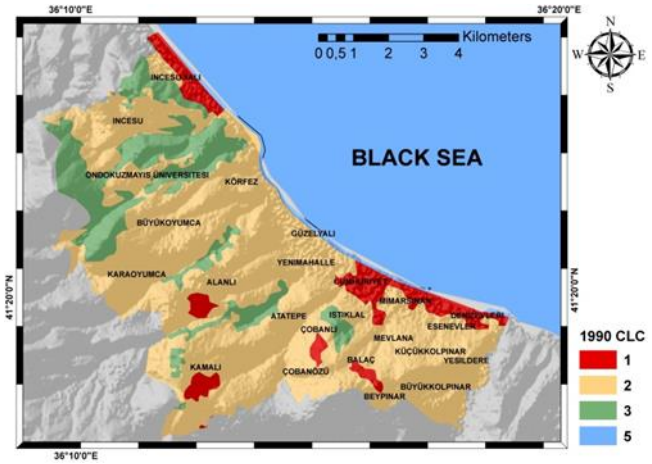

Figure 4. CORINE Land Cover Map of 1990

When the land cover data of 1990 were examined, wetlands class was not found. Artificial surfaces class is 7.44% with 5,279 km^2; agricultural areas class is 52.076 km^2 with 73.41%; forest and semi natural areas class with 12,475 km^2, 17.59%; the water bodies class covers an area of 1,108 km^2 and with 1.56%.

Table 3. Distribution of CORINE Land Cover in 1990

Land Cover	Area (km^2)	Percent (%)
1.Artificial Surfaces	5,279	7,44
2.Agricultural Areas	52,076	73,41
3.Forest and Semi Natural Areas	12,475	17,59
4.Wetlands	0,000	0,00
5.Water Bodies	1,108	1,56

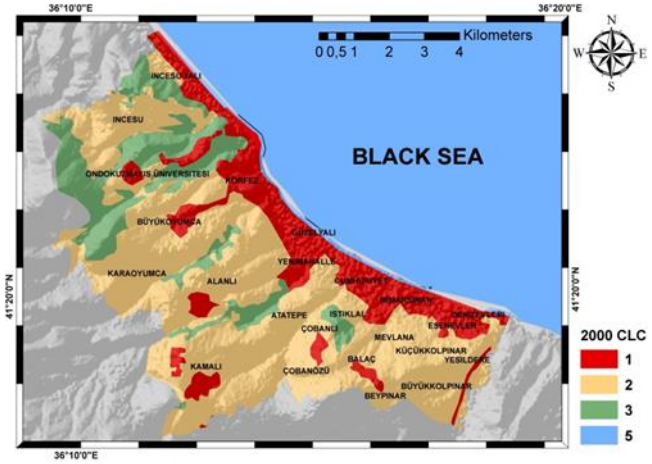

Figure 5. CORINE Land Cover Map of 2000

When the land cover data of 2000 were examined, artificial surfaces class is 19.28% with 13,677 km^2; agricultural areas class is 44.261 km^2 with 62.39%; forest and semi natural areas class is 16.76% with 11,892 km^2; the water bodies and wetlands classes is the same in 1990.

Table 4. Distribution of CORINE Land Cover in 2000

Land Cover	Area (km^2)	Percent (%)
1.Artificial Surfaces	13,677	19,28
2.Agricultural Areas	44,261	62,39
3.Forest and Semi Natural Areas	11,892	16,76
4.Wetlands	0,000	0,00
5.Water Bodies	1,108	1,56

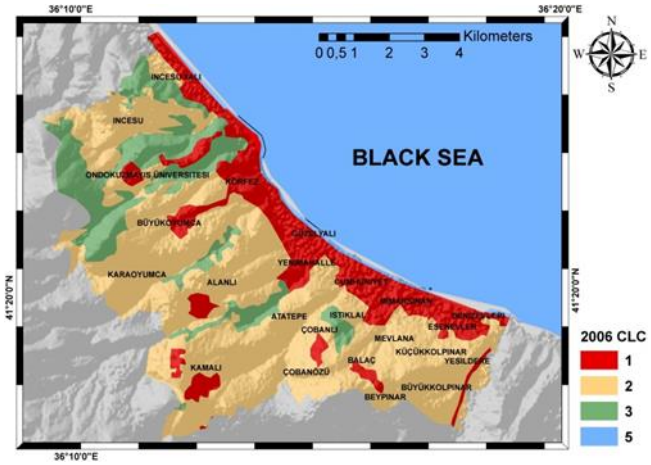

Figure 6. CORINE Land Cover Map of 2006

When the land cover data of 2006 were examined, artificial surfaces class is 19.28% with 13,679 km^2; agricultural areas class is 44,267 km^2 with 62,40%; forest and semi natural areas class 11,881 km^2 with 16.75%; the water bodies and wetlands classes is the same in 1990 and 2000.

Table 5. Distribution of CORINE Land Cover in 2006

Land Cover	Area (km^2)	Percent (%)
1.Artificial Surfaces	13,679	19,28
2.Agricultural Areas	44,267	62,40
3.Forest and Semi Natural Areas	11,881	16,75
4.Wetlands	0,000	0,00
5.Water Bodies	1,110	1,56

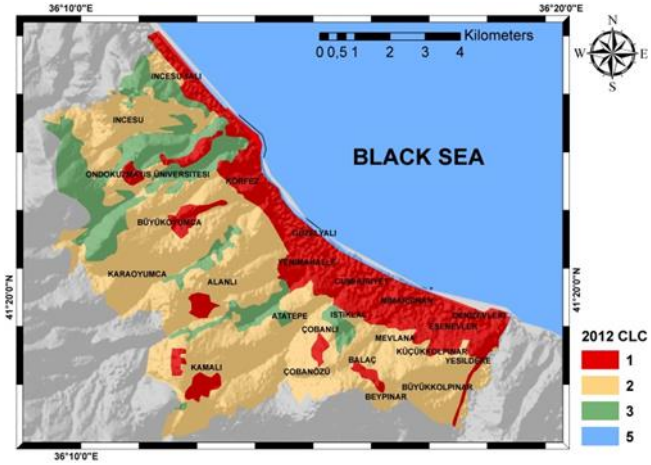

Figure 7. CORINE Land Cover Map of 2012

When the land cover data of 2012 were examined, artificial surfaces class is 23.95% with 16,987 km^2; agricultural areas class is 40.865 km^2 with 57.61%; forest and semi natural areas class 12,114 km^2 with 17.08%; the water bodies class covers an area of 0.971 km2 and 1.37% and the wetlands class is the same in 1990, 2000 and 2006.

Table 6. Distribution of CORINE Land Cover in 2012

Land Cover	Area (km^2)	Percent (%)
1.Artificial Surfaces	16,987	23,95
2.Agricultural Areas	40,865	57,61
3.Forest and Semi Natural Areas	12,114	17,08
4.Wetlands	0,000	0,00
5.Water Bodies	0,971	1,37

Figure 8. CORINE Land Cover Map of 2018

When the 2018 land cover data were examined, artificial surfaces class is 26.18% with 18.569 km^2; agricultural areas class is 39,283 km^2 with 55.38%; forest and semi natural areas class 12,127 km^2 with 17.10%; the water bodies and wetlands classes are nearly the same the others.

Table 7. Distribution of CORINE Land Cover in 2018

Land Cover	Area (km^2)	Percent (%)
1.Artificial Surfaces	18,569	26,18
2.Agricultural Areas	39,283	55,38
3.Forest and Semi Natural Areas	12,127	17,10
4.Wetlands	0,000	0,00
5.Water Bodies	0,958	1,35

4. Discussion and Conclusion

Within the scope of this study, the urban sprawl and land cover change of Atakum district were examined using CORINE data (Table 5). Wetlands class was not found in the study area between 1990-2018. When the land cover change data is examined, an increase of 251.75% with 13,290 km^2 in the artificial surfaces class; A decrease of 12,793 km^2 and 24.57% in the agricultural areas class; a decrease of 0.347 km^2 and 2.78% in the forest and semi natural areas class; A decrease of 0.149 km^2 and 13.49% was detected in the water bodies class. The results obtained showed that the study area is under intense urbanization pressure.

Table 8. Difference Between 1990-2018

Land Cover	Difference (km^2)	Ratio (%)
1.Artificial Surfaces	+13,290	+251,75
2.Agricultural Areas	-12,793	-24,57
3.Forest and Semi Natural Areas	-0,347	-2,78
4.Wetlands	0,000	0,00
5.Water Bodies	-0,149	-13,49

Monitoring and interpreting urban changes and taking necessary precautions are of great importance for the city's developments. In this way, it will be possible to prevent environmental problems. Changes in the land cover should be examined periodically. The urban areas changing, agricultural areas, forest areas and water resources is important for planning activities. Examination of the factors that cause urban sprawl and the consequences are among the important research topics today.

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