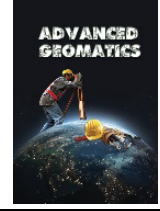




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## Monitoring urban sprawl in Atakum district using CORINE data

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### Keywords

Land Cover,  
Change Detection,  
Urban Sprawl,  
CORINE,  
GIS.

### 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. In this study 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 for Atakum district. It is seen that, the study area is under intense urbanization pressure. Also, the land cover change data have an increase of 251.75% with +13.289,91 da in the artificial surfaces class. In addition to these, it has a dense urban structure especially in seaside districts such as Esenevler, Denizevleri, Mimarsinan and Cumhuriyet neighborhoods; It has been determined that Yenimahalle, Mevlana, Küçükkolpınar, Güzelyalı, Körfez and İncesu Yalı neighborhoods are under the pressure of urbanization.

## 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 Örcü 2019). With the increasing population and developing technology, the pressure on natural resources is increasing. The determination and analysis of urban sprawl is important for effective management and planning. The degree, causes and consequences of urban sprawl is very important in order to taking necessary precaution. (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 has got 41°19'48.4176" North and 36°17'32.9172" East coordinates, 7 kilometers away from Samsun city center and located in border Black Sea (Fig. 1). The residential areas of Atakum has changed in recent years due to its long coastline, university potential and tram line, which has an important place in urban transportation. The study area, consisting of the central areas of Atakum district along the coast, was select as of 70,937 km<sup>2</sup> (Figure 1).

## 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).

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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.

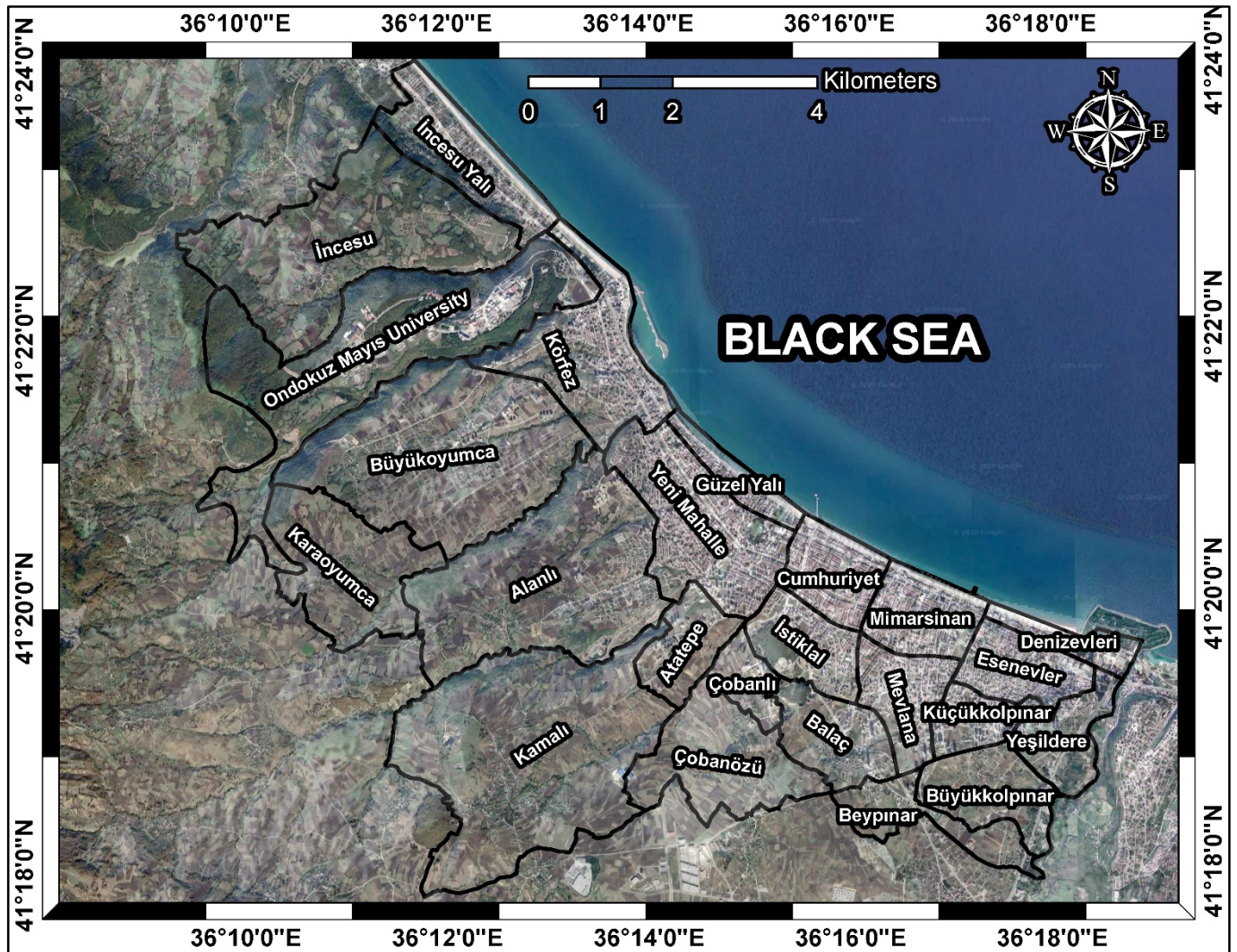


Figure 1. Study Area

Table 1. CORINE Data Sources (Falt'an et al. 2020)

Dataset	Spatial Resolution	Source	Format
CLC1990	≤ 50m	Landsat-5 MSS/TM	Vector
CLC2000	≤ 25m	Landsat-7 ETM	Vector
CLC2006	≤ 25m	SPOT-4/5, IRS P6 LISS III	Vector
CLC2012	≤ 25m	IRS P6 LISS III, RapidEye	Vector
CLC2018	≤ 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 50 da, have width at least 100 m, describe a real evolution process that occurred between yearold and yearnew, and be detectable on satellite images.

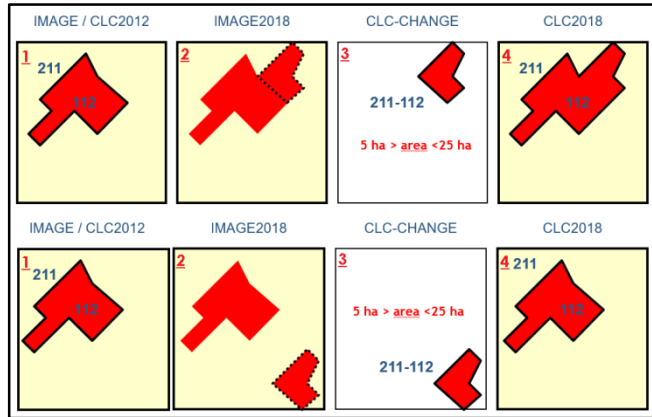


Figure 2. Consistent mapping of CLC Change

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(GIS) 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).

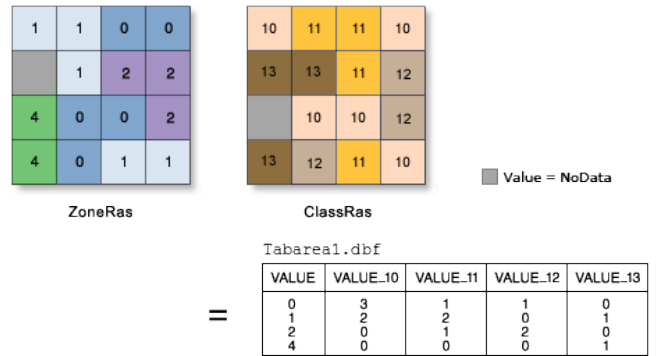


Figure 3. Tabulate Area Illustration

### 3. APPLICATION AND RESULTS

Land cover maps of the years 1990, 2000, 2006, 2012, 2018 were processed in accordance with the study area using GIS software according to CORINE Land Classes (Artificial surfaces, agricultural areas, forest and semi natural areas, wetlands and water bodies) given Table 2. The areal changes of study area were analyzed. The results of these analyses were given in Fig. 4-8 as land cover map and Table 3-7 as areal and percent.

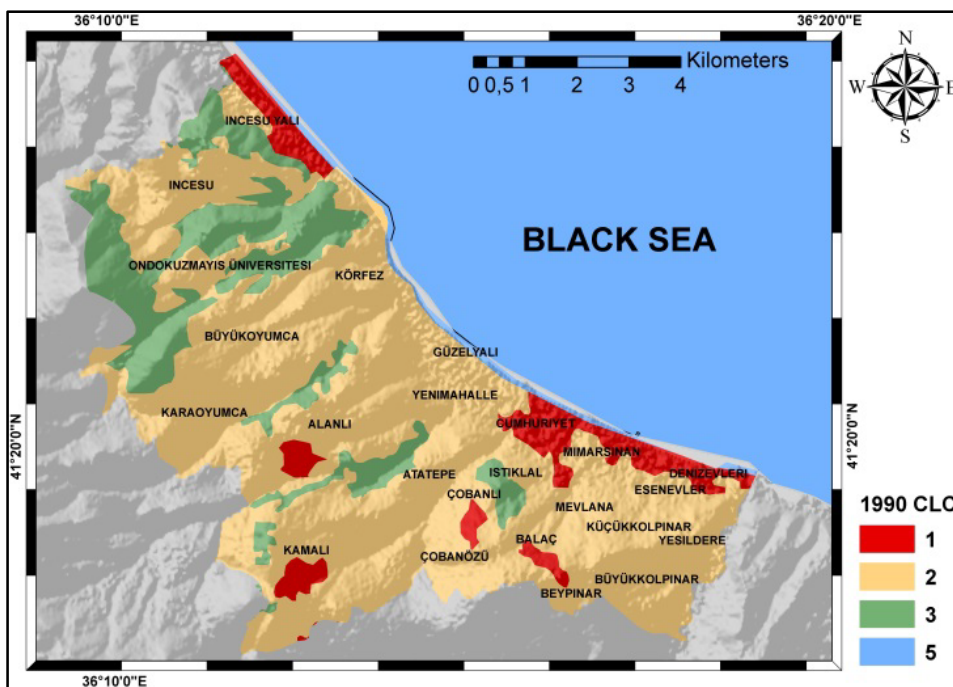


Figure 4. CORINE Land Cover Map of 1990

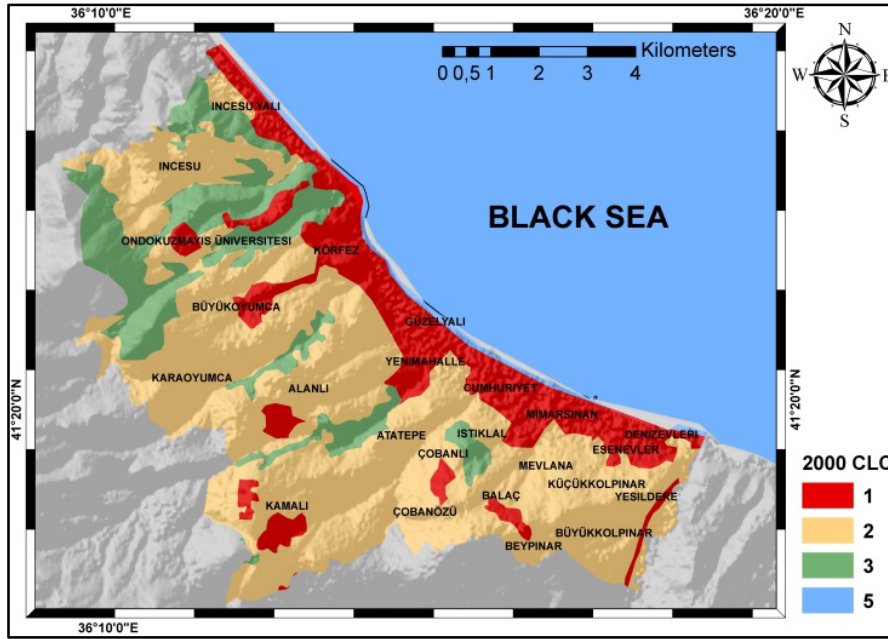


Figure 5. CORINE Land Cover Map of 2000

When the land cover data of 1990 were examined, wetlands class was not found. Artificial surfaces class is 7,44% with 5.279 da; agricultural areas class is 52.076 da with 73,41%; forest and semi natural areas class with 12.475 da, 17,59%; the water bodies class covers an area of 1.108 da and with 1,56%.

Table 3. Distribution of CORINE Land Cover in 1990

Land Cover	Area (da)	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	0,00
5.Water Bodies	1.108	1,56

It is seen that the artificial surfaces class changed 13.677 da with 19,28%; the agricultural areas class changed 44.261 da with 62,39%; the forest and semi natural areas class changed 16,76% with 11.892 da; the water bodies and the wetlands classes don't change for the land cover data of 2000.

Table 4. Distribution of CORINE Land Cover in 2000

Land Cover	Area (da)	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	0,00
5.Water Bodies	1.108	1,56

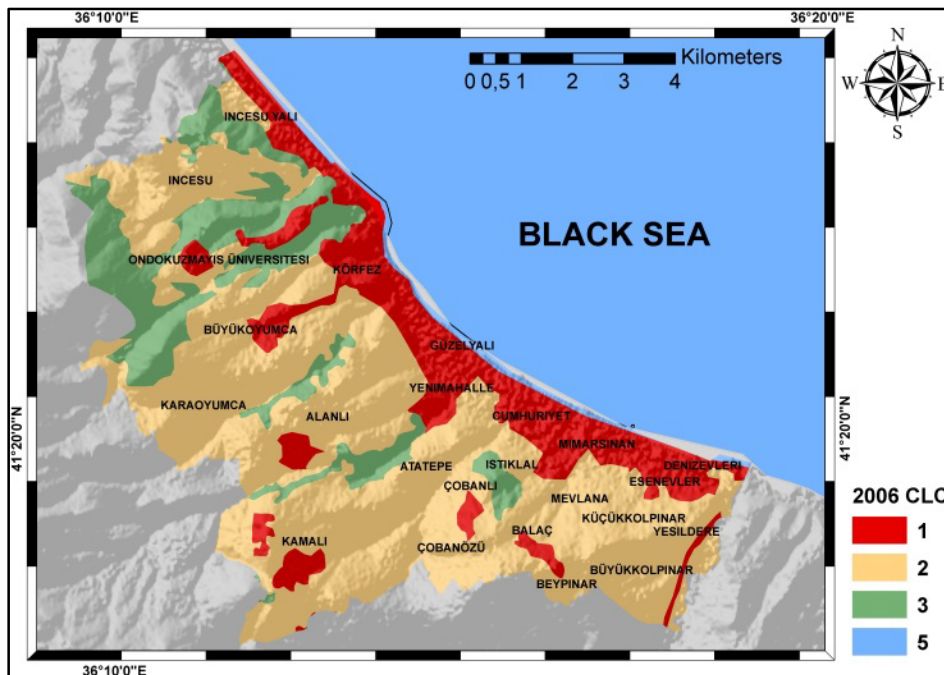
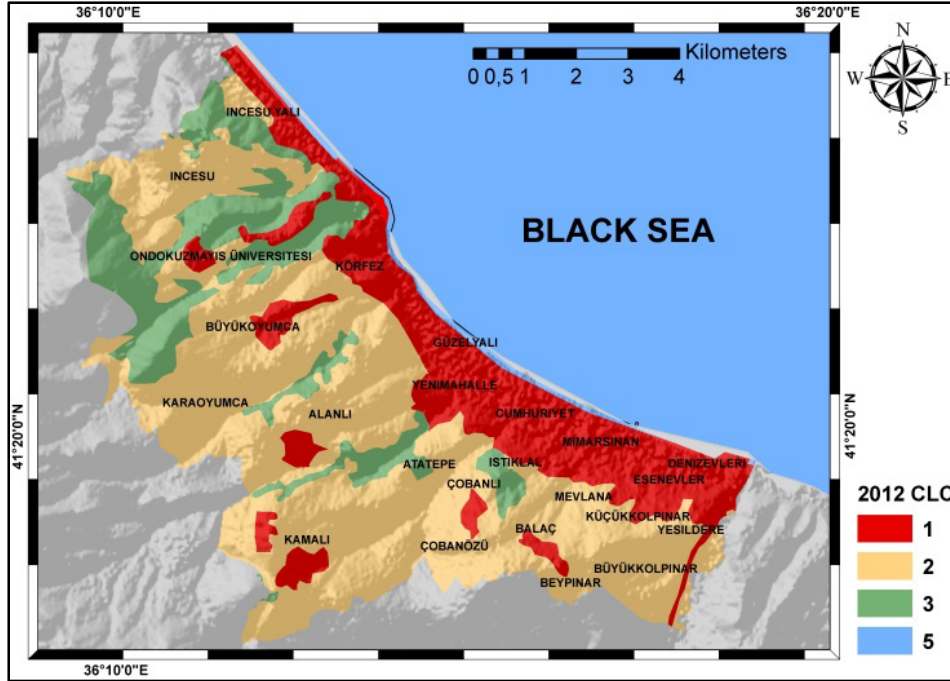


Figure 6. CORINE Land Cover Map of 2006

Also, the land cover data of 2006 were examined, the artificial surfaces class was 13.679 da with 19,28%; agricultural areas class was 44.267 da with 62,40%; the forest and semi natural areas class was 11.881 da with 16,75%; the water bodies and wetlands classes were the same in 1990 and 2000.

**Table 5.** Distribution of CORINE Land Cover in 2006

Land Cover	Area (da)	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	0,00
5.Water Bodies	1.110	1,56

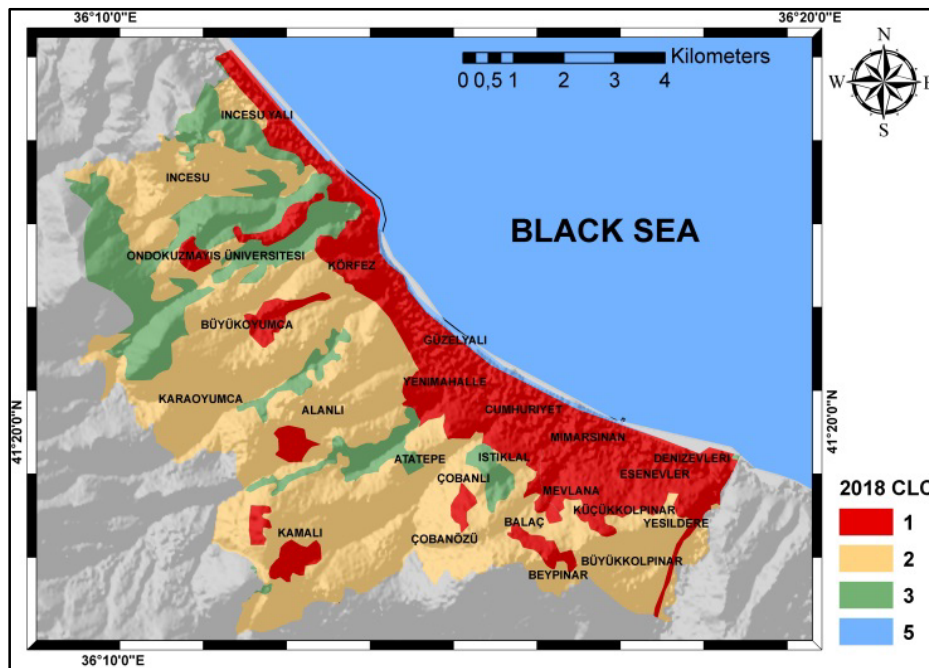


**Figure 7.** CORINE Land Cover Map of 2012

When the land cover data of 2012 were examined, the artificial surfaces class was 16.987 da with 23,95%; the agricultural areas class is 40.865 da with 57,61%; the forest and semi natural areas class was 12.114 da with 17,08%; the water bodies class covered an area of 971 da and 1,37% and the wetlands class was the same.

**Table 6.** Distribution of CORINE Land Cover in 2012

Land Cover	Area (da)	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	0,00
5.Water Bodies	971	1,37



**Figure 8.** CORINE Land Cover Map of 2018

It is seen that the artificial surfaces class changed 18.569 da with 26,18%; the agricultural areas class changed 39.283 da with 55,38%; the forest and semi natural areas class changed 12.127 da with 17,10%; the water bodies and wetlands classes were nearly the same the others for the 2018 land cover data analysis,

**Table 7.** Distribution of CORINE Land Cover in 2018

Land Cover	Area (da)	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	0,00
5.Water Bodies	958	1,35

#### 4. DISCUSSION

The urban sprawl and land cover change of Atakum district were analyzed using CORINE data for 1990-2000-2006-2012-2018 (Table 8). Wetlands class was not found in the study area between 1990-2018. At the end of these analyzes, it was observed that an increase of 13.290 da with 251,75% in the artificial surfaces class. Also a decreases of 12.793 da and 24,57%; 347 da and

2,78% ; 149 da and 13,49% in the agricultural class, the forest and semi natural class, the water bodies class were detected, respectively.

**Table 8.** Land Cover Change

Land Cover	Difference	Percent (%)
1.Artificial Surfaces	+13.290 da	+251,75
2.Agricultural Areas	-12.793 da	-24,57
3.Forest and Semi Natural Areas	-347 da	-2,78
4.Wetlands	0 da	0,00
5.Water Bodies	-149 da	-13,49

The results obtained showed that the study area is under intense urbanization pressure.

In addition, the urbanization pressure for Atakum district was examined on a neighborhood basis. As a result of this examination, the data in Table 9 were obtained. Urbanization rate data for the years 1990, 2000, 2006, 2012, 2018 are given in Table 10.

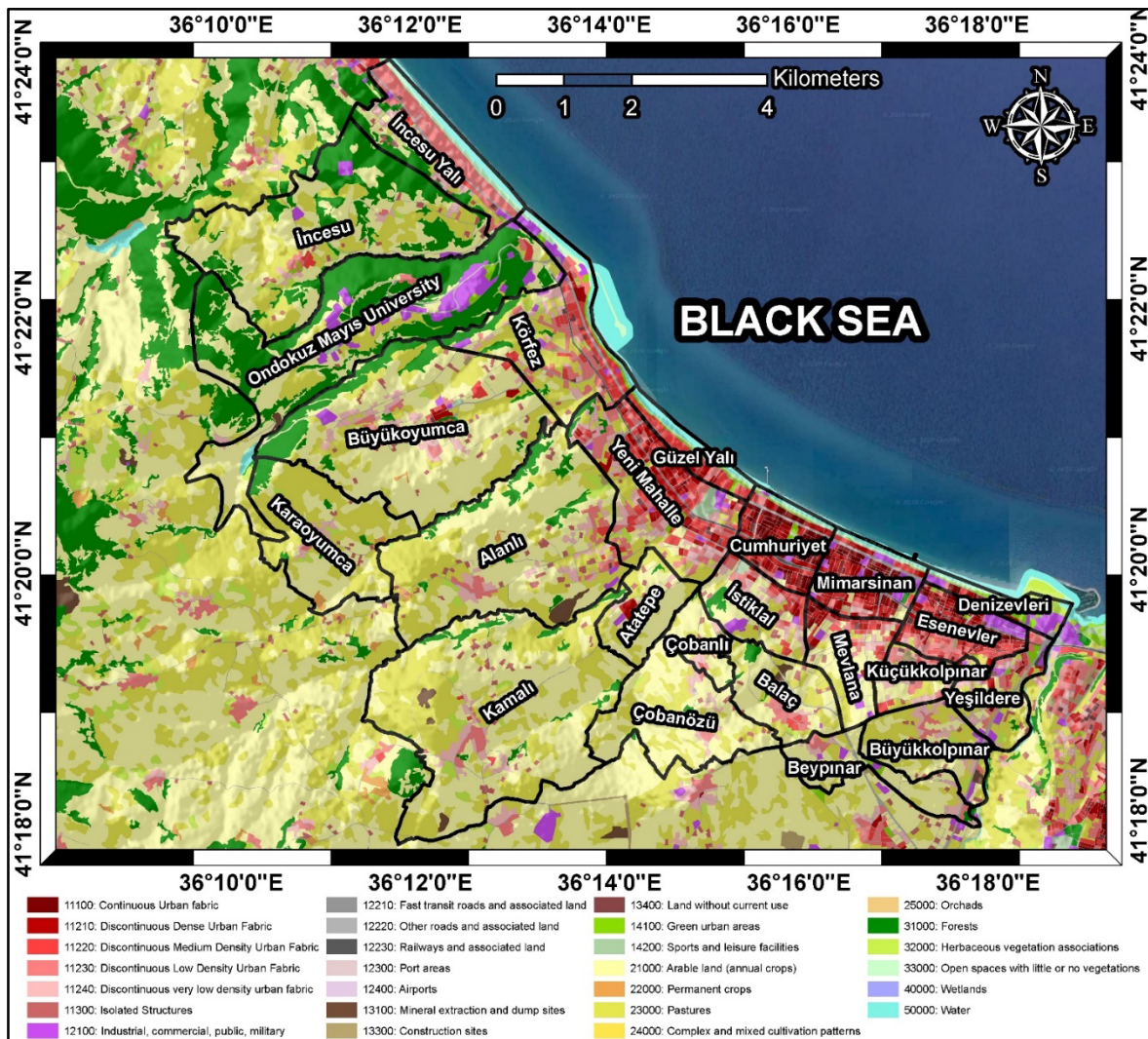
When the data are examined, it is seen that the urban sprawl has increased rapidly in Atakum district. As a result of the study, the city atlas produced by using the CORINE data of Atakum district in the study area is given in Figure 9.

**Table 9.** Urban Area Quantities (da)

Neighbourhood	Total Area (da)	1990 Urban Area (da)	2000 Urban Area (da)	2006 Urban Area (da)	2012 Urban Area (da)	2018 Urban Area (da)	Difference (da)	Percent (%)
Alanlı	6.727,370	408,785	408,785	410,983	402,192	402,192	-6,593	-1,61%
Atatepe	1.318,661	(-)	28,571	28,571	26,373	28,571	No change observed	
Balaç	1.727,446	235,161	235,161	235,161	228,568	426,367	191,206	81,31%
Beypınar	1.393,385	63,735	94,504	94,504	98,900	199,997	136,262	213,79%
Büyükkolpınar	1.777,995	(-)	85,713	85,713	81,317	87,911	2,198	2,56%
Büyükoyumca	7.248,241	(-)	654,935	654,935	648,342	648,342	-6,593	-1,01%
Cumhuriyet	1.490,087	982,403	1.239,542	1.239,542	1.369,210	1.369,210	386,807	39,37%
Çobanlı	758,230	123,075	123,075	123,075	120,877	120,877	-2,198	-1,79%
Çobanözü	2.909,846	147,251	147,251	142,855	142,855	142,855	-4,396	-2,99%
Denizevleri	749,439	514,278	514,278	514,278	731,857	731,857	217,579	42,31%
Esenevler	1.494,483	340,654	999,985	999,985	1.461,516	1.461,516	1.120,862	329,03%
Güzelyalı	817,570	(-)	523,069	520,871	536,256	536,256	13,187	2,52%
İncesu	6.615,284	(-)	(-)	(-)	(-)	(-)	No change observed	
İncesu Yalı	2.329,635	1.210,971	1.228,553	1.230,750	1.232,948	1.232,948	21,978	1,81%
İstiklal	1.540,636	4,396	105,493	105,493	569,222	676,913	672,517	15300,00%
Kamalı	8.696,571	534,058	797,790	799,988	793,395	793,395	259,337	48,56%
Karaoyumca	3.318,631	(-)	(-)	(-)	(-)	(-)	No change observed	
Körfez	3.369,179	(-)	2.158,209	2.158,209	2.114,254	2.114,254	-43,955	-2,04%
Küçükkolpınar	988,996	(-)	(-)	(-)	380,214	681,308	301,094	79,19%
Mevlana	1.527,449	109,888	127,471	127,471	437,356	1.134,049	1.024,160	932,00%
Mimarsinan	1.599,976	593,398	1.239,542	1.239,542	1.494,483	1.494,483	901,085	151,85%
OMÜ	7.573,511	(-)	1.008,776	1.010,974	982,403	982,403	-26,373	-2,61%
Yenimahalle	3.657,087	6,593	1.828,544	1.828,544	2.606,554	2.775,782	2.769,189	42000,00%
Yeşildere	1.307,672	4,396	127,471	127,471	527,464	527,464	523,069	11900,00%

**Table 10.** Urban Area Rate (%)

Neighbourhood	Total Area (da)	1990 Urban Area	2000 Urban Area	2006 Urban Area	2012 Urban Area	2018 Urban Area
Alanlı	6.727,370	6,08 %	6,08 %	6,11 %	5,98 %	5,98 %
Atatepe	1.318,661	( - )	2,17 %	2,17 %	2,00 %	2,17 %
Balaç	1.727,446	13,61 %	13,61 %	13,61 %	13,23 %	24,68 %
Beypınar	1.393,385	4,57 %	6,78 %	6,78 %	7,10 %	14,35 %
Büyükkolpınar	1.777,995	( - )	4,82 %	4,82 %	4,57 %	4,94 %
Büyükoyumca	7.248,241	( - )	9,04 %	9,04 %	8,94 %	8,94 %
Cumhuriyet	1.490,087	65,93 %	83,19 %	83,19 %	91,89 %	91,89 %
Çobanlı	758,230	16,23 %	16,23 %	16,23 %	15,94 %	15,94 %
Çobanözü	2.909,846	5,06 %	5,06 %	4,91 %	4,91 %	4,91 %
Denizevleri	749,439	68,62 %	68,62 %	68,62 %	97,65 %	97,65 %
Esenevler	1.494,483	22,79 %	66,91 %	66,91 %	97,79 %	97,79 %
Güzelyalı	817,570	( - )	63,98 %	63,71 %	65,59 %	65,59 %
İncesu	6.615,284	( - )	( - )	( - )	( - )	( - )
İncesu Yalı	2.329,635	51,98 %	52,74 %	52,83 %	52,92 %	52,92 %
İstiklal	1.540,636	0,29 %	6,85 %	6,85 %	36,95 %	43,94 %
Kamalı	8.696,571	6,14 %	9,17 %	9,20 %	9,12 %	9,12 %
Karaoyumca	3.318,631	( - )	0,00 %	0,00 %	0,00 %	0,00 %
Körfez	3.369,179	( - )	64,06 %	64,06 %	62,75 %	62,75 %
Küçükkolpınar	988,996	( - )	( - )	( - )	38,44 %	68,89 %
Mevlana	1.527,449	7,19 %	8,35 %	8,35 %	28,63 %	74,24 %
Mimarsinan	1.599,976	37,09 %	77,47 %	77,47 %	93,41 %	93,41 %
OMÜ	7.573,511	( - )	13,32 %	13,35 %	12,97 %	12,97 %
Yenimahalle	3.657,087	0,18 %	50,00 %	50,00 %	71,27 %	75,9 %
Yeşildere	1.307,672	0,34 %	9,75 %	9,75 %	40,34 %	40,34 %



**Figure 9.** Study Area Urban Atlas (2018)

## 5. CONCLUSION

It was observed that neighborhoods with dense urban structure in 1990, such as Esenevler, Denizevleri, Mimarşinan and Cumhuriyet neighborhoods, turned into a dense urban structure of over 90%. In these neighborhoods, it has been determined that the rate of urbanization has increased very rapidly in the last 10 years, compared to the rate of urbanization in previous years.

The urbanization rates of Yenimahalle, Mevlana, Küçükkolpınar, Güzelyalı, Körfez and İncesu Yalı neighborhoods were quite low in 1990. These neighborhoods have rapidly urbanized in recent years and have an urban structure of more than 50%.

Monitoring and interpreting urban changes and taking necessary precautions are of great importance for the cities 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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## Author contributions

1st Author: Conceptualization, Methodology, Software, Data Curation, Writing-Original Draft Preparation, Validation and Visualization

2nd Author: Methodology, Software, Writing and Original Draft Preparation

3rd Author: Writing, Original Draft Preparation, Validation, Visualization

4th Author: Conceptualization, Reviewing and Editing

## Conflicts of interest

The authors declare no conflicts of interest.

## Statement of Research and Publication Ethics

The authors declare that this study complies with Research and Publication Ethics

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