

DYNAMICS OF THE URBAN TERRITORY OF ISTANBUL PROVINCE (REPUBLIC OF TÜRKIYE) FOR THE 1985-2018 PERIOD

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Abstract

Turkey's rapid urbanization over the past four decades has significantly altered the country's rural and urban landscape, creating new temporal and spatial patterns of urban fabric. Though the geographical evolution of urban territory and the trends toward urbanization are somewhat diverse in the various Turkish cities, these processes are most noticeable in Istanbul. The complex and multi-layered nature of the urbanization processes in Istanbul, as well as their rapid development in recent years, determine the need to investigate trends in the spatial expansion of the urban territory in Istanbul province. The current study uses GIS and remote sensing data for the years 1985–2018 to evaluate changes in urban expansion and land cover types in the Istanbul province. At the beginning of the considered period, the urbanized territory of the province's total area was 13.29%, and in 2018 it was 23.03%. We identified the following classes of urban territory in the study area: Continuous urban fabric (CLC 111), Discontinuous urban fabric (CLC 112), Industrial or commercial units (CLC 121), Road and rail networks and associated land (CLC 122), Port areas (CLC 123), Airports (CLC 124), Mineral extraction sites (CLC 131), Construction sites (CLC 133), Green urban areas (CLC 141), and Sport and leisure facilities (CLC 142).

Keywords: Google Earth Pro (GEP), remote sensing (RS), geographic information systems (GIS)

INTRODUCTION

In the last four decades, the intensive urbanization in Turkey has resulted in substantial changes in urban and rural fabric, thus generating new spatial and temporal organization of the country's territory (World Urbanization Prospects: The 2018 Revision, 2018a). Logically, the urbanization trends as well as the spatial evolution of urban territories are quite distinctive in the different cities of Turkey but these processes are most prominent in Istanbul.

Istanbul, with its ancient origin and unrest history, has been always one of the biggest and most influential urban centers in Europe, Asia, and the world. At the end of the XIX century, Istanbul already had a population of 1,000,000 people.

However, according to the first census in 1927, its population decreased to 794,444 because the city lost its capital functions (Mazam, 2019). Istanbul reached over 1 million people again after the Second World War, and after 1950 there has been a steady and continuous population increase (Table 1). Today the city reaches 15,655,923 inhabitants (2023) and is among the 20 largest urban agglomerations in the world (World Urbanization Prospects: The 2018 Revision, 2018b). The Istanbul residents represent 18.71 % of Turkey's population and urban density exceeds more than 2,900 people per square km.

Istanbul, like the majority of large urban agglomerations, confronts various challenges and problems in spatial development. Historically, rapid urban growth is dependent more on intensive migration than birth and fertility values thus most of Istanbul's citizens are of origin outside the agglomeration (Mazam, 2019). Recently, the urban sprawl of the agglomeration has been caused mainly by the huge concentration of economic activities, higher incomes, the boom of tourism, improvement of the transport network and accessibility, better public transport, intensive construction of big infrastructure projects like the Marmaray tunnel, Istanbul Airport, etc (Şahin, 2019a). Concurrently with successful projects for urban renovation and revitalization of the urban fabric of Istanbul, a growing array of socioeconomic and ecological problems emerge. The agricultural and forest lands are the main territories that are converted into urban and sealed ones. In addition, a sizable part of legally and irregularly (illegally) constructed residential areas are located in zones vulnerable to natural hazards like earthquakes, landslides, and floods (Unsal and Ozgur, 2010). It is noteworthy to emphasize that population provision with drinking water is seriously threatened by the growth of Istanbul's agglomeration towards the north and east (Tanik et al., 2000).

Table 1. Istanbul provincial population (1927-2023)

Year	Population	Year	Population	Year	Population	Year	Population	Year	Population
1927	794 444	1960	1 882 092	1990	7 309 190	2012	13 854 740	2018	15 067 723
1935	883 599	1965	2 293 823	2000	10 018 735	2013	14 160 467	2019	15 590 266
1940	991 237	1970	3 019 032	2008	12 697 163	2014	14 377 018	2020	15 462 451
1945	1 078 399	1975	3 904 588	2009	12 915 157	2015	14 657 434	2021	15 840 899
1950	1 166 477	1980	4 741 890	2010	13 255 684	2016	14 804 116	2022	15 907 950
1955	1 533 822	1985	5 842 985	2011	13 624 239	2017	15 029 231	2023	15 655 923

Source data: <https://data.twik.gov.tr/Kategori/GetKategori?p=Population-and-Demography-109>; <https://www.nufusu.com/il/istanbul-nufusu> (2008-2023)

Since 2000, remote sensing and geographic information systems (GIS) have become crucial tools for studying, mapping, and evaluating the urbanization processes and their territorial peculiarities (Coskun et al., 2008; Koncak Doğruer et al., 2023; Purwona et al., 2024; Topaloğlu et al., 2022; Vatseva, 2015). These digital technologies allow thorough investigation as well as data collecting and processing of the many levels of urbanization phenomena when paired with statistical and other quantitative methods (Akyürek et al., 2018; Bozkurt et al., 2022; Guler, Yomralioglu, 2017; Stoycheva and Geneletti, 2023).

The complex and multi-layered nature of the urbanization processes in Istanbul, as well as their rapid development in recent years, determine the need to investigate trends in the spatial expansion of the urban territory in Istanbul province. The current study uses GIS and remote sensing data for the years 1985–2018 to evaluate changes in urban expansion and land cover types in the Istanbul province.

MATERIALS AND METHODS

Study area

The study area covers Istanbul province, which is located on two continents: Europe and Asia (Northwest Türkiye) and is extended between the parallels of latitude N 41°35' and N 40°45' and the meridian of longitude E 27°50' and E 30°00'. The size of the study area is 7337.24 km² (733.724 ha). Istanbul province has 39 districts (ilçeleri): 25 are located in Europe (Arnavutköy, Avcılar, Bağcılar, Bahçelievler, Bakırköy, Başakşehir, Bayrampaşa, Beşiktaş, Beylikdüzü, Beyoğlu, Büyükçekmece, Çatalca, Esenler, Esenyurt, Eyüpsultan, Fatih, Gaziosmanpaşa, Güngören, Kağıthane, Küçükçekmece, Sarıyer, Silivri, Şişli, Sultangazi, Zeytinburnu), and 14 are on Asian continent (Adalar, Ataşehir, Beykoz, Çekmeköy, Kadıköy, Kartal, Maltepe, Pendik, Sancaktepe, Şile, Sultanbeyli, Tuzla, Ümraniye, Üsküdar), (Figure 1). Adalar district (Asian part) has the smallest area (11.05 km²) and population (16.325) in Istanbul province. District Çatalca (European part) is the largest in terms of territory size (1959.92 km²), and district Esenyurt (978.007) has the largest population (also located on the European continent).



Figure 1. Study area (Sources: ArcGIS Desktop)

Data and Methods

The urbanized territories were surveyed, and analyzed from the following sources: 1. Vector data from the third level of the European program Coordination of Information on the Environment (CORINE) Land Cover (CLC1990, CLC2000, CLC2006, CLC2012, and CLC2018) for the Republic of Türkiye; 2. Monochromatic aerial photographs of 1970 and 1982, which are available in the interactive sustainable web mapping application for research and the public - Istanbul Urban Database (IUDB), (Figure 2), (Istanbul Urban Database); 3. Satellite images for 1985 and 2018 from Google Earth Pro (GEP), (Figure 3), and 4. ArcGIS Desktop (Esri, Maxar, Earthstar Geographics, and the GIS User Community). Land cover changes have also been added to the fourth level of the CORINE Land Cover nomenclature. This level was developed for PHARE countries and corresponds to M 1:50 000 (Feranec and Otahel, 1998).



Figure 2. Aerial photographs of 1982
(Source: <http://www.istanbulurbandatabase.com/>)

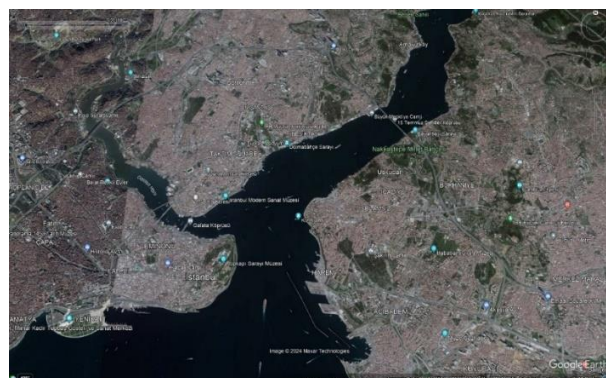


Figure 3. Satellite image of 2018
(Source: Google Earth Pro)

RESULTS AND DISCUSSION

Dynamics of the urban areas for the period 1985-2018

Analyzing the data from Table 2, it is obvious that the urbanized territory enlarged throughout the studied period. The highest rate was witnessed in the 1990-2000 period when Istanbul's urban area increased most profoundly: with 29386.7 ha. This period also coincides with the fastest-growing population of Istanbul from 7309190 (1990) to 10018735 (2000), (Table 1). On the contrary, the smallest urban area changes were observed in the period 2006 - 2012 (2446.5 ha) when the population growth rate was the lowest.

Table 2. Urban areas of Istanbul in 1985 - 2018 (ha)

Year	1985	1990	2000	2006	2012	2018
Total (ha)	59417.8	72177.9	101564.6	108945.2	111411.7	123041.8

The dynamics of urban areas by the district are shown in Figures 4 and 5. The maximum area of change of the urbanized territories is the district Arnavutköy (European part) in the period 2012-2018 from 21.73% (1990) to 40.95% (2018) (Figure 6). The reason is the newly built international airport in the city - Istanbul Airport (Turkish: İstanbul Havalimanı). It was opened on October 29, 2018. The development of the city in this area poses a serious ecological threat to local flora and fauna (Akyürek et al, 2018).

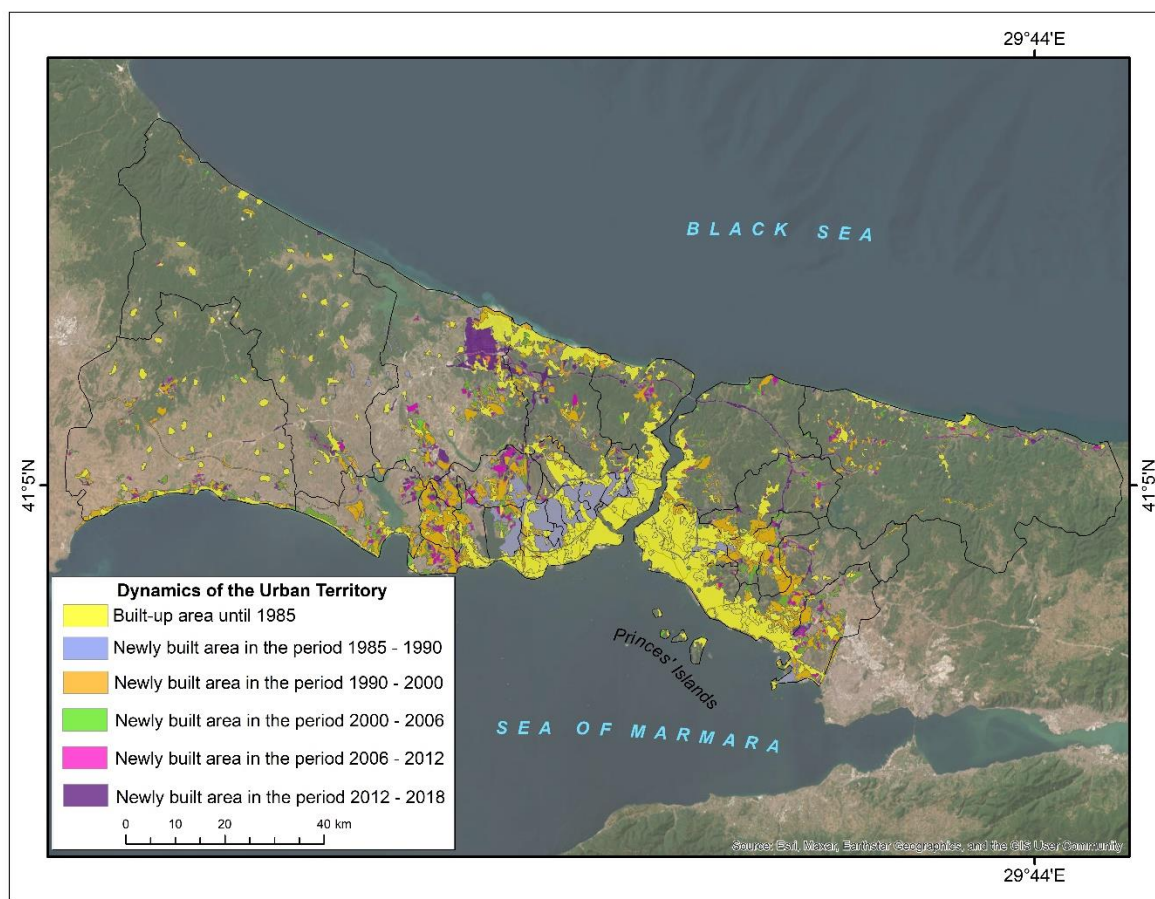


Figure 4. Dynamics of the Urban Territory

The maximum change in the urbanized area in the Asian part of Istanbul is in the Tuzla district, which increased from 27.42% (1990) to 80.09% (2018), (Figure 7). After 1990, the reason for the increase in Tuzla is the development of industrial areas in Aydınlı, Orhanlı, and Tepeören. The Kazlıçeşme Tannery (founded in 1992), the Trans-European (TEM) highway route, and the Istanbul Park Formula 1 track (built in the 2003-2005 period) also contribute to the active urbanization of the area. The Tuzla district is a popular location for wealthy or retired Istanbul residents who are moving further away from the city center (Şahin, 2019b).

Other districts with more significant changes are Çekmeköy (Figure 8) and Şile. The Şile Highway (Ümraniye-Şile Highway), and industrial facilities around Taşdelen and Alemdağ play a substantial role in expanding of urban areas, and after the Marmara Earthquake of August 17, 1999, the demand for housing in the northern part of the city increased. The development of the city in these areas poses a serious threat to the forest areas and to the Ömerli Dam, which provides half of the city's drinking water (Şahin, 2019b).

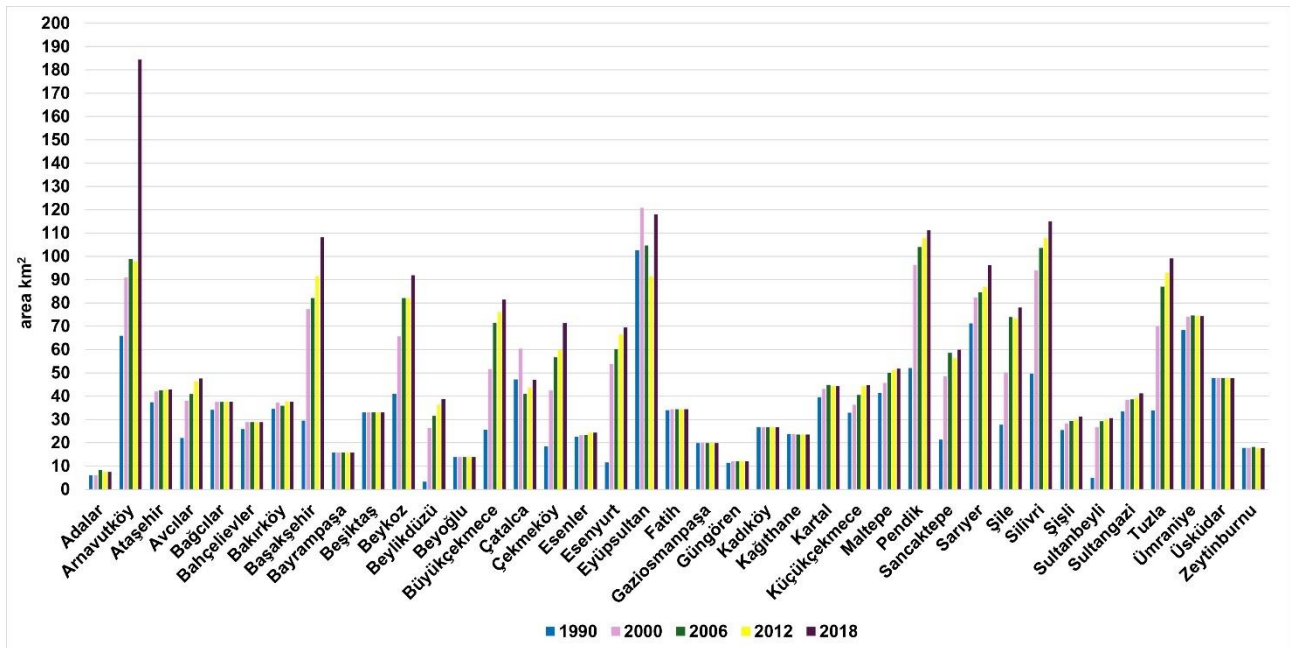


Figure 5. Dynamics of urbanized areas in Istanbul province for the period 1990-2018 (by districts)



Figure 6. Example of land cover change (the yellow contour) in district Arnavutköy (2012–2018)

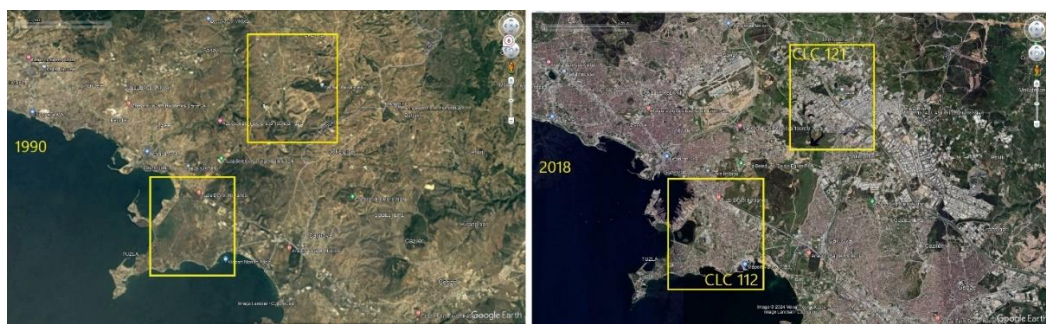


Figure 7. Example of land cover change (the yellow contour) in district Tuzla (1990–2018)

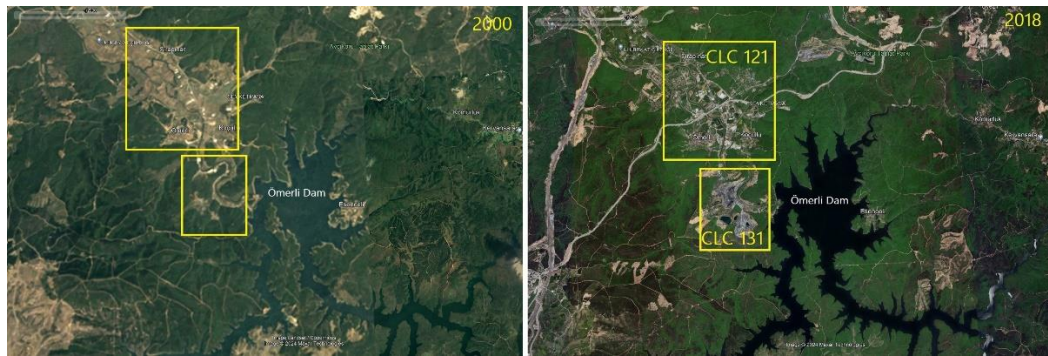


Figure 8. Example of land cover change (the yellow contour) in district Çekmeköy (2000–2018)

Classification of urbanized areas in the 1985-2018 period

The urbanized areas are classified according to CORINE Land Cover, Levels 2 and 3. The results of the classification of urbanized areas are shown in Figure 9, and the names of the land cover classes and their areas are presented in Table 3.

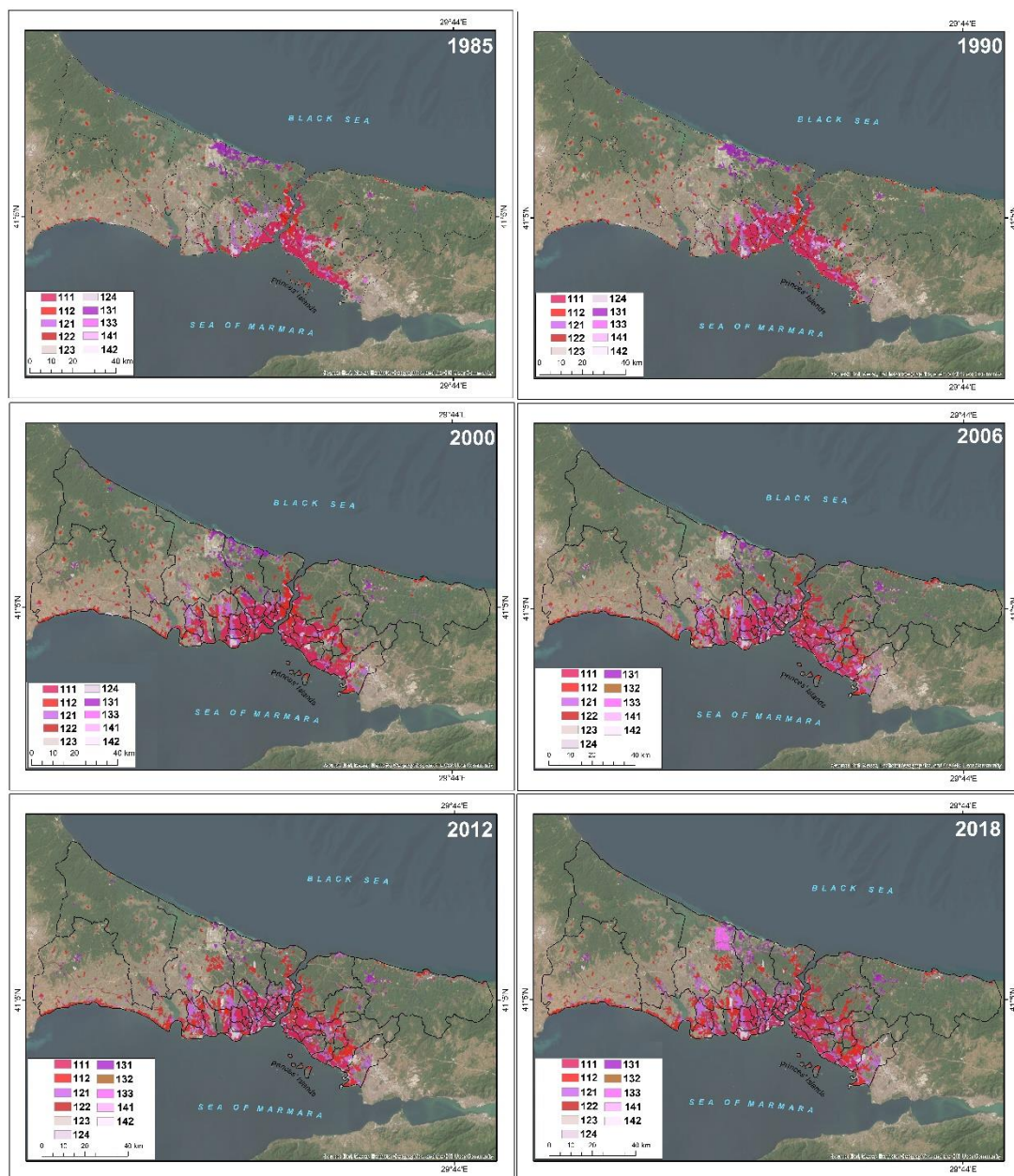


Figure 9. Classification of urbanized areas (The names of the classes are given in Table 3)

Table 3. Classification of urbanized areas, 1985-2018

<i>CORINE Land Cover</i>	<i>Class Code</i>	1985	1990	2000	2006	2012	2018
ARTIFICIAL SURFACES (Level 1)	Level 3	ha	ha	ha	ha	ha	ha
1.1. Urban fabric (Level 2)							
<i>Continuous urban fabric</i>	111	20271.75	28941.55	36511.35	29568.36	29308.36	29350.46
<i>Discontinuous urban fabric</i>	112	17320.06	18571.95	31241.96	32969.73	37827.14	39548.56
1.2. Industrial, commercial, and transport units (Level 2)							
<i>Industrial or commercial units</i>	121	5055.74	5055.74	11716.97	18498.03	20057.48	20890.37
<i>Road and rail networks and associated land</i>	122	416.04	416.04	2698.35	3305.19	4739.39	5975.62
<i>Port areas</i>	123	387.44	387.44	594.07	596.08	662.60	673.09
<i>Airports</i>	124	679.64	679.64	922.02	1202.06	1481.16	1481.16
1.3. Mine, dump, and construction sites (Level 2)							
<i>Mineral extraction sites</i>	131	7470.78	7470.78	9364.12	8072.42	6062.00	6746.88
<i>Dump sites</i>	132	-	-	-	104.80	201.41	57.609
<i>Construction sites</i>	133	2475.83	5314.22	3727.45	7890.64	3619.62	11370.10
1.4. Artificial, non-agricultural vegetated areas (Level 2)							
<i>Green urban areas</i>	141	4048.19	4048.19	2924.64	4520.11	4896.86	4193.79
<i>Sport and leisure facilities</i>	142	1292.30	1292.30	1863.61	2217.82	2555.67	2754.16

Urbanized areas in the CORINE Land Cover classification refer to Level 1 Artificial surfaces. We identified four classes of land cover at Level 2 of the CLC nomenclature in the study area during the 1985-2018 period. These are 1.1. Urban fabric; 1.2. Industrial, commercial, and transport units; 1.3. Mine, dump, and construction sites, and 1.4. Artificial, non-agricultural vegetated areas.

Continuous urban fabric (CLC 111) strongly predominated over the other classes. This class refers to the central part of the city and the historic (old) town (Figures 10 and 11). This class is the main one in the areas around the Bosphorus (Fatih, Beyoğlu, Beşiktaş, Kadıköy, Üsküdar, Gaziosmanpaşa, et al.) where the city was established. CLC 111 was prevalent until 2000.



Figure 10. The historic (old) town (CLC 1112) - Hagia Sophia Grand Mosque (Source: A- Satellite image - Google Earth Pro; B – Fotos – Velimira Stoyanova)

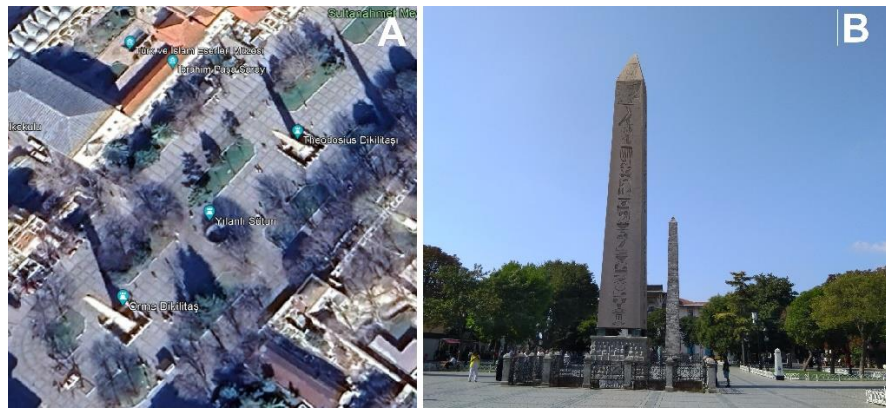


Figure 11. The historic (old) town (CLC 1112) - Hippodrome of Constantinople: Obelisk of Theodosius and Walled Obelisk (Constantine's Obelisk) (Source: A- Satellite image - Google Earth Pro; B – Fotos – Velimira Stoyanova)

The largest extent of the urbanized territory after 2000 is occupied by class Discontinuous urban fabric (CLC 112). The following classes are included in the CLC 112: Discontinuous built-up areas with multi-flat houses prevailing without gardens (CLC 1121); Discontinuous built-up areas with family houses with gardens (CLC 1122), and Discontinuous built-up areas with greenery (CLC 1123).

After 2006, the share of Industrial or commercial units (CLC 121) also increased significantly. The same tendency is observed for Road and rail networks, associated land (CLC 122), and Airports (CLC 124). Istanbul has three international airports (CLC 124), with artificial surfaces of runways (CLC 1241). The Atatürk Airport (IST), which opened in 1912 and closed to passenger traffic on April 7, 2019; Istanbul Airport (ISL) which opened on October 29, 2018, and both are located on the European side of the city and the Sabiha Gökçen Airport (SAW) which is operating from January 08, 2021, is on the Asian continent.

The share of the classes Green urban areas (class 141) and Sports and leisure facilities (class 142) is very small in the urbanized territory of Istanbul province (Figures 12 and 13).



Figure 12. Green urban areas (CLC 1411) – Gülhane Park (Source: A- Satellite image - Google Earth Pro; B and C – Fotos – Velimira Stoyanova)



Figure 13. Sports and leisure facilities (class 1421) – Beşiktaş Stadium (Source: A- Satellite image - Google Earth Pro; B and C – Fotos – Velimira Stoyanova)

CONCLUSION

It is projected that by 2035, over 80% of Turkey's population will live in urban areas, with an additional 18 million people living in the Istanbul agglomeration (World Urbanization Prospects: The 2018 Revision, 2018a, 2018b). Istanbul will therefore continue to be one of the major cities in the world, and the way the urban areas in the province evolve in the future will depend on a wide range of variables and how they interact, giving rise to various possible outcomes for their development.

The urban transformation in Istanbul province is evolving at a rapid pace, especially in the 1990-2000 period. The agglomeration spreads continuously in the west-east direction, following the Marmara Sea coast and main road infrastructure that links the European and Asian regions of Turkey. The urban sprawl and suburbanization occur with uneven speed in the different districts of Istanbul province but the urban territories in the study area are dominated by Continuous urban fabric (class 111) and Discontinuous urban fabric (class 112) in the 1985-2018 period.

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BIOGRAPHY



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