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THE SPATIAL IMPACTS OF RAPID URBANIZATION ON THE LIMITED SURFACE WATER RESOURCES IN ISTANBUL

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Abstract

In the second half of the 20th Century, during which Turkey has experienced rapid industrialization and urbanization, Istanbul has been the destination of influx of large scale rural to urban migrants. Between 1950 and 2000, the city has grown by an average of 4.5% annually. The city has been the preferred destination not only by large numbers of low skilled rural migrants who seek employment in various informal sectors, but also by capital owners looking for a large scale cheap labor source and an extensive local market. Besides, Istanbul provides a relatively well established basic infrastructure (e.g. transportation and services) compared to the rest of Turkey. Given the scale of the growth, neither local nor the central governments have shown capability of controlling the influx of migration, most of which settled illegally on public lands creating low quality low cost housing and industrial environments. Most of the settlements lack the basic sewerage facilities, and a significant portion of which are on the major water resource basins. As of today, the Greater Istanbul Metropolitan Municipality (GIMM) not only has to cope with the infrastructure problems, but also has to find ways of solving the problem of illegal occupations of public lands and water resource basins.

This paper presents the land use changes in the water resource basins providing water to the Istanbul Metropolitan Area. Using four consecutive Landsat images between 1990 and 2005, the changes in 12 different land use categories are obtained via overlay

operations by GIS for water resource basins surrounding the City of Istanbul. It has been observed that the most critical land use changes are in the nearest basins to the city. It has also been observed that large public capital improvement projects such as Trans-European Motorway (TEM) contributed to the trend of illegal occupation of these public lands; however it should not be considered as the sole reason. The capability of Landsat images in determining the alterations in the macro form of the city are also discussed. Finally, possible policy implications are put forward for the preservation of water resource basins in Istanbul.

Keywords: Urbanization, Industrialization, Migration, Surface Water Resources, Sustainability, Image Processing, Basin Management,

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"Water is not necessary to life but rather life itself."
Antoine de Saint-Exupery[1]

1. INTRODUCTION

For a human life, in order to survive and sustain, the primary need is to have clean air, however, for a city, it is to have potable water. Not only existence of water, but also its being in a reasonable distance and quality carries quite an importance. Especially, in the metropolitan cities, water is a quite intricate issue to solve from its abstraction to its discharge.

Istanbul is one of the largest metropolitan cities in the World. With its dense population, it is one of the top 25 crowded metropolitan cities. Because it is located at the far end of two peninsulas and at the junction of Asia and Europe, city is surrounded by large body of sea waters. Its shape, in contrast to geopolitical advantages, lacks large body of water basins to sustain the Metropolitan City of Istanbul; therefore, the closest water catchments are utilized as surface water resources via dams and their reservoirs in different sizes and scales. The closer the water reservoirs to the city the lower the cost of supplying water to the users; however, proximity to an immense metropolitan city like Istanbul brings about difficulties of protection and management of the scarce water resources basins against illegal and unplanned rent seeking developments. Nowadays, given the economic and population dynamics of the Metropolitan City of Istanbul, Istanbul Water and Sewerage Directorate (İSKİ) and the General Directorate of State Hydraulic Works (DSİ) have proactively initiated a series of extensive water conveyance projects with large capital and operation costs to cope with prospective water shortages.

This paper focuses on 1) the land use changes in the closest water resource basins to the Istanbul Metropolitan Area, and then 2) the potentials of the satellite images and air photos in monitoring the land use changes. As a base for evaluations, Landsat Geocover, Landsat TM, and IKONOS images are utilized. In the article, first, urbanization in Turkey and impacts on Istanbul are reviewed, then, the impacts of urbanization on the sensitive water resource areas in Istanbul are studied. Afterward, introduction of remote sensing techniques and tools monitoring the land use changes in these basins is followed by a discussion on the potentials of these tools and techniques. Then the obtained land use changes in the water resource basins in Istanbul are analyzed in terms of different scales and levels of planning.

[1] In eds., Cooley J. K. (1984).

Before concluding, the capabilities of Landsat and IKONOS images in detecting the alterations in the macro form of the city are discussed.

2. ISTANBUL UNDER THE INTENSE PRESSURE OF URBANIZATION

Historically, Istanbul is a natural node of social, economic, cultural activities. It is also conjunction of land, air, and sea based flows. These flows are not limited to human based activities (goods and services) but also seasonal migration of birds and fishes. This node not only establishes the link between cities in the Turkey but also continents - Europe, Asia, and Africa (Figure 1). Also with its distinctive natural beauty and moderate climate, it has been the location of large number of civilizations in the world history.

Figure 1: Istanbul as a Node of Transportation[2]

In a historical context, after the foundation of the Turkish Republic in 1923 on the ruins of the Ottoman Empire, Turkey had faced not only shortage of human capital but also a wide range of problems accumulated through centuries, mainly due to lack of industrialization, urbanization, and modernization, which had been mostly resolved in the western world during the 19th Century.

In the last 80 years of experience, Turkey has faced many rapid changes in her spatial organizations given the changes in agriculture and industry. These changes are well observed on every corner of country's agricultural landscape and mainly in several urban spaces. The overwhelming influx of internal migrants from mainly eastern part of the country (Figure 2) informally or/and illegally occupied the land at the outskirts of several major cities. These occupied spaces are primarily in Istanbul, and then Ankara, Izmir, and Adana. The spatial changes in the cities have been one of the toughest to manage and

[2] The image is courtesy of the Bureau of Istanbul Metropolitan Planning and Design (İMP).

control. With its uncontrolled population dynamics, later, Istanbul has turned out to be one of the well-known primate cities in the world. Today, at the metropolitan scale, Istanbul is one of the largest cities of the world.

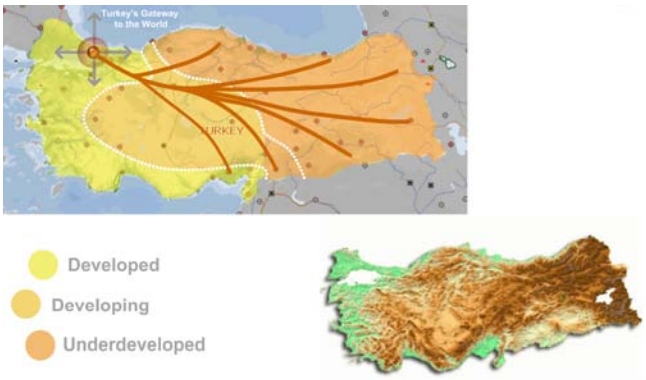

Figure 2: Istanbul as a Destination of Internal Migration[3]

In the second half of the 20th Century, which can be named as the post World War II Era, coincides with the fundamental changes in the economy (open economy and encouraged private sector), transportation, and communication, and with an extensive population growth and a far-reaching spatial changes in Istanbul. From 1950 to 2000, the city has grown annually an average of 4.5% (Table 1). The city has been the preferred destination not only by a large numbers of low skilled unemployed rural migrants who seeks employment in various informal sectors, but also by capital owners looking for a large scale cheap labor and an extensive local market. Besides, Istanbul provides a relatively well established basic infrastructure (e.g. transportation and services) compared to the rest of Turkey. Given the scale of the growth, neither local nor the central governments have shown capability of controlling the influx of migrants, most of which settled illegally on public lands creating low quality low cost housing and industrial environments. Most of the settlements lack the basic sewerage facilities, and a significant portion of which are on the major water resources basins.[4]

Similar to high rate of growth presented in Table 1, Figure 3 schematically shows not only historical evolution, but also the extent of exponential growth of the city of Istanbul in the last eighty-year period in three increments (1920-1950, 1950-1970, and 1970-

[3] The image is courtesy of the Bureau of Istanbul Metropolitan Planning and Design (İMP).
[4] Hydrology Studies at the Bureau of Istanbul Metropolitan Planning and Design.

2000). During these stages, the Greater Istanbul Metropolitan Municipality (GIMM)[5] and even the central Government of Turkey have had to cope with the infrastructural problems, but also had to find ways to solve the problem of illegal occupations of public lands, a significant portion of which is in the water resource basins.

Table 1: Population Figures of Istanbul

Years	Provincial Population	Annual Rate of Increase (%) [1]	Urban Population	Annual Rate of Increase (%) [1,2]
1950	1.166.477		1.002.085	
1955	1.533.822	5,6	1.297.372	5,3
1960	1.882.092	4,2	1.506.040	3,0
1965	2.293.823	4,0	1.792.071	3,5
1970	3.019.032	5,6	2.203.337	4,2
1975	3.904.588	5,3	2.648.006	3,7
1980	4.741.890	4,0	2.909.455	1,9
1985	5.842.985	4,3	5.560.908	13,8
1990	7.309.190	4,6	6.753.929	4,0
2000	10.018.735	3,2	9.085.599	3,0
Average		**4,4**		**4,5**

[1]: The model for the rate calculation: $Y=Y_0(1+r)^t$

[2]: Between 1980 and 1985 some of the local administrative units and villages are incorporated into the urban counties.

Source: DİE, Census 2000.

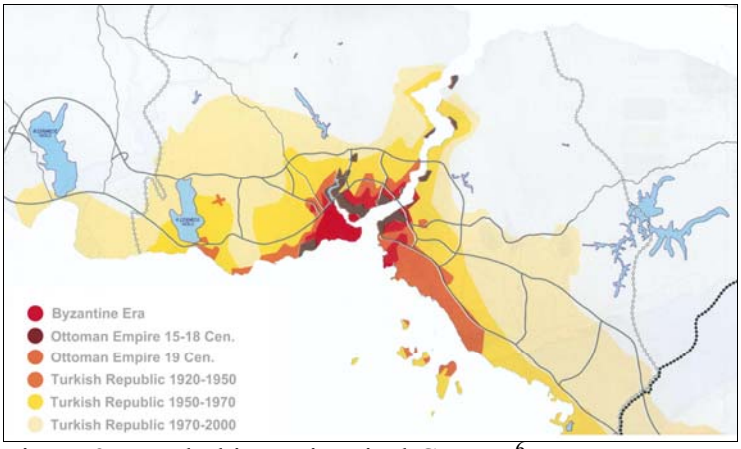

Figure 3: Istanbul in a Historical Context[6]

[5] In Turkish, GIMM refers to `İstanbul Büyükşehir Belediyesi – İBB.`

[6] The Figure is obtained from the Bureau of Istanbul Metropolitan Planning and Design (İMP).

3. LITERATURE REVIEW

In Istanbul, like in many rapidly growing cities, officials - especially planners and politicians - are in need of spatial information from macro scale to micro scale in order to determine plans and spatial policies for the management of natural resources. In the last decade, remote sensing techniques have been employed not only to document available resources but also to monitor spatial activities. The obtained information, then, is evaluated for macro scale plan and policy formulations and for micro scale implementations. There are increasing number of researches in monitoring sensitive resources, and illegal developments in and around the metropolitan areas.

Sunar (1998) in her study for İkitelli area of Istanbul, in order to evaluate remote sensing images obtained from Landsat Thematic Mapper (TM) (12 August, 1984 and 6 September, 1992), applies four change detection techniques, which are image overlay, image differencing, principal component analysis, and classification comparison. She, then, analyzes the land use changes in the selected study site. Then, she draws attention to the potentiality of the techniques in the spatial analysis and policy formulations.

A similar study was done by Maktav and Erbek (2005) using the IKONOS XS+Pan (13 February 2002), Landsat TM (12 June, 1984 and 16 April, 1998), and SPOT P (11 July, 1998) images for the 14 administrative units of Büyükçekmece area of Istanbul in order for visual analysis and interpretation of the classification results. In their study area, between the years 1984 and 1998, they detect rapid spatial changes, which are mainly loss of agricultural lands for urban uses, due to migration and high natural population growth rate. Finally, they discuss the potentiality of aerial photos and satellite images in monitoring the land use changes and urban policy formulation.

Musaoglu et al. (2005) in their study on a temporal assessment of land-cover changes of the Beykoz province in Istanbul, part of which lies within the boundary of Elmalı Basin, use June 1984, September 1992, and May 2001 Landsat 5 TM images. They found that the rapid, uncontrolled, and illegal urbanization accompanied by insufficient infrastructure has caused degradation of forests and barren lands in the province, especially within the past two decades. Afterward, they concluded that the proximity of the province to the reservoir's watershed, downtown Istanbul, and the transportation network has accelerated the land-cover changes whose adverse impacts on the reservoir water quality are sensed.

Baykal et al. (1999) and Tanık et al. (1999) in their researches utilize satellite images to monitor pollutions in the water resource basins in Istanbul. They also try to find out the sources of pollutions.

Kaya and Curan (2006) in their research aim at to quantify urban growth on the European side of Istanbul by using Landsat 5 TM images for 1987, 1992, 1997 and 2001. They monitored the differences in those periods and measured the changes in the urban areas between 1987 and 2001. They conclude that urban residential areas increased by around 1000 ha per year and forest, semi-natural vegetation, crop and bare soil areas decreased collectively at a similar rate.

Göksel (1998) studied the land-use/land-cover characteristics of Elmalı Water Resource Basin by using Landsat TM and Spot P images (1984 and 1992). She developed a data base with population, water potential, topographic position, and industry labor force to be used for water basin planning and management. She also argues that unplanned development in Elmalı Basin, which is closest to the city center, resulting from intense immigration flow is the result of the creation of the Trans European Motorway (TEM) and the second Bosporus Bridge.

These studies generally conclude that the growth of illegal settlements in the water resources basins is resulted from major infrastructure investments such as TEM and the second Bosporus Bridge. This claims fall short of explaining spontaneous illegal uncontrolled growths. Reason-result analyses should also be focused on the difficulties in making plan and implementation of those, pre/post ownership structure, availability of economic activities surrounding these settlements sustaining migrants' life. It should be noted that, without any planning and legal guidance, both industrial and informal real estate investors automatically take advantage of the accessibility provided by highways and bridges.

In contrast to earlier studies, this study focuses on *all water resource basins in Istanbul*, because some of the basins have been relatively more affected than the others due to such factors as jurisdictional boundaries, relative distance to the metropolitan city centers, proximity to transportation networks and large industrial districts. In this respect, this study provides a wider perspective for a more extensive spatial area incorporating all basins within Istanbul. In the technical perspective, this research utilizes three different remote sensing image sources, which are Landsat GeoCover LC (1990, 2000), Landsat TM (1995, 2005), and IKONOS (2005), and provides a comparison base to discuss their strengths and weaknesses.

4. SURFACE WATER RESOURCES FOR THE CITY OF ISTANBUL

Urban macro form of Istanbul stretched both east and west direction from the southern shores of Bosporus. Simultaneously, there are also intense growth pressures towards north along the Bosporus and along the highways constructed towards the end of 1980s. After the construction of the Trans European Motorway (TEM) and the second Bosporus Bridge, the urban macro form is stretched out to the northward where water resource basins lie.

Table 2: The Current Water Resources Basins and Their Contributions to the Uses of the City of Istanbul

Code No:	Source Name	Date of Completion	Major Rivers & Lakes	Annual Average Capacity (m^3)	Ratio in Total (%)
1	Elmalıdere Regülatörü	1997	Elmalıdere	11.600.000	1,1
2	Büyükdere Barajı	1995	Büyükdere	28.400.000	2,7
3	Kuzuludere Barajı	1995	Kuzuludere	11.300.000	1,1
4	Düzdere Barajı	1995	Düzdere	4.500.000	0,4
5	Terkos Barajı	1883	Terkos Gölü	162.000.000	15,6
6	Büyükçekmece Barajı	1989	B.Çekmece Gölü	120.000.000	11,6
7	Sazlıdere Barajı	1998	Sazlıdere	85.000.000	8,2
8	Alibeyköy Barajı	1972	Alibey Deresi	36.000.000	3,5
9	Küçükçekmece (Excluding Sazlıdere)	---	---	---	---
10	Elmalı I ve II Barajları	1893-1950	Göksu	15.000.000	1,4
11	Ömerli Barajı	1972	Çayağzı Çayı	235.000.000	22,7
12	Darlık Barajı	1989	Darlık Deresi	97.000.000	9,4
---	Bentler ve Yeraltısuları	1453-1893		10.000.000	1,0
---	Yeşilvadi Çevirme Yapısı	1992	Yeşil Dere	10.000.000	1,0
---	Sultanbahçedere Barajı	1997	Sultanbahçe Dere	19.400.000	1,9
---	Kazandere Barajı	1997	Kazandere	100.000.000	9,7
---	Pabuçdere Barajı	2000	Nazlıdere	60.000.000	5,8
---	Şile Keson Kuyuları	1996		30.000.000	2,9
T o t a l				**1.035.200.000**	**100,0**

Source: İSKİ Faaliyet Raporu (2002).

4.1. Basins and Reservoirs

In the provincial boundary of Istanbul, as can be seen on Table 2, there are a total of 12 coded water basins; however, only 11 of them provide water to the City of Istanbul. Due to intense developments surrounding the lake, Küçükçekmece basin no longer provides water to the City of Istanbul and has been officially removed from the list of drinking water resources. Instead, its sub-portion, named Sazlıdere Basin, is preserved for the same purpose. Beyond these 12 basins, there are other basins providing water to the City of Istanbul; however - even tough are shown on Table 2- these basins are excluded from the analyses because they are either out of the Province of Istanbul or are groundwater resources. Among the 12 coded basins, the seven major reservoirs supplying 72.4% of all water to the City of Istanbul surrounds the city and provides significant amount low cost

clean water. From the west to east, these are, *on the European side*, Terkos (5), Büyükçekmece (6), Sazlıdere (7), Alibeyköy (8), and Küçükçekmece (9), and *on the Asian side*, Elmalı (10), Ömerli (11), and Darlık (12) water basins. A significant portion of Ömerli and Darlık water basins lay out of the provincial boundary of Istanbul. A list of reservoirs and basins and their associated annual contributions are summarized in Table 2 and visually presented in Figure 4.

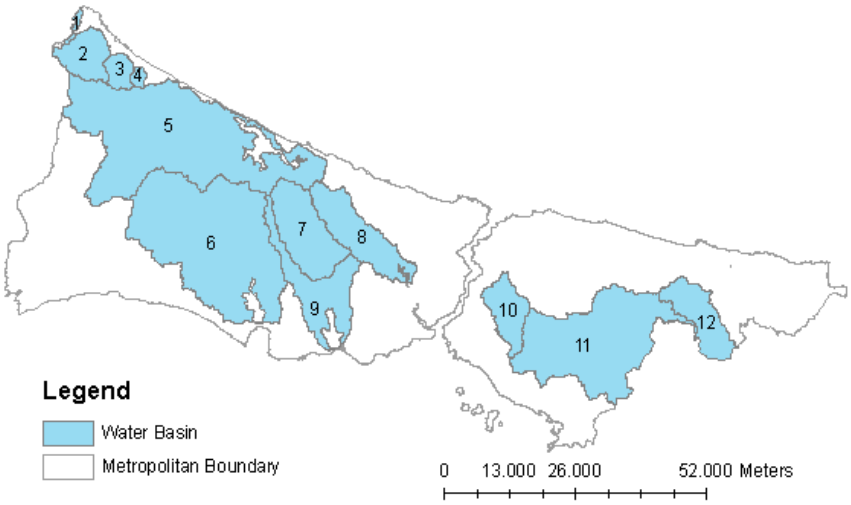

Figure 4: Surface Water Resources Basins in the Province of Istanbul[7]

5. METHODOLOGY

In order to determine the land use changes in the water basins in Istanbul, three different data of satellite images and maps obtained from the following sources have been used. The inter-temporal dimensions of the sources vary between 1990 and 2005:

1. Landsat GeoCover LC - 1990, 2000;
2. Landsat TM - 1995-2005; and
3. IKONOS – 2005.

In this research, Erdas Imagine 8.5 and ArcGIS 9.1 are the selected softwares. Initially, all images are rectified to the UTM coordinate system. Erdas Imagine is used to classify

[7] Obtained from the Hydrology Studies at the Bureau of Istanbul Metropolitan Planning and Design.

the land uses from the satellite images, then all raster images are passed through a filtering process, after which the obtained raster images are converted to vector maps. The following steps are completed in the ArcGIS environment. An interface has been developed in ArcGIS 9.1 environment, which provides the users an efficient and correct area calculation tool. Then the land use changes are measured and the obtained values are summarized in table forms for all water basins in Istanbul. This process is applied for all images but Landsat GeoCover LC - 1990, 2000 which has already been classified by EartSat.

The GeoCover LC are delivered in a Universal Transverse Mercator (UTM)/World Geodetic System 1984 (WGS84) projection. A standard 13-class land cover legend designed. The landcover categories in the GeoCover LC product follow closely to those defined by Anderson et al. in his 1976 publication. Brief descriptions of the 13 landcover categories are shown below in Table 3.[8] Among 13 categories the 10 are applicable to Istanbul, and presented in the summary tables. The same categories also obtained for Landsat TM and IKONOS images in order to observe the changes in the surface water resource basins.

5.1. Accuracy of Information Obtained from Landsat GeoCover, Landsat TM, and IKONOS Images

The 1990 and 2000 Landsat GeoCover LC data have spatial resolutions of 40 m. The overall accuracy of the product within areas assessed is 73% (www.geocover.com).[9] The same procedure is applied to the 1995 and 2005 Landsat TM images with 30 m spatial resolution. Over these images, 300 sample points are selected in order to pursue the classification process and to test the accuracy of classification. Later, those samples are evaluated in Erdas 8.5 environment, and then, the rates of accuracy are estimated as 82.7% for the year 1995 and %79 for the year 2005.[10] Only for Elmalı Basin, 2005 IKONOS remote sensing images having 1 m resolution has been processed. Its accuracy rate has not been calculated; however, as a result of comparison with the Landsat TM

[8] www.geocover.com .
[9] In this model, except water resources, all classes less than 5 ha are eliminated. For the water resources the critical area is selected 0.2 ha.
[10] The estimation is calculated by BİMTAŞ Remote Sensing and GIS Department, Metropolitan Planning and Design

over Elmalı Basin, IKONOS 2005 gives nearly 3% deviations from the classification obtained from Landsat TM 2005.[11]

Table 3. Landsat GeoCover and Landsat TM Land Cover Legend[12]

Class	Class Title	Definition
1	Forest, Deciduous	Trees > 3 meters in height, canopy closure >35% (<25% intermixture with evergreen species), of species that seasonally lose leaves. Includes deciduous tree species in the wetland environment.
2	Forest, Evergreen	Trees > 3 meters in height, canopy closure >35% (25% intermixture with deciduous species), of species that do not seasonally lose leaves. Includes both broadleaf and needle leaf species, as well as evergreen tree species in the wetland environment.
3	Shrub/Scrub	Woody vegetation < 3 meters in height, with at least 10% ground cover. Includes wetlands with woody vegetation < 3 meters in height.
4	Grassland	Upland herbaceous grasses, >10% ground cover.
5	Barren/Minimal Vegetation	Land with minimal ability to support vegetation, including rock, sand, and beaches.
6	Urban/Built-	Developed areas at least 60 meters wide.
7	Agriculture, General	Cultivated crop and pasture lands, except paddy agriculture.
8	Agriculture Rice/Paddy	Paddy croplands characterized by inundation for a substantial portion of the growing season.
9	Wetland, Permanent/Herbaceous	Areas where the water table is at or near the surface for a substantial portion of the growing season. Vegetated wetlands consist of herbaceous species only. Also includes playas, salt flats, and non-tidal mud flats.
10	Wetland, Mangrove	Sheltered coastal (i.e., estuarine tropical wetlands supporting woody species of Mangrove.
11	Water	All water bodies of size greater than 0.08 ha (1 TM pixel).
12	Permanent Ice and Snow	Land areas covered permanently or nearly permanently with ice or snow.
13	Cloud/Cloud Shadow/No Data	Areas where no land cover interpretation is possible due to obstruction caused by clouds and their shadows, smoke, haze, terrain shadow, or satellite or transmission malfunction.

[11] For each land use category, first, absolute value of area differences (between IKONOS and Landsat TM land use categories) are obtained and summed, then their percent share in total basin area is computed.
[12] www.geocover.com .

6. RESULTS AND DISCUSSIONS

In this research, the focus is directed to the land use changes in the surface water resource basins within the provincial boundary of Istanbul. Among the land use changes, the size of *built-up areas* and its change over time is the center of attention. These land use changes between 1990 and 2005 are summarized in Table 4 - 9 in which the rows refer basins with their codes and the columns show the land use classifications defined in Table 2, except for Table 6 and 9, which are designed to show potentials of different satellite images with different resolutions over the case of Elmalı Basin.

Table 4 is prepared for Landsat GeoCover satellite images and shows the changes in the basins between 1990 and 2000. Table 5 is arranged for Landsat TM satellite images and presents the changes in the basin between 1995 and 2005. These two tables lack a common base year to be able to compare the obtained land use classifications. However, they still provide information about the land uses in the water basins. Finally, including IKONOS 2005 land use classifications, Table 6 combines the results obtained from these three sources for only Elmalı Basin which is common in all. Though there is a base year difference between Landsat GeoCover and other IKONOS & Landsat TM, the obtained land use values worth paying attention to.

Any increase in built-up area is strongly associated with the decline in the other land uses; therefore, for each basin, all negative changes in, other than *built-up area*, land use classification are summed up and its correlation with positive value changes in *built-up* areas is calculated. Results show that correlations obtained from the Landsat GeoCover classifications are very weak, $r = 0.014$, but correlations obtained from the Landsat TM classifications are as expected negative and relatively strong, $r = -0.715$. This indicates that Landsat TM is relatively better tool compared to Landsat GeoCover in order to monitor the land use changes especially for *built-up* areas.

Both tables (Table 4 and 5) also show the changes in the built up areas especially in the basins closer to the core of the City of Istanbul. The highly occupied water resource basins in Table 4 and 5 are Elmalı (10), Ömerli (11), Alibeyköy (8), Küçükçekmece (9), and Sazlıdere (7) water basins. Both Figure 5 and 6 summarize the changes in built-up areas, which are shown by red (for the beginning of period) and black (for the changes in the following ten-year-period).

Between Figure 5 and 6 which are respectively based on 1990-2000 Landsat GeoCover and 1995- 2005 Landsat TM satellite images, there is an apparent resolution difference which can be seen in the solid black spots referring recent growths in built-up areas.

Table 4: Land Use Classification and Changes (ha) Between 1990 and 2000 (Landsat GeoCover LC 1990 & 2000)

Basin Code	Basin	Barren Ground			Cloud			Wetland			Cropland			Forest-Deciduous			Forest Evergreen			Built-up Area			Water			Scrub/Brush			Grassland			Total		
		1990	2000	Δ	1990	2000	Δ	1990	2000	Δ	1990	2000	Δ	1990	2000	Δ	1990	2000	Δ	1990	2000	Δ	1990	2000	Δ	1990	2000	Δ	1990	2000	Δ	1990	2000	Δ
1	Elmalıdere	7	45	38	0	0	0	0	0	0	0	0	-0	2234	2173	-60	2	2	-0	0	19	19	1	3	2	136	138	1	0	0	0	2381	2381	-0
2	Büyükdere	0	25	25	0	0	0	2	0	-2	0	0	0	7388	7292	-96	77	76	-1	0	29	29	2	45	43	490	492	2	0	0	0	7960	7960	0
3	Kuzuludere	0	12	12	0	0	0	0	0	0	0	0	0	3138	3115	-24	6	6	0	0	0	0	0	30	30	154	137	-17	2	0	-2	3300	3300	0
4	Düzdere	0	9	9	0	0	0	0	0	0	12	12	1	750	726	-24	0	0	0	0	0	0	0	5	5	229	240	11	1	0	-1	991	991	-0
5	Terkos	377	348	-29	0	0	0	873	1343	470	9820	9608	-213	26157	25837	-320	544	514	-29	310	309	-0	3760	3426	-334	29990	30304	314	1793	1934	141	73623	73623	-0
6	Büyükçekmece	438	488	50	0	0	0	0	0	0	44797	44286	-510	5048	4906	-142	97	94	-3	628	780	152	2245	2500	254	8556	8509	-47	1355	1600	245	63165	63165	0
7	Sazlıdere	129	201	72	0	0	0	0	0	0	8849	10063	1214	924	1170	246	703	698	-5	0	0	0	61	659	598	2291	2309	18	3911	1766	-2145	16867	16867	-0
8	Alibeyköy	1033	1430	397	0	0	0	0	0	0	2713	2075	-638	4952	4659	-293	1369	1316	-53	848	842	-6	330	285	-46	3856	4203	347	784	1076	292	15886	15886	-0
9	Küçükçekmece	538	383	-154	0	0	0	10	11	1	10059	9308	-751	0	0	0	13	13	-0	1511	3571	2060	1666	1650	-16	1616	1254	-362	2505	1727	-778	17917	17917	0
10	Elmalı	200	169	-31	0	0	0	0	0	0	2	9	7	676	666	-10	1363	1337	-26	2117	2347	230	90	77	-13	2654	2676	22	1240	1060	-179	8341	8341	0
11	Ömerli	1400	1116	-284	0	0	0	0	0	0	3196	2975	-221	5878	5844	-34	4194	4307	113	2690	4968	2278	2026	1950	-76	15333	14786	-547	6319	5090	-1229	41036	41036	0
12	Darlık	273	102	-171	0	0	0	0	0	0	191	210	19	4478	4433	-45	909	799	-110	0	0	0	1	526	525	4168	4040	-128	362	271	-91	10382	10382	-1
ALL		**4394**	**4329**	-65	**0**	**0**	0	**885**	**1354**	469	**79639**	**78547**	-1092	**61622**	**60821**	-801	**9278**	**9163**	-114	**8103**	**12865**	4761	**10182**	**11156**	974	**69473**	**69087**	-386	**18271**	**14525**	-3746	**261848**	**261847**	-1

Table 5: Land Use Classification and Changes (ha) Between 1995 and 2005 (Landsat TM 1995 & 2005)

Basin Code	Basin	Barren Ground			Cloud			Wetland			Cropland			Forest-Deciduous			Forest Evergreen			Built-up Area			Water			Scrub/Brush			Grassland			Total		
		1995	2005	Δ	1995	2005	Δ	1995	2005	Δ	1995	2005	Δ	1995	2005	Δ	1995	2005	Δ	1995	2005	Δ	1995	2005	Δ	1995	2005	Δ	1995	2005	Δ	1995	2005	Δ
1	Elmalıdere	23	0	-23	0	18	18	0	0	0	67	0	-67	1211	950	-261	14	0	-13	2	0	-2	0	0	0	127	50	-77	1	0	-1	1444	1018	-427
2	Büyükdere	11	0	-11	0	177	177	0	0	0	131	0	-131	7254	7167	-87	95	127	32	0	0	-0	0	0	0	388	137	-252	8	10	2	7887	7617	-269
3	Kuzuludere	17	11	-6	0	276	276	0	0	0	126	0	-126	2864	2860	-4	25	53	28	0	2	2	0	25	25	267	72	-195	1	1	0	3299	3299	0
4	Düzdere	6	3	-3	0	125	125	0	0	0	63	0	-63	898	750	-148	4	33	30	0	0	-0	0	5	5	21	75	55	0	0	0	991	991	-0
5	Terkos	962	183	-779	221	741	521	245	244	-1	14448	7191	-7257	25585	50756	25171	452	1558	1106	340	365	25	3295	3778	483	27763	8282	-19481	228	440	212	73538	73538	0
6	Büyükçekmece	586	1220	634	30	0	-30	1	1	-0	44862	39397	-5466	5233	10665	5433	87	409	321	1149	1639	490	2271	2641	370	8793	5936	-2857	152	1257	1105	63165	63165	0
7	Sazlıdere	148	270	122	8	21	13	0	0	0	11448	7691	-3758	1372	1733	362	606	990	384	518	622	104	48	895	847	2684	2890	206	34	1755	1721	16867	16867	0
8	Alibeyköy	1150	1003	-146	105	0	-105	7	0	-7	3891	807	-3084	4166	5280	1114	1246	2456	1210	1253	1051	-202	230	605	375	3710	4362	651	128	322	193	15886	15886	0
9	Küçükçekmece	455	694	239	72	0	-72	0	0	-0	8810	4266	-4544	135	42	-93	22	30	9	3525	4730	1204	1594	1693	100	3005	5995	2990	298	432	134	17917	17883	-34
10	Elmalı	86	61	-24	1	0	-1	0	0	0	2061	117	-1944	1218	1787	569	1591	1991	400	2444	3233	789	55	72	17	837	1080	242	48	0	-48	8341	8341	0
11	Ömerli	529	412	-117	651	816	165	37	6	-31	7381	6476	-905	6596	10387	3791	6561	6696	135	5076	6053	977	1439	2073	634	12237	8779	-3459	529	98	-430	41036	41796	759
12	Darlık	12	0	-12	6	1404	1398	0	0	0	728	833	105	5717	5710	-7	796	671	-125	18	0	-18	372	0	-372	2707	1228	-1479	26	56	30	10382	9902	-480
ALL		**3984**	**3858**	-126	**1093**	**3578**	2486	**291**	**251**	-40	**94017**	**66777**	-27240	**62249**	**98087**	35839	**11497**	**15014**	3517	**14327**	**17695**	3368	**9303**	**11787**	2484	**62538**	**38884**	-23654	**1454**	**4371**	2918	**260753**	**260304**	-449

Table 6: Land Use Changes (ha) in Elmalı Basin Using Different Image Sources

Year / Source	Barren Ground			Cloud			Wetland			Cropland			Forest-Deciduous			Forest Evergreen			Built-up Area			Water			Scrub/Brush			Grassland			Total		
Year	**1990**	**2000**	Δ	**1990**	**2000**	Δ	**1990**	**2000**	Δ	**1990**	**2000**	Δ	**1990**	**2000**	Δ	**1990**	**2000**	Δ	**1990**	**2000**	Δ	**1990**	**2000**	Δ	**1990**	**2000**	Δ	**1990**	**2000**	Δ	**1990**	**2000**	Δ
Landsat GeoCover LC	200	169	-31	0	0	0	0	0	0	2	9	7	676	666	-10	1363	1337	-26	2117	2347	230	90	77	-13	2654	2676	22	1240	1060	-179	8341	8341	0
Year	**1995**	**2005**	Δ	**1995**	**2005**	Δ	**1995**	**2005**	Δ	**1995**	**2005**	Δ	**1995**	**2005**	Δ	**1995**	**2005**	Δ	**1995**	**2005**	Δ	**1995**	**2005**	Δ	**1995**	**2005**	Δ	**1995**	**2005**	Δ	**1995**	**2005**	Δ
Landsat TM	86	61	-24	1	0	-1	0	0	0	2061	117	-1944	1218	1787	569	1591	1991	400	2444	3233	789	55	72	17	837	1080	242	48	0	-48	8341	8341	0
IKONOS		59			0			0			121			1699			1950			3312			75			1125			1			8342		

Different from the Table 4 and 5, Table 6 includes IKONOS 2005 land use classifications for Elmalı Basin (10), which is only comparable to the Landsat TM 2005. The obtained classifications are reasonably close to each other.

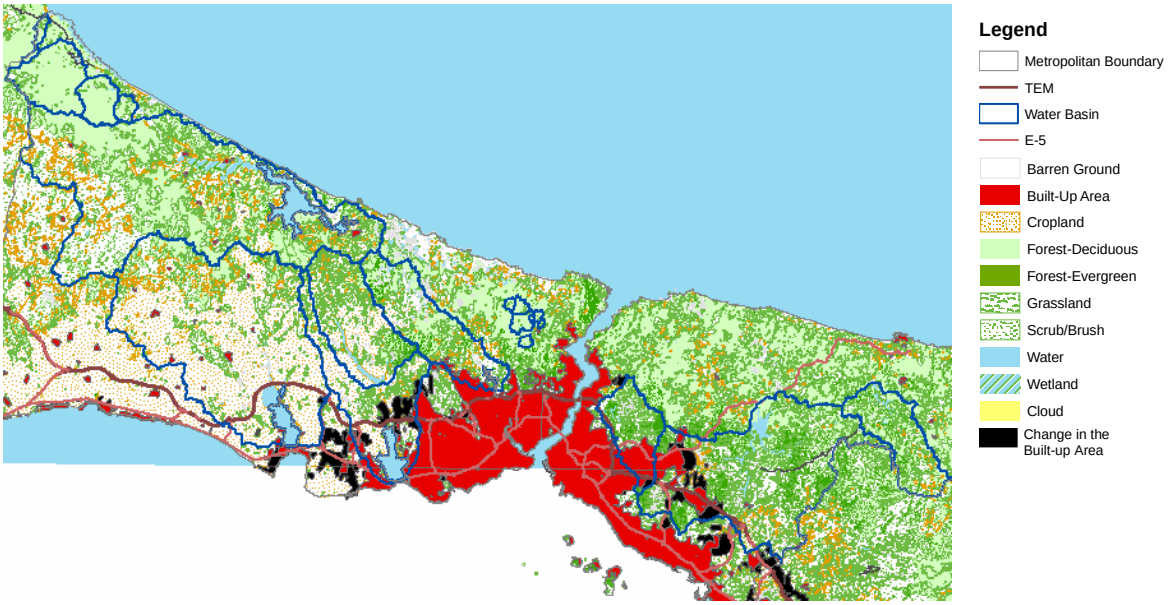

Figure 5: Land Use Classification by Landsat GeoCover LC – 1990 – 2000

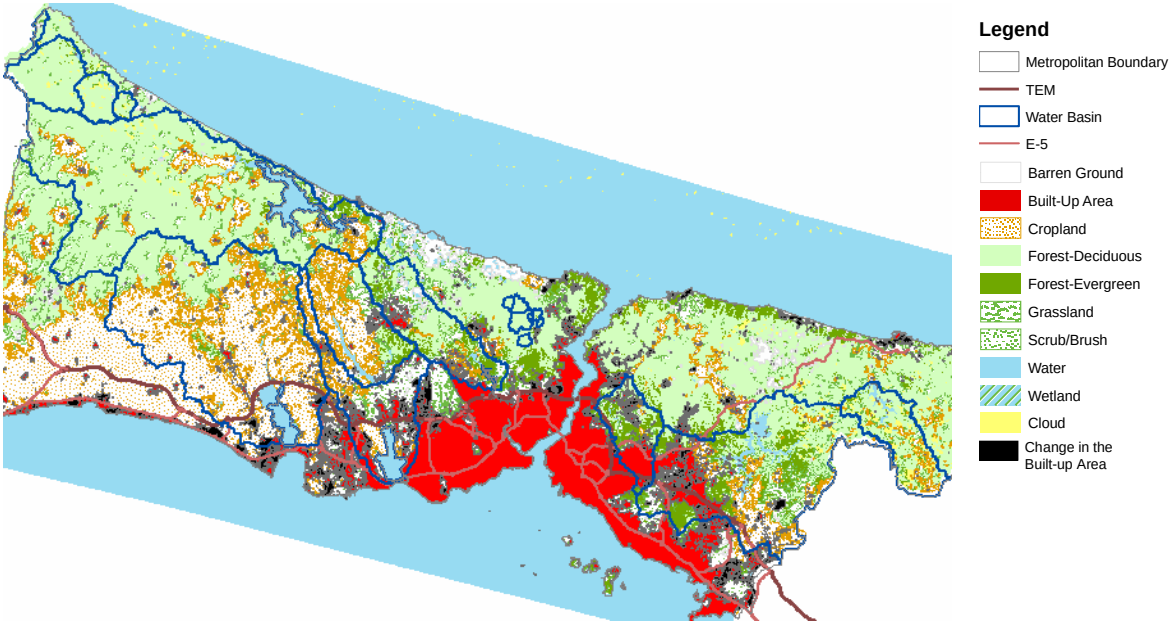

Figure 6: Land Use Classification by Landsat TM – 1995 -2005

As a detailed subset of Table 4 and 5, Table 7, 8, and 9 focus on built-up areas, which are almost irreversible facts in the water basins. Using Landsat GeoCover, Table 7 shows the size of built-up areas and their percentages for each basin, and the changes in percents between the years 1990 and 2000 in Istanbul. The corresponding values for the years 1995 and 2005 are presented in Table 8, but this time, by using Landsat TM satellite images.

In Table 7, in 1990, in terms of total size of built-up areas, Ömerli Basin (11) comes first, which is followed by Elmalı (10), Küçükçekmece (9) (not a drinking water resources basins), Alibeyköy (8), Büyükçekmece (6), and Terkos (5) basins. Ten years later, in 2000, Küçükçekmece Basin comes before Elmalı Basin. The reason for this is the official removal of Küçükçekmece Basin from the list of drinking water resources basins. Regarding the built-up areas as percentages of the total basin areas, the largest share is in Elmalı Basin (25% in 1990 and 28% in 2000), which is followed by Küçükçekmece & Ömerli basins (respectively by 8.4 and 6.6% in 1990, and 8.4 and 12.1% in 2000). From the same table, from 1990 to 2000, the largest changes in the built-up area are observed for these same three basins; Ömerli (11), Küçükçekmece (9), and Elmalı (10). These figures are graphically presented in Figure 7, 11, 14, and 17 for the basins surrounding the City of Istanbul. The current situations on the water resources basins are captured in Figure 10, 13, 16, and 19.

Table 7: The Changes in the Built-up Area via Landsat GeoCover

Basin Code	Basin	Built-up Area								Total	
		1990			2000			Change			
		ha	% in the Basin	% in All Basins	ha	% in the Basin	% in All Basins	ha	%	1990	2000
1	Elmalıdere	0	0.0	0.0	19	0.8	0.0	19	---	2381	2381
2	Büyükdere	0	0.0	0.0	29	0.4	0.0	29	---	7960	7960
3	Kuzuludere	0	0.0	0.0	0	0.0	0.0	0	---	3300	3300
4	Düzdere	0	0.0	0.0	0	0.0	0.0	0	---	991	991
5	Terkos	310	0.4	0.1	309	0.4	0.1	0	0	73623	73623
6	Büyükçekmece	628	1.0	0.2	780	1.2	0.3	152	24	63165	63165
7	Sazlıdere	0	0.0	0.0	0	0.0	0.0	0	---	16867	16867
8	Alibeyköy	848	5.3	0.3	842	5.3	0.3	-6	-1	15886	15886
9	Küçükçekmece	1511	8.4	0.6	3571	19.9	1.4	2060	136	17917	17917
10	Elmalı	2117	25.4	0.8	2347	28.1	0.9	230	11	8341	8341
11	Ömerli	2690	6.6	1.0	4968	12.1	1.9	2278	85	41036	41036
12	Darlık	0	0.0	0.0	0	0.0	0.0	0	---	10382	10382
ALL		**8103**	**3.1**	**3.1**	**12865**	**4.9**	**4.9**	**4761**	**59**	**261848**	**261847**

In Table 8, in 1995, regarding the total size of built-up area, Ömerli (11) is on the top of the list again. It is followed by Küçükçekmece (9) (not a drinking water resources basins), Elmalı (10), Alibeyköy (8), Büyükçekmece (6), Sazlıdere (7), and Terkos (5) basins. Ten years later, in 2005, Büyükçekmece Basin comes after Elmalı but before Alibeyköy Basin. The built-up areas as a percent of basin areas, the largest share is in Elmalı Basin (29% in 1995 and 38% in 2005), and Küçükçekmece & Ömerli basins

follow it (respectively by 19.7 and 12.4% in 1995, and 26.4 and 14.8% in 2005). Table 8 also shows that from 1995 to 2005, the largest changes in the built-up area are observed in Küçükçekmece (9), Ömerli (11), Elmalı (10) and Büyükçekmece (6) basins. These figures are graphically presented in Figure 8, 12, 15, and 18 for the basins surrounding the City of Istanbul. The Figure 10, 13, 16, and 19 provide the photos reflecting the current situations on the water resources basins.

Table 8: The Changes in the Built-up Area via Landsat TM

Basin Code	Basin	Built-up Area								Total	
		1995			2005			Change			
		ha	% in the Basin	% in All Basins	ha	% in the Basin	% in All Basins	ha	%	1995	2005
1	Elmalıdere	2	0.1	0.0	0	0.0	0.0	-2	-100	1444	1018
2	Büyükdere	0	0.0	0.0	0	0.0	0.0	0	-100	7887	7617
3	Kuzuludere	0	0.0	0.0	2	0.1	0.0	2	---	3299	3299
4	Düzdere	0	0.0	0.0	0	0.0	0.0	0	-100	991	991
5	Terkos	340	0.5	0.1	365	0.5	0.1	25	7	73538	73538
6	Büyükçekmece	1149	1.8	0.4	1639	2.6	0.6	490	43	63165	63165
7	Sazlıdere	518	3.1	0.2	622	3.7	0.2	104	20	16867	16867
8	Alibeyköy	1253	7.9	0.5	1051	6.6	0.4	-202	-16	15886	15886
9	Küçükçekmece	3525	19.7	1.4	4730	26.4	1.8	1204	34	17917	17883
10	Elmalı	2444	29.3	0.9	3233	38.8	1.2	789	32	8341	8341
11	Ömerli	5076	12.4	1.9	6053	14.8	2.3	977	19	41036	41796
12	Darlık	18	0.2	0.0	0	0.0	0.0	-18	-100	10382	9902
ALL		**14327**	**5.5**	**5.5**	**17695**	**6.8**	**6.8**	**3368**	**24**	**260753**	**260304**

As stated before, Landsat GeoCover images are based on 40 m resolution, and applies 5 ha elimination technique; therefore, the computed built area values turn out to be too rough for land use classifications compared to Landsat TM and IKONOS images. If there is sufficiently intense built-up area in and out of basin, then processed Landsat GeoCover provides red and black colored spots representing built-up areas in Figure 7, 11, 14, and 17. To illustrate, Figure 17 and 18 show the treatment difference between Landsat GeoCover and Landsat TM over Arnavutköy and surrounding municipal district, which is shared by both Sazlıdere (7) and Alibeyköy (8) water resource basins. Arnavutköy and surrounding settlements are completely disappeared in the analyses based on Landsat GeoCover images. Similar results are also apparent in Figure 7 over Çavuşbaşı and Çekmeköy Municipal Districts in Elmalı Basin (10) and in Figure 11 in Ömerli Basin (11).

In Table 9, the total built-up areas in Elmalı Basin computed from 2000-Landsat GeoCover images are found to be less than the total built-up areas in the same basin computed from 1995-Landsat TM. Therefore, it can be said that Landsat GeoCover is insufficient to make detailed analyses in the basins. The same table (9) also presents that 2005-IKONOS image provides almost the same built-up area figures with the 2005-Landsat TM images. It should be noted that IKONOS images have 1 m resolutions and provide quite extensive details in the classification process.

In the following ten-year-periods, new built-up areas shown by black spots present the new developments increasing the density and closing the gaps between settlements. During these periods, there are also scattered leap frog developments spread out in the basins represented by the same color-coded black spots. These developments are partially associated with the large regional scale capital improvement projects, which are the second bridge crossing the Bosporus and TEM. However, the fact that the second bridge crossing the Bosporus and TEM became operational in 1989, and that most of the built-up areas in all basins occurred prior to the year 1990 (see Figures 7-18, especially those figures obtained from 1990 Landsat GeoCover images) indicate that these capital improvements are not solely to blame for the unplanned developments in the water resources basins.

Table 9: The Changes in the Built-up Area in the Case of Elmalı Basin

Source \ Year	**Built-up Area**								**Total**
	Area (ha)	% in the Basin	% in All Basins	Area (ha)	% in the Basin	% in All Basins	Area Change (ha)	Area Change (%)	
Year	**1990**			**2000**					
Landsat GeoCover	2117	25,4	0,8	2347	28,1	0,9	230	11	8341
Year	**1995**			**2005**					
Landsat TM	2444	29,3	0,9	3233	38,8	1,2	789	32	8341
IKONOS				3312	39,7	1,3			8342

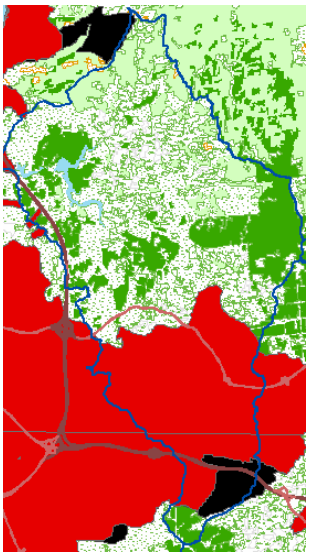

Figure 7: The Change in Built-up Area in Elmalı Basin (10) via 1990-2000 Landsat GeoCover

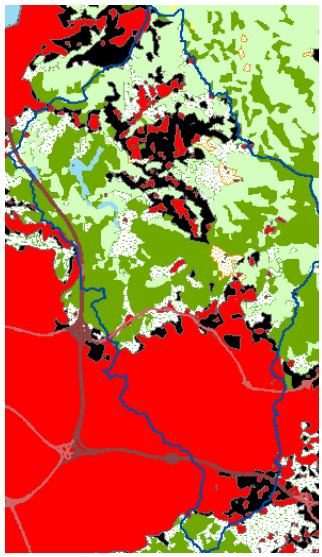

Figure 8: The Change in Built-up Area in Elmalı Basin (10) via 1995-2005 Landsat TM

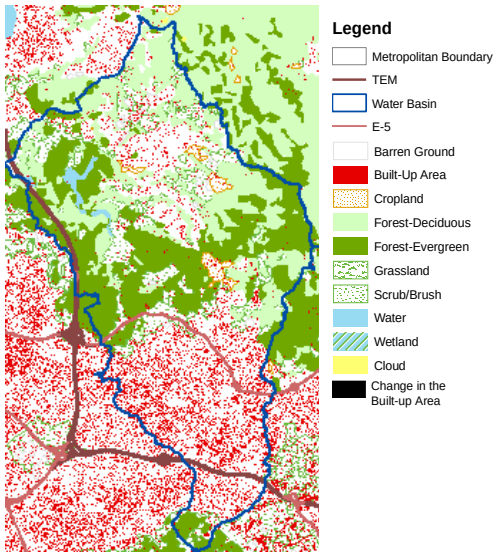

Figure 9: The Built-up Area in Elmalı Basin (10) via 2005 - IKONOS

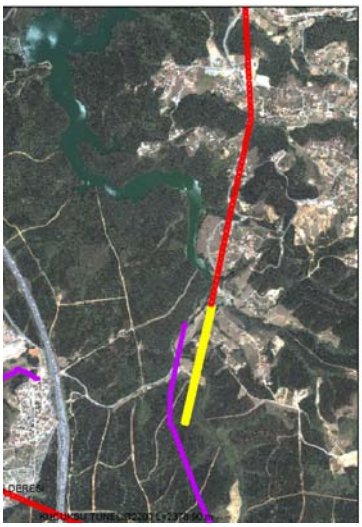

Figure 10: Built-up Areas in Elmalı Basin[13]

[13] Picture on the left obtained from the "*Asya Yakası Dereleri Ekim 2005 Bilgi Notları"*

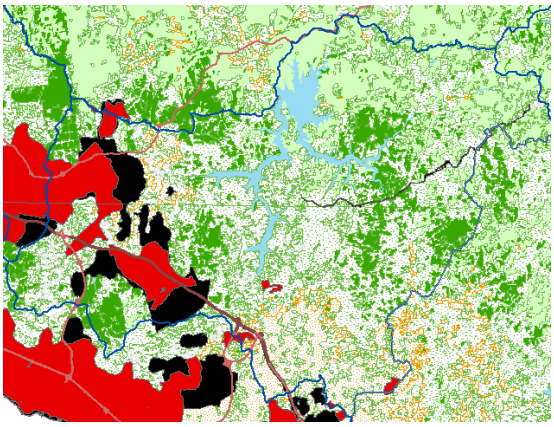

Figure 11: The Change in Built-up Area in Ömerli Basin (11) via 1990-2000 Landsat GeoCover

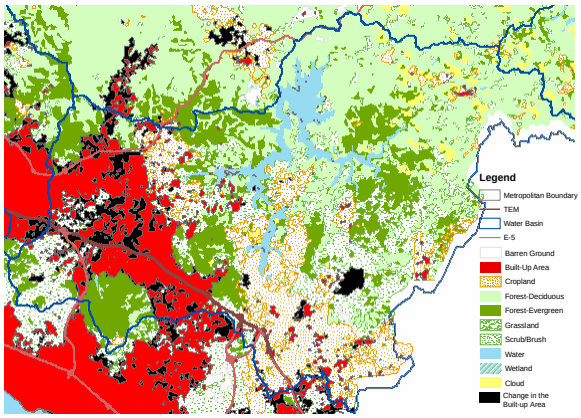

Figure 12: The Change in Built-up Area in Ömerli Basin (11) via 1995-2005 Landsat TM

Figure 13: Built-up Area in Ömerli Basin[14]

[14] The picture on the left is obtained from İSKİ.

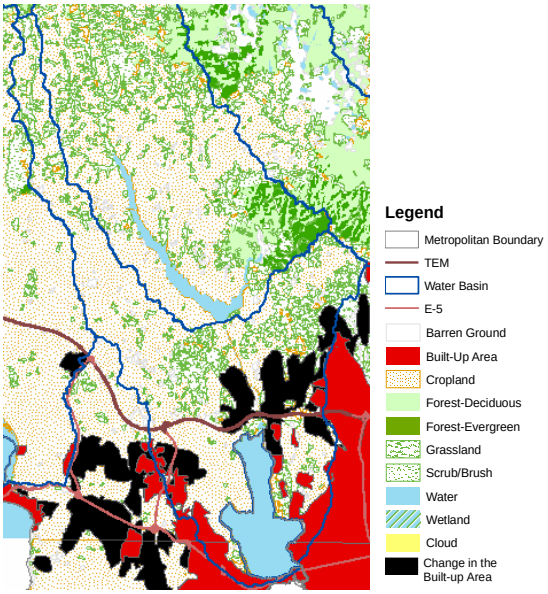

Figure 14: The Change in Built-up Area in Küçükçekmece Basin (9) via 1990-2000 Landsat GeoCover

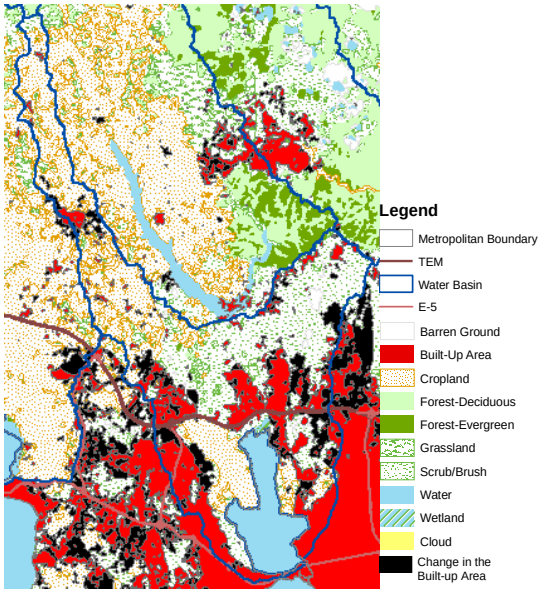

Figure 15: The Change in Built-up Area in Küçükçekmece Basin (9) via 1995-2005 Landsat TM

Figure 16: Built-up Area in Küçükçekmece Basin

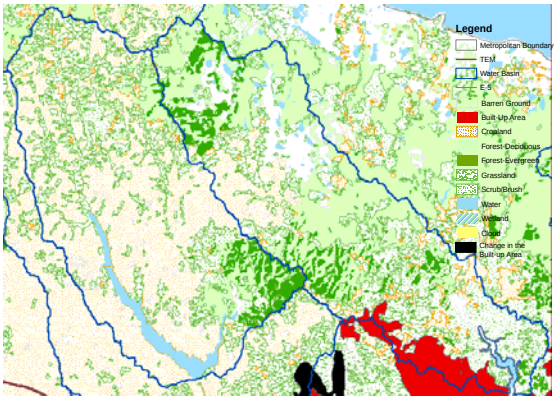

Figure 17: The Change in Built-up Area in Alibeyköy (8) and Sazlıdere (7) Basins via 1990-2000 Landsat GeoCover

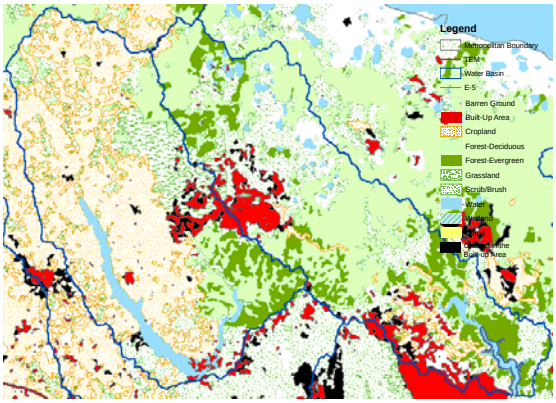

Figure 18: The Change in Built-up Area in Alibeyköy (8) and Sazlıdere (7) Basins via 1995-2005 Landsat TM

Figure 19: Built-up Area in Sazlıdere and Alibeyköy Basin[15]

6.1. Discussion: The Reasons for Illegal Occupations in the Water Resources Basins

Though, there is not a certain figure, it is generally accepted that around 60-70% of Istanbul developed illegally without any plan. A non-negligible portion of these developments has been in the water resources basins. Lack of planning was not the only reason for such uncontrolled development; the desperation of a society in transition from an agrarian economy to industrial one, and the inability of the government institutions in controlling these overwhelmingly rapid changes are also worth to inquiry. None being independent of the others, there are many dimensions in the process of illegal occupation

[15] The picture on the left is obtained from İSKİ.

of water resources basins in Istanbul, of which major ones are the physical, socio-economic and political, and legal dimensions.

The Physical Dimensions: According to the Charter of Athens, cities have four functions: dwelling, work, recreation, and transportation.[16] Daily human life on space continues among dwelling, work, and recreation activities interlinked by transportation facilities. While people selecting their home and work location, they try to optimize their scarce time and monetary resources in reaching those activities. In this respect, the government decisions implemented via planning and zoning on space determine spatial allocation of human activities. In the process of urbanization in Istanbul, local and central governments put more emphasis on the determination of industrial districts as a source of income and employment, and their accessibility to resource areas and markets via transport projects. Focusing mostly on economy, the governments lost track of, and in some cases disregarded, the issue of controlling and managing dwelling and recreation based activities. As can be seen in Figure 20, there are several organized industrial zones in Istanbul, one of which directly at the boundary of Elmalı Basin named Dudullu Organized Industrial District.[17] On the east of Elmalı, there is Tuzla Organized Industrial District at the edge of Ömerli Basin. Both Organized Industrial Districts are served by TEM cutting through both basins and surrounded by settlements providing employees to these districts. On the European side, the industrial districts are scattered at the close distance of water resources basins, and are located around the major transportation lines, E-5, TEM and their connections. One of those industrial districts, named İkitelli Industrial District is at the edge of Küçükçekmece Basin (Figure 20), which is the most negatively affected basin in terms of the extent of surrounding settlements.

The Socio-Economic and Political Dimensions: In line with its high population growth rate, Turkey has been experiencing a rapid mechanization in agriculture which is followed by a rapid industrialization where environmental considerations are mostly disregarded. Rapid mechanization and high population growth rate in rural area have created an environment in which farm workers no longer could find employment opportunities to sustain their lives in their villages. On the other hand, initial migrants settling at the outskirts of large cities are relatively better-off as compared to rural counterparts. Their economic up-mobility has become a signal of abundance of opportunities in the large cities. This flow of information is transformed into hope for prospective immigrants seeking better lives around urban lands. Those migrants mostly occupied public and unprotected lands belonging to foundations (Figure 20). Not

[16] Ekistics, 1963, 264-267, in eds. of Günay, B. (1988). History of CIAM and TIAM 10. Journal of the Faculty of Architecture, 8(1), 29.

[17] İMES Organized Industrial Area is one of the major portion of Dudullu Organized Industrial District. And it was initiated in 1976 and completed in 1986.

necessarily totally occupied illegally, Table 10 shows scale of development on public lands as percentage of built-up areas.[18] The scale and the speed of this transition have been too overwhelming for the politicians and the local governments to develop planning methods to control the development and the means to implement them. Even in some cases, given the nature of the politics, elected officials, turn a blind eye to these activities for the sake of political support. During this period, environmental consciousness had not been as high as it is today, and the values of natural resources surrounding the city have not been well appreciated by neither the immigrants nor the politicians. Even in some areas, these values have been ignored in order to take the advantage of increasing urban land rent.

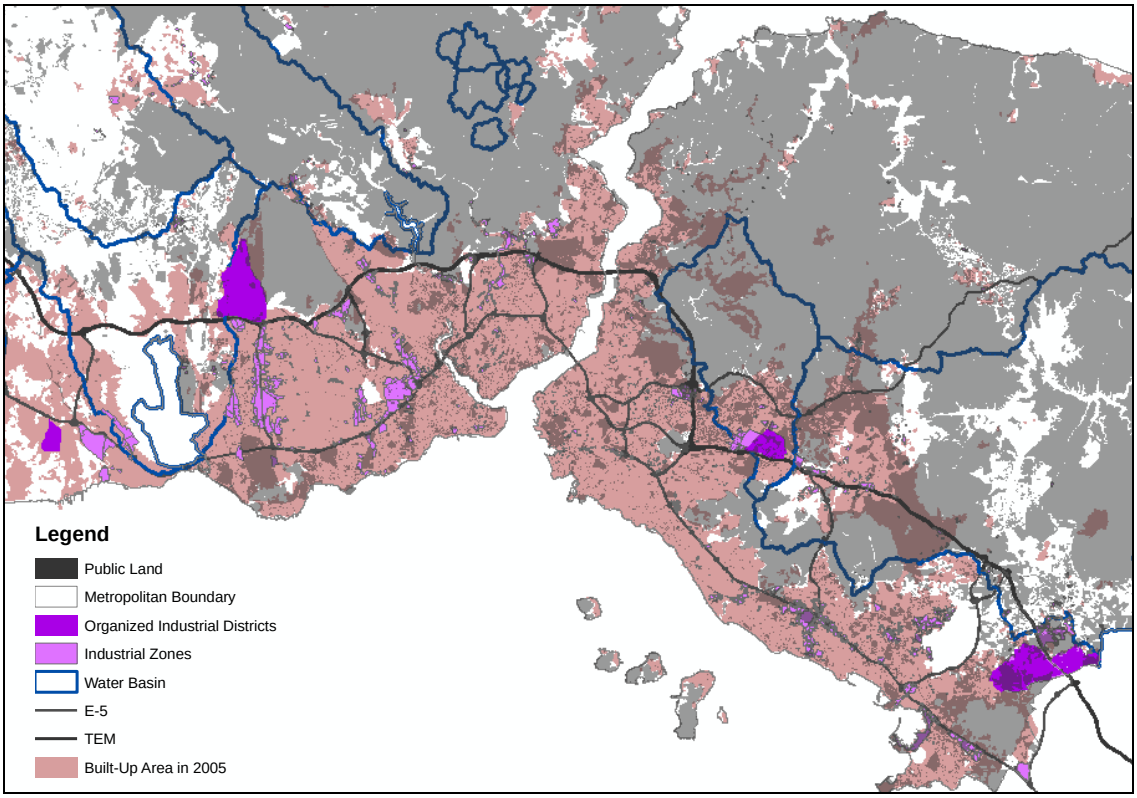

Figure 20: Transport Networks, Industrial Districts, Built-Up Areas (2005 Landsat TM), Public Lands and their Relations with the Water Resource Basins[19]

[18] Public land is a combined set of municipal lands, provincial public lands, district level public lands, state treasury lands, public forest areas, properties of foundations, military zones, and other public lands. All these classifications are presented by the grey color in Figure 20. Built-up areas figures are based on the classification obtained from Landsat TM 2005.

[19] Industrial spots are obtained from IMP. The Public land classifications are obtained form BİMTAŞ Remote Sensing and GIS Department and processed for the purpose of this research.

Table 10: The Area and Share of Public Land in the Built-up Area on the Water Basins

Water Resources Basins		Elmaldere	Büyükdere	Kuzuludere	Düzdere	Terkos	Büyükçekmece	Sazlıdere	Alibeyköy	Küçükçekmece	Elmalı	Ömerli	Darlık	Total
Basin Code		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**ALL**
Built-up Area on Public Land	**(ha)**	0	0	2	0	101	59	21	168	1324	2429	3639	0	**7743**
Total Built-up Area	**(ha)**	0	0	2	0	365	1639	622	1051	4730	3233	6053	0	**17695**
Share of Public Land	**(%)**	---	---	100	---	28	4	3	16	28	75	60	---	**44**

The Legal Dimension: Illegal developments in the water resources basins can be explained by 1) uncertainty in jurisdictional authority, 2) slow judicial process, and 3) absence of stable and effective water resources protection law strengthening the enforcement power of the Istanbul Water and Sewerage Directorate (İSKİ).

- *Uncertainty in jurisdictional authority and reluctance to take responsibility of coping with illegal and unplanned developments:* According to the Metropolitan Municipalities Act of 1984 (No. 3030), Greater Istanbul Metropolitan Municipality (GIMM) is sub-divided into District (İlçe) Municipalities (DM) of which there were 27 in Istanbul (Figure 21). This act lacked the clarification of authority between the different levels of governance, especially between GIMM and some of DMs. The authority given GIMM fell short of against with illegal developments in and out of water resource basins. This has become highly noticeable especially during the general and local election campaigning periods during which governing authorities of DM, Town (Belde) Municipalities (TM), even Ministries have acted pragmatically not to loose political support and showed reluctance to monitor illegal developments.[20] As a result, the spots in brick color overlaid by the transparent yellow shown in Figure 21 covered the water resource basins. In order to bring about a sound solution to this problem, Metropolitan Municipalities Act of 2004 (No: 5216) has been passed. The new law aimed at correcting the shortcomings of the Metropolitan Municipalities Act of 1984 (No. 3030).[21] According to Article 10 of the new act, GIMM has been entitled to inspect and take the necessary actions in fight against illegal and unplanned growths within boundaries of the Province of Istanbul as opposed to the boundary lines drawn by the Act of 1984 (No 3030) which left greater parts of the basins out of control of GIMM.
- *Slow judicial process:* İSKİ is the legal institution entitled to protect quantity and quality of water resources in Istanbul and to take any necessary technical and legal steps to this ends. İSKİ also prepares reports and provides opinions about plans

[20] www.belgenet.com/yasa/k5216-2.html
[21] www.ibb.gov.tr

prepared by DM and TM. However, there are cases that DM, TM, even Ministries involved planning process have disregarded İSKİ opinions, and approved their plans in their councils irrespective of İSKİ's concerns over protection of water resources. And there ever some cases that they totally ignored İSKİ and have not followed the due process. On the other hand, when İSKİ takes necessary legal steps to revoke the ongoing applications of those plans, the due process in the Administrative Court to revoke a plan normally takes 2-4 years. This is an ample time span for any plan to turn into a de facto physical existence. Unplanned developments in Ömerli Basin Sultanbeyli, Yenidoğan, Samandıra, in Elmalı Basin Çekmeköy, Çavuşbaşı, and in Alibeyköy ve Sazlıdere Basins Arnavutköy, etc. are examples of these settlements, which are represented in yellow and overlaid on top of the built-up area in Figure 21.

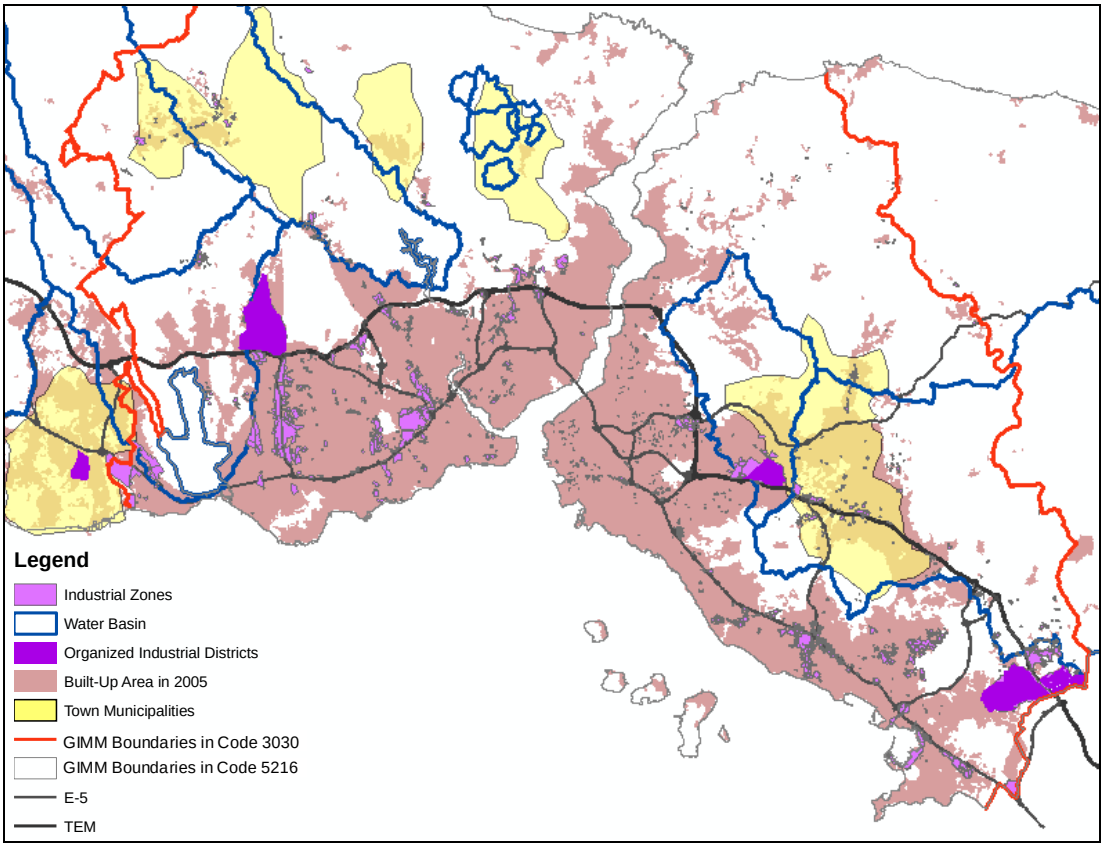

Figure 21: Transport Networks, Industrial & Built-Up Areas (Landsat TM), Jurisdictional Boundary of Towns Municipalities According to Code: 3030 and Relations with the Water Resource Basins[22]

[22] Industrial spots are obtained from IMP.

- *Absence of stable and consistent water resources protection law for the use of İSKİ:* İSKİ protects the water resource basins using a bylaw named as 'Regulation on Watershed Protection and Management of Drinking Water Reservoirs of Istanbul' dating back to the year 1984.[23] Proposed amendment on this bylaw in 1995, 1998, and 2003 have been sequentially canceled by the Administrative Court (İdare Mahkemesi) after a series of litigations by the Turkish Chambers of Architects which sought after better regulations and stricter restrictions on development in basins.[24] The most recent amendment on this bylaw is enacted in 2006. These interruptions in the legislative processes disrupted the effective implementation of the bylaw defining the maximum densities in water basins. Local governments in the basins have taken advantage of not having any bylaw restricting their density decisions in their jurisdictions and allowed higher densities for the sake of political gain. However, the Strategic Plan for Istanbul (Scale: 1/100000), which is in the process of approval, stipulates that the responsibility of taking planning decisions and determining the densities in the water basins is be left to the Planning Agencies of the Greater Istanbul Metropolitan Municipality (GIMM) instead of the bylaw.

In the literature, some of the large capital improvement projects, such as highways and bridges providing links between Asia and Europe have been pointed out as the foremost reason for this illegal occupation of public lands and water basins. In fact, this claim is partially true in terms of encouraging unplanned growth surrounding the highways and bridges by supplying accessibility; however, unplanned growth, by definition, is not an outcome of a plan, it is, first of all, an outcome of a system not providing timely and sound plans and; secondly, is due to absence of a legally strong, environmentally conscious, and inter-institutionally coordinated authority preparing and enforcing prepared plans.

7. CONCLUSION

Remote sensing techniques are outstanding tools to monitor spatial activities on space in time. It enables planners and policy makers see the spatial dynamics, and take appropriate actions proactively. In water resource planning and preservation works, there is an extensive potential uses of these techniques. In this study, first, uses and potentials of remote sensing techniques are shown, second, the potentials of available resources are evaluated, and third, starting from 1990 satellite images, the changes focused on basically built-up areas in the water resource basins in Istanbul are evaluated.

[23] Update years are sequentially 1986, 1988, 1990, 1992, 1995, 1998, 2003 and 2006.
[24] Güner, E. (2003). Su Havzaları ve Planlama İlişkisi, Master Thesis. İTÜ-İstanbul, p.48-49.

The satellite images provided by today's technology are the easiest snapshots picture of spatial data, which need to be processed in order to convert into information. This is also a replicable procedure giving the power of monitoring continuous changes in time spaces within certain intervals. In this research, it has been observed that the most critical land use changes are seen in the nearest basins to the city. It has been also observed that large public capital improvement projects such as Trans-European Motorway (TEM) and bridges crossing the Bosporus *contributed* to the trend of illegal occupation of these public lands in the water resource basins.

It has been argued in the literature that the government's capital investments such as bridges and highways increase the accessibility therefore cause the illegal occupation in these basins. However truth this may possesses, it is still needed to conduct thorough research and pre/post analyses before reaching an instant conclusion to develop any arguments against other capital improvement projects, such as a third bridge over the Bosporus, and the associated highway networks. Solutions for the illegal occupations and developments should be searched in planning discipline to control and manage any developments, and protecting the sensitive resources with its zoning tools and planning techniques sustained by consistent application of legal framework without any delays, exclusions, and abuses by proper political, administrative, and police powers.

There are other factors aside from the large capital projects and requiring in-depth analyses, affecting illegal occupations in the water resources basins:

- *Land ownership structure:* Compared to private land, it has been easy to occupy the public land illegally.
- *Existence of an employment opportunity, mainly industrial, in a reasonably close distance from the potential public lands:* Any public land closer to industrial districts used to be a potential site for illegal occupation.
- *Absence of a persistent and strong monitoring institution trying to protect the public property and guide the development:* The preserved lands have been the areas assigned mainly for the use of army and classified as military restricted zones.
- *Absence of a sound and strong legal base to prevent illegal occupations and absence of persistent police power to prevent and deter the unwarranted developments*.
- *Lack of public consciousness to preserve the water resource basins for the current and prospective uses of the City of Istanbul:* Municipal authorities' actions and political approaches to the problems need to be redirected towards the preservation and be backed by greater public support rather than rent seeking approach.
- *Also there has been shortage of human capital directing the spatial organization of transition from agrarian rural society to an industrialized urban one.*

GIMM (İstanbul Büyükşehir Belediyesi - İBB) and İSKİ has recently started to monitor these illegal developments in and out of the water basin via remote sensing tools and techniques, and then takes the necessary actions promptly. In this way, one of the primary reasons for illegal developments has been loosing ground ever more. In the ongoing transition period, progressive intends of politicians and local officials still play important roles in the journey of Turkey towards industrialization, and modernization. In this respect, the laws have been amended and updated to reflect the progressive approaches of the politicians. It should be noted that accession process to European Union has mobilized the society to tackle with the chronic problems of the country one of which is the spatial problems in and around the urban space.

Lastly, from the methodology stand point, given the resolution and technical differences in different sources of satellite images: It is observed that, Landsat GeoCover images are too rough for detailed policy analyses; however, it still provides pictures of spatial activity in time at macro scales, whereas, Landsat TM images with its relatively better resolution and better elimination technique provide much higher details in land use classifications. On the other hand, IKONOS images with their outstanding resolutions grant one-to-one plan and policy application potentials in micro scales.

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