

Investigation Land Use Changes in Megacity Istanbul Between the Years 1903-2010 by Using Different Types of Spatial Data

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SUMMARY

This study aims to as a result of rapid examine the temporal land use changes in the mega city of Istanbul, Turkey between 1903 and 2010. Urbanization has been rapidly increased due to industrialization and immigration from the other regions of Turkey especially after the year of 1960s. In this study, spatial distribution of urban sprawls and their temporal changes were analyzed and presented using different types of spatial data such as hard copy map produced in the year of 1903 and remotely sensed data obtained in 1987 and 2010. The conducted methodology to process these spatial data is presented in the study.

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1. INTRODUCTION

Integrated usage of remote sensing and space technologies have been utilized for multidisciplinary applications by several scientists. Satellite sensor images provide rapid, economic, up-to-date information of earth surface characteristics, and can be used for various researches. Remote sensing accommodates accurate and reliable information to many researchers with high spatial, spectral and temporal resolution, synoptic view and very short data collection time. Land cover which is a fundamental variable impacting and linking many parts of the human and physical environments can be derived using remotely sensed data. Several different applications such as management of environmental and natural resources, sea and coastline studies, land use/cover changes in global and regional scales, weather forecasting and climate modeling can be conducted using the remote sensing technology (Schweiger et al., 2005; Brivio et al., 2002; Ostir et al., 2002; Celikoyan, 2004; Kaya, et al., 2004; Ormeci and Ekercin, 2007).

Monitoring of urbanization using spatial data has been widely used by scientists, planners and decision makers etc. Most of the big cities of the world have faced to rapid urbanization due to heavy population. As it is known, currently, Istanbul is ranked among the first 20 crowded cities of the world (Seker, et al, 2010). Beyond its current population around 13 million, during the history of this ancient city that has hosted many different civilizations, it has always gained an attraction for human settlement due to its geographical location.

In this study, different types of spatial data obtained between 1903 and 2010 were used to derive land use changes occurred in Istanbul especially as a result of urbanization. Digitization and classification techniques were applied to spatial data set to determine the area of urban and non-urban classes. Urban area changes between 1903 and 2010 around Bosphorus Strait of Istanbul were presented. The study area was selected considering the size of the map produced in the year of 1903. It is found that while the total urban area was 11 % of selected region in 1903, it increased to 35 % in 2010, parallel to population increase.

2. THE STUDY AREA

The Marmara Region occupies the northwest corner of Turkey with a surface area of 67.000 km² and represents approximately 8.6% of the Turkish national territory. It is the smallest but most densely populated of the seven geographical regions of Turkey. The region experienced significant land cover changes as a result of rapid industrialization and population increase especially after 1980s. Istanbul, which is the biggest metropolitan of Turkey located in the Marmara Region, has been on the focus of these changes and selected as the study area which is given in Figure 1.

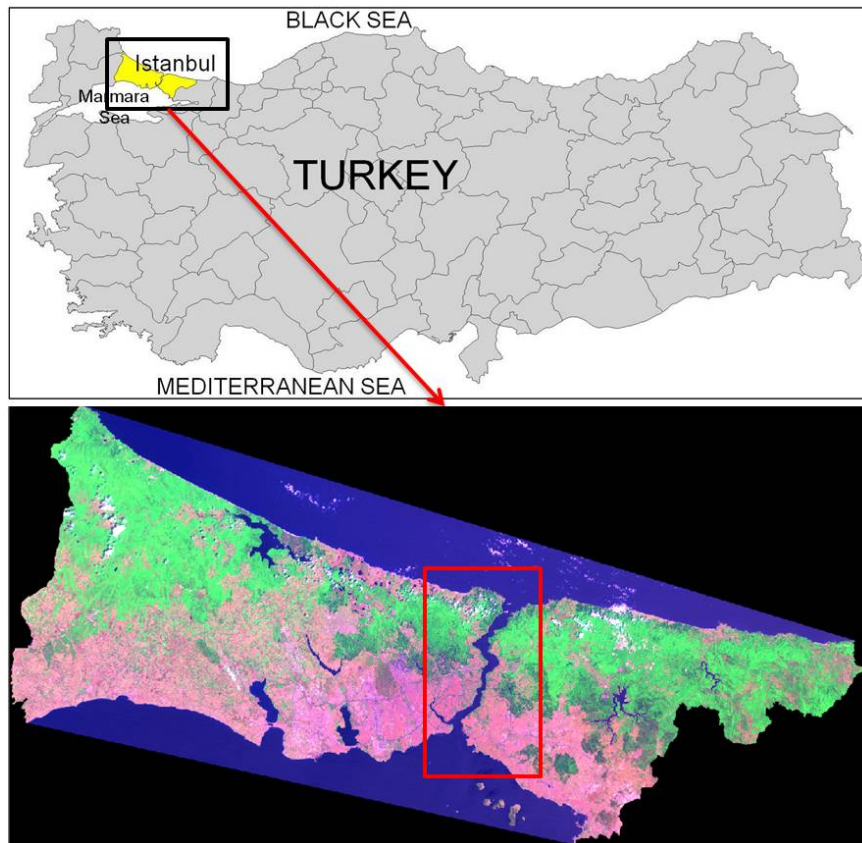


Figure 1. The Study Area

Istanbul is the most populated city of Turkey which has huge impact on Turkish Economy and it lies over two continents separated by the Bosphorus Strait. Istanbul is also one of the oldest cities in the world date back to B.C. 3000 and hosted as capital for several empires between AD 330 and 1923 namely Roman Empire, Eastern Roman Empire and Ottoman Empire.

Urbanization have increased and several agricultural and forest areas have been transformed into urban and built-up areas in Istanbul. The city population has been affected because of huge immigration, the city population was around 1 million in 1900s, it became 13 million in 2010 (URL-1). The population of Istanbul for different years is displayed in Figure 2.

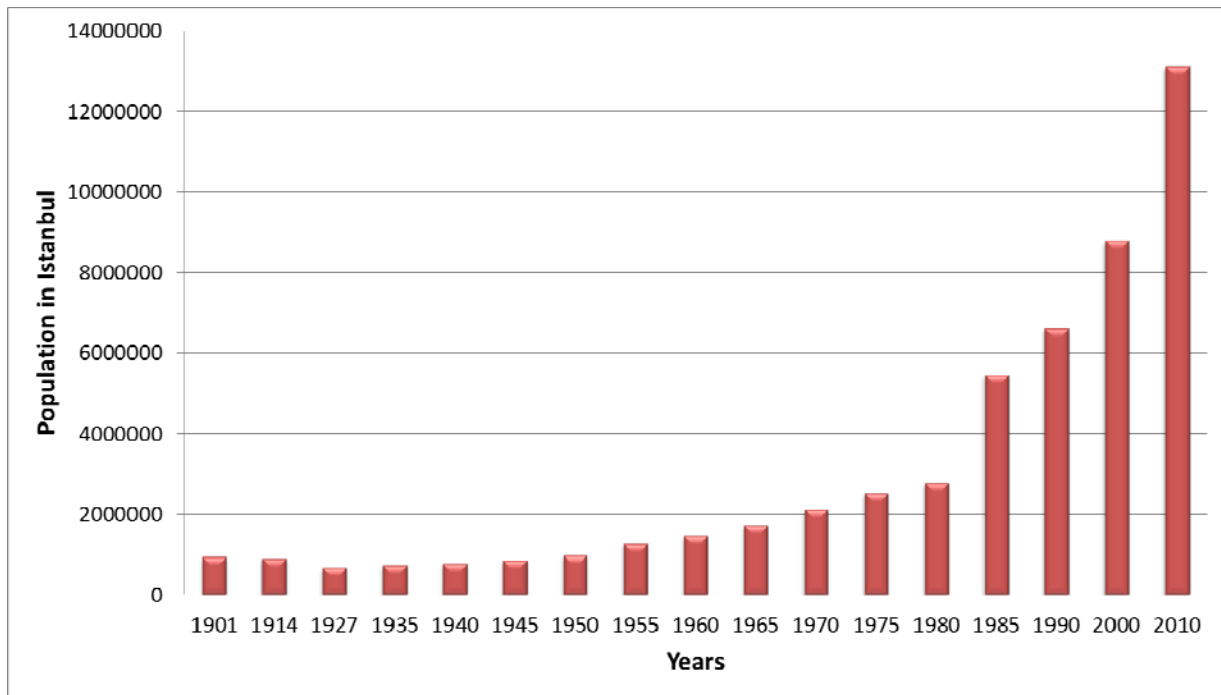


Figure 2: Population of Istanbul from the year of 1901(source; URL-1)

3. DATA and METHOD

Hard copy map and satellite imageries were used in this study as spatial data. The map of Istanbul prepared in 1903 by J. Sloniewski who is a French civil engineer in the period of the Ottoman Emperor, was used as the initial spatial data. This map includes the region around Bosphorus Strait which was the main settlement areas in those years. The boundary of this map was accepted as the borders of the study area and the latter spatial data were subset based on these boundaries. This map is given in Figure 3.

This map was scanned and converted into the digital format. Common points which could be seen both on this map and 1:25000 standard topographic maps of the study region were selected and used for the rectification. These points were also used as ground control point (GCP) during the geometric correction of satellite imageries.

The rectified map was digitized to delineate the spatial distribution of urban and non-urban areas. The total urban area was found as 9062 ha, while non-urban areas were calculated as 71128 ha of 80190 ha total area in 1903.



Figure 3. Hardcopy map of Istanbul dated 1903.

For the later period, Landsat 5TM satellite sensor imageries obtained in 1987 and 2010 were used. Satellite imageries were geometrically corrected and subset as explained above then classification was employed using ISODATA algorithm with 25 clusters and 95% convergence value. Four main first level classes including Sea, Forest, Agriculture and Urban were selected and 25 clusters were merged into these 4 classes. Obtained classification results are given in Table 1.

Table 1. Classification results of satellite imageries

	1987 (ha)	2010 (ha)
Urban	19258.92	27719.46
Agriculture	8427.78	3150.98
Water	17732.60	17789.90
Forest	34771.41	31530.37
Total	80190.71	80190.71

The classified imageries were rearranged as two classes namely urban and non-urban in order to facilitate the comparison with the 1903 map and focusing on the urbanized areas in the

selected region. Obtained thematic maps representing the urban and non-urban areas in the year of 1903, 1987 and 2010 are given in the Figure 4.

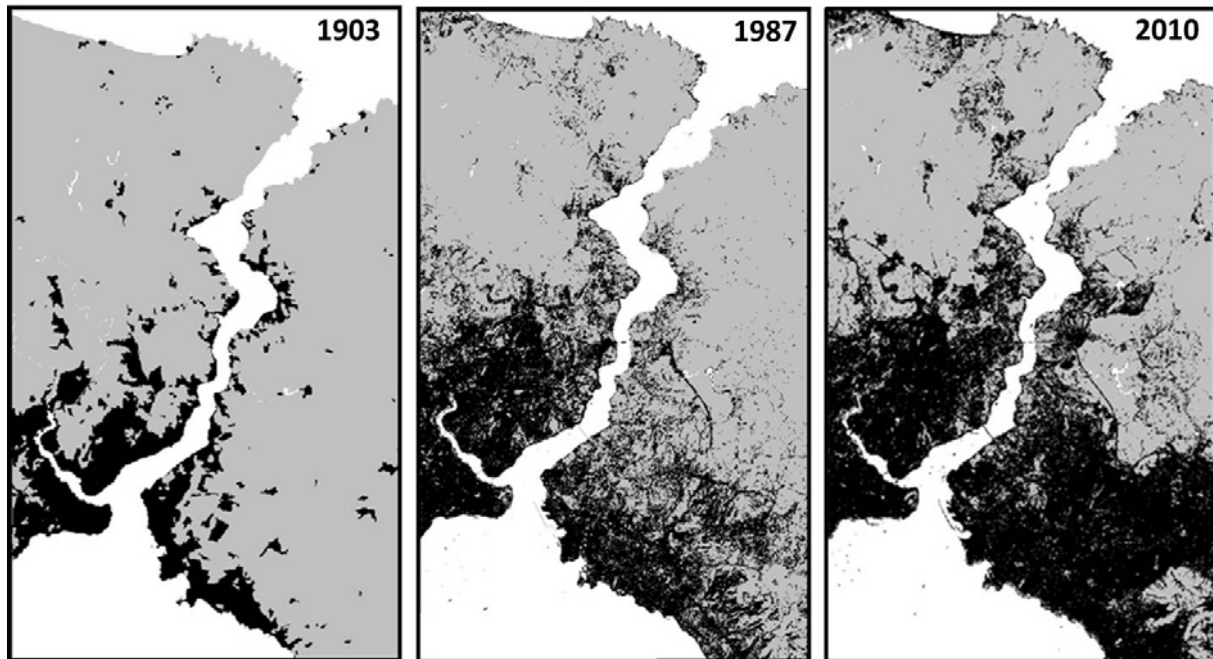


Figure 4. Thematic maps of the different years

The changes were examined in detail for different periods such as 1903-1987, 1987-2010 and 1903-2010. The analyses show that urban area increased from 11% to 24% between 1903 and 1987 representing the increase of 13%. Whereas, the area of urban class was 35% in 2010 representing a change of 11% between 1987 and 2010 and a change of 24% between 1903 and 2010. Since the selected area was a small portion of the Istanbul metropolitan administrative boundary, obtained results do not reflect the real situation in Istanbul, which might show much higher urbanization rate. Since there is no metadata for 1903 dated map, the accuracy assessment of the digitation procedure could not be evaluated.

4. CONCLUSIONS

A number of countries have been negatively affected as a result of last century's wars. Many cities collapsed or conquered and birth rate dropped dramatically. However, the world became industrialized after 1950s and this resulted in immigration from suburban to urban areas. Especially big cities of developing countries such as Istanbul have faced with many problems because of this situation.

This study examined the spatial distribution of urban areas in 1903, 1987 and 2010. Analysis illustrated that population density was 100 person/km² in 1903, whereas this ratio increased to 500 person/km² in 2010. This study proved that integration of old hard copy maps with new technological remotely sensed data could provide valuable information to monitor urbanization in different cities.

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URL-1: http://tr.wikipedia.org/wiki/%C4%B0stanbul#Tarihsel_n.C3.BCfus

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