Modelling Spatial Changes in Suburban Areas of Istanbul Using Landsat 5 TM Data

Şinasi Kaya (Assoc. Prof. Dr. ITU)
Elif Sertel (Assoc. Prof. Dr. ITU)
Dursun Z. Şeker (Prof. Dr. ITU)

Contents

Introduction

Rapid population growth and migration causes the creation of new residential areas around the city every year that leads heavy increase in the urbanization in the internal parts of the urban areas. Better job opportunities and development in the service sector are other reasons for the rapid increases in the metropolitans. Due to this reason land use/cover changes has been accelerated. Especially agricultural and semi-vegetation areas were negatively affected from the growth of the urbanized areas. Presently, satellite sensor data are extensively used for monitoring land use/cover changes in the large areas. The satellite sensor data with higher resolution and accuracy is an important data source for such kind of problems.

Introduction

Urban land use change detections have been analyzed using remotely sensed data by many researchers (Tapiador and Casanova 2003, Ridd and Liu 1998, Kaya and Curran 2006, Weng 2012, Taubenböck et al. 2012). Monitoring the trend of changes in urban land use classes with time were the objectives of many remote sensing studies (Ridd 1995).

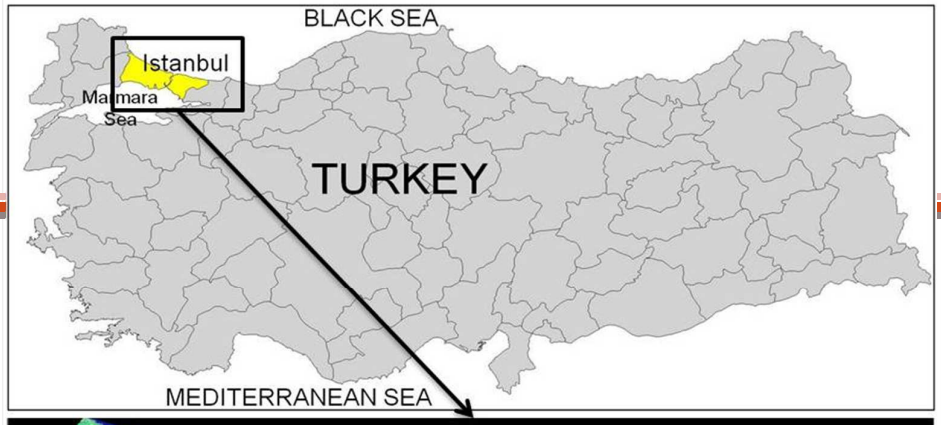
This study aims to determine land use/cover changes in 34 different districts of Istanbul city using V-I-S model and Landsat 5 TM imageries obtained in 1987 and 2011.

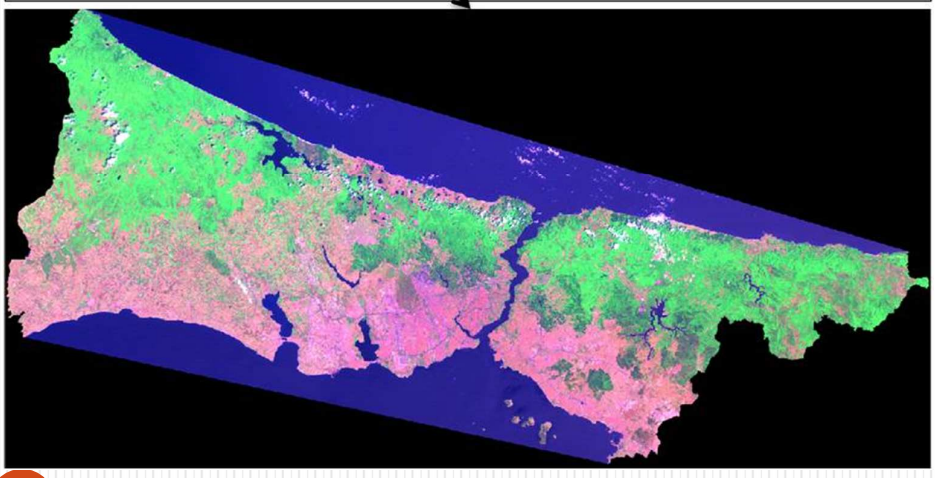
Introduction

Istanbul is one of the significant metropolitans of the world and the biggest of Turkey considering its population, socio-economic patterns and industrial infrastructure. 1987 and 2011 dated satellite sensor images were classified into three main land cover categories namely Vegetation, Impervious Land and Soil. These categories were located on the appropriate positions on the V-I-S diagram based on their % distributions. A specific attention was given to the impervious class and its change considering the urbanized lands fall in this category. The results of this study illustrated that only 3 out of 34 districts had 70% or more impervious surfaces in 1987 whereas the number of districts having significant impervious areas increased to 11 in 2011.

Study Area

Istanbul is ranked among the first 20 crowded cities of the world. Beyond its current population around 14.2 million (14 160 467 in the year of 2013 according to the official figures), during the history of this old and ancient city that has hosted many different civilizations, it has always gained an attraction for human settlement due to its geographical location. The population of the city has been rapidly increased from the year of 1985 (5 842 985 capita) to present.





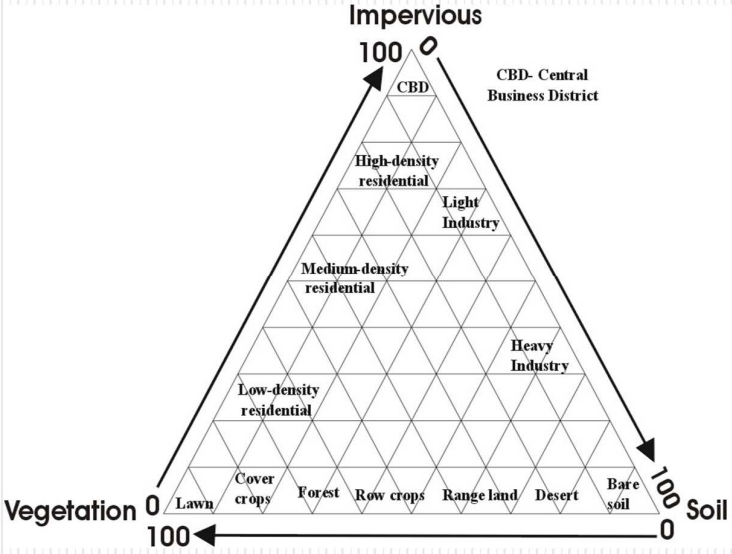
Mega city Istanbul is selected as study area.

Study Area (District of Istanbul)

Data and Methodology

Landsat 5 TM satellite imageries obtained in 1987 and 2011 the years were classified into 25 clusters using ISODATA (The Iterative Self-Organizing Data Analysis Technique) clustering algorithm. These clusters were then merged into four main classes which are; Vegetation, Impervious Surface, Soil and Water. In this study Water class is not considered to be used in V-I-S model. Istanbul metropolitan area was divided into 34 districts before 2010. Subsets of the Landsat 5 TM satellite imageries of each separate district were obtained using administrative boundaries. Then these obtained subset images classified separately.

V-I-S Model

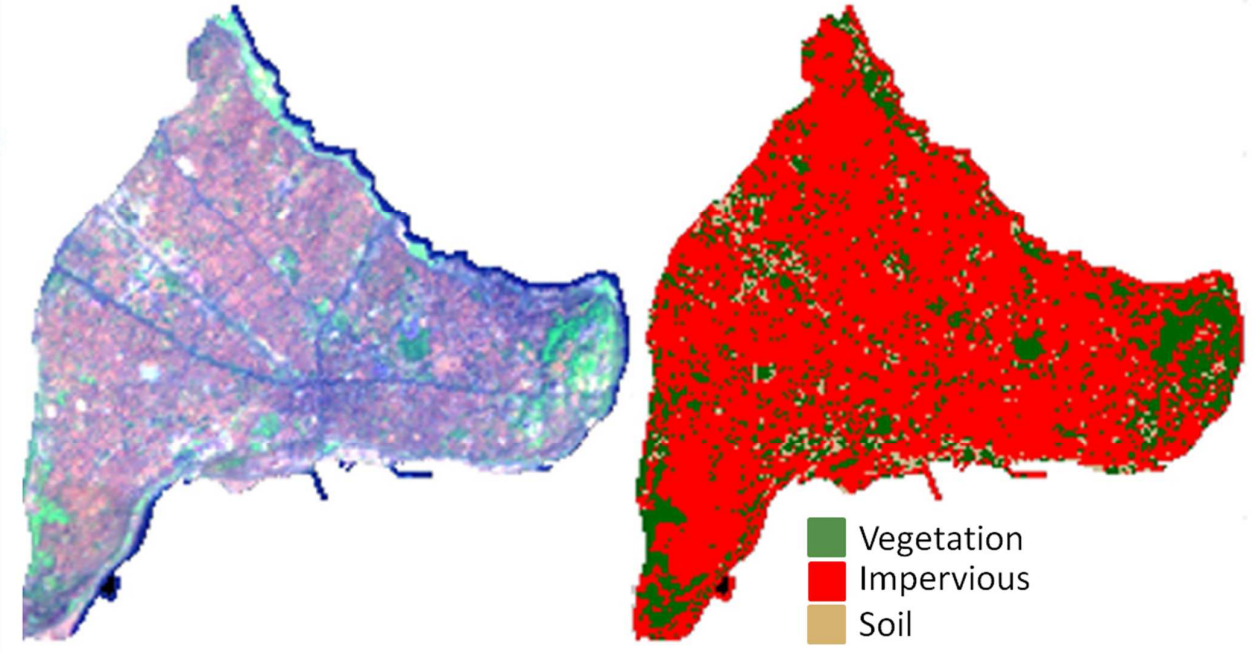


The Vegetation-Impervious-Soil model (Ridd, 1995).

A biophysical arrangement can be obtained by the determined values for those 3 components (VIS: Vegetation - Impervious Surface- Soil) that indicate the urban surface properties. This method is usually used in examining the urban regions with satellite images. In order to identify and visualize the environmental changes in an urban area, VIS method is a convenient one to apply and achieve good results.

V-I-S Model

The Vegetation-Impervious-Soil (V-I-S) model in remote sensing was proposed by Ridd (1995) as an objective, quantitative method for identifying the most common biophysical composition of an urban area as a function of three components: vegetation, impervious (surfaces such as buildings and roads) and soil (defined as surfaces that are neither vegetation or urban). Ridd (1995) suggested that the spatial composition of a segment of urban landscape can be described as a lineer combination of V-I-S. These componets can be organised within a diragram. As such it provides a means of assessing the trend and relative magnitude of land use/cover change in an urban area.



Landsat 5 TM (1987) of Fatih District

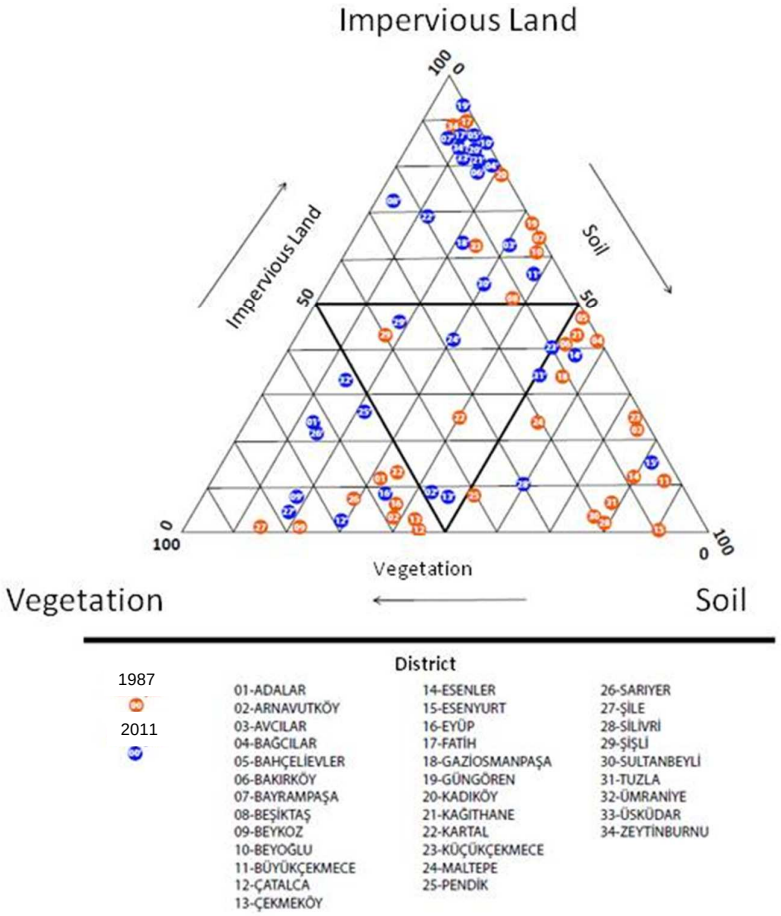
Classified Landsat 5 TM image

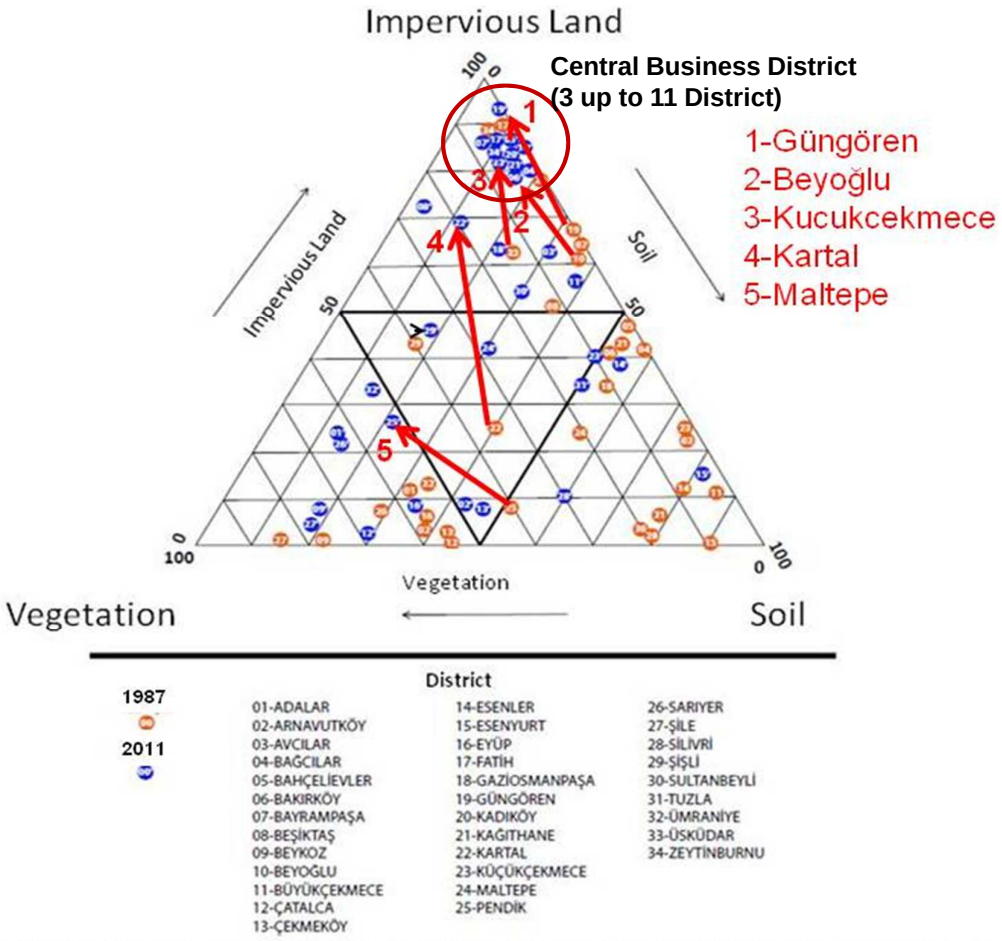
Results

Suburban areas were classified using ISODATA method to verify the used methodology. Distribution of Vegetation, Impervious Surface and Soil components in all districts were calculated as percentage. Calculated distributions for the year of 1987 and 2011 are displayed in V-I-S diagram.

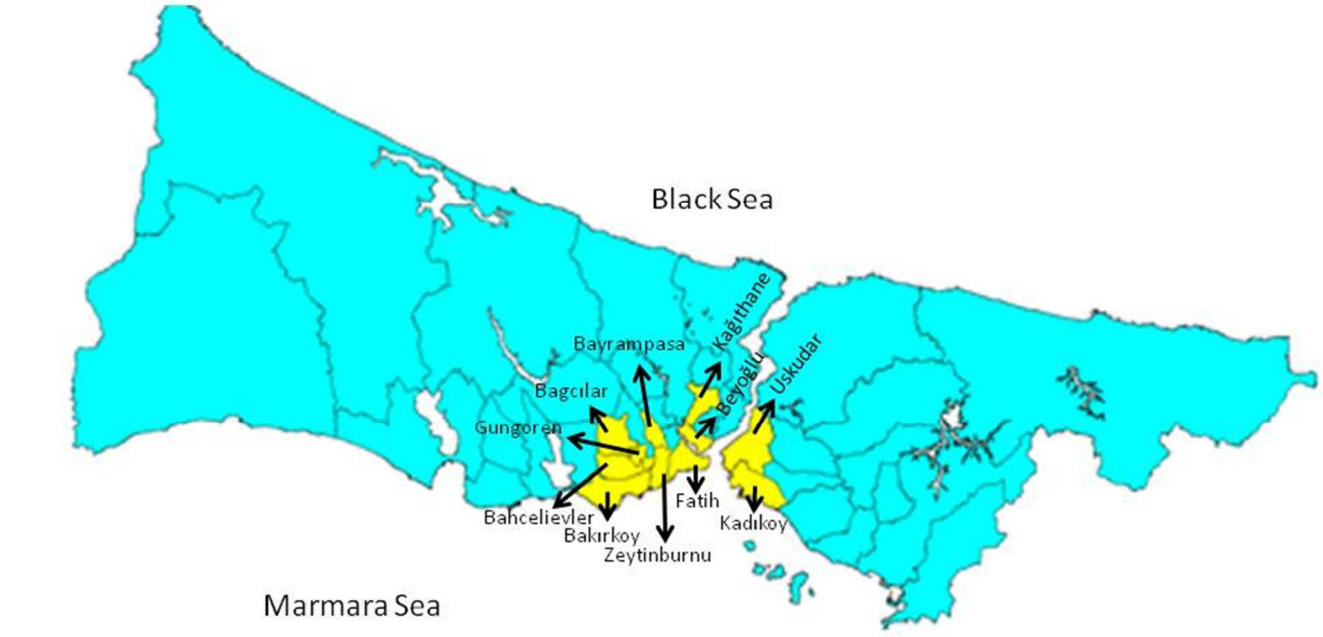
Results

In this diagram, changes and codes of each district were displayed. According to this diagram, the districts having impervious surface over 70% in 1987 are Kadikoy, Fatih and Zeytinburnu. In 2011, Kadikoy, Fatih, Zeytinburnu, Bakirkoy, Bahcelievler, Bagcilar, Gungoren, Besiktas, Uskudar, Sisli and Beyoglu as presented in Figure 5. These results indicate that the metropolitan area of Istanbul is under the highly occupied with the impervious surface.


Impervious Land
Impervious Land
Soil
Vegetation
Vegetation
Soil
100
0
50
District
1987
2011
01-ADALAR
02-ARNAVUTKÖY
03-AVCILAR
04-BAĞCILAR
05-BAHÇELİEVLER
06-BAKIRKÖY
07-BAYRAMPAŞA
08-BEŞİKTAŞ
09-BEYKOZ
10-BEYOĞLU
11-BÜYÜKÇEKMECE
12-ÇATALCA
13-ÇEKMEKÖY
14-ESENLER
15-ESENYURT
16-EYÜP
17-FATİH
18-GAZİOSMANPAŞA
19-GÜNGÖREN
20-KADIKÖY
21-KAĞITHANE
22-KARTAL
23-KÜÇÜKÇEKMECE
24-MALTEPE
25-PENDİK
26-SARIYER
27-ŞİLE
28-SİLİVRİ
29-ŞİŞLİ
30-SULTANBEYLİ
31-TUZLA
32-ÜMRANİYE
33-ÜSKÜDAR
34-ZEYTİNBURNU


Impervious Land
Central Business District
(3 up to 11 District)
1-Güngören
2-Beyoğlu
3-Kucukcekmece
4-Kartal
5-Maltepe
Impervious Land
Soil
Vegetation
Vegetation
Soil
100
0
50
1
2
3
4
5
District
1987
2011
01-ADALAR
02-ARNAVUTKÖY
03-AVCILAR
04-BAĞCILAR
05-BAHÇELİEVLER
06-BAKIRKÖY
07-BAYRAMPAŞA
08-BEŞİKTAŞ
09-BEYKOZ
10-BEYOĞLU
11-BÜYÜKÇEKMECE
12-ÇATALCA
13-ÇEKMEKÖY
14-ESENLER
15-ESENYURT
16-EYÜP
17-FATİH
18-GAZİOSMANPAŞA
19-GÜNGÖREN
20-KADIKÖY
21-KAĞITHANE
22-KARTAL
23-KÜÇÜKÇEKMECE
24-MALTEPE
25-PENDİK
26-SARIYER
27-ŞİLE
28-SİLİVRİ
29-ŞİŞLİ
30-SULTANBEYLİ
31-TUZLA
32-ÜMRANİYE
33-ÜSKÜDAR
34-ZEYTİNBURNU

Districts having more than 70% impervious surface for the year of 1987



Districts having more than 70% impervious surface for the year of 2011

Discussion and Conclusions

Digital multi-spectral satellite sensor technology nowadays provides valuable opportunities for qualifying and comparing urbanized areas in the world.

Determination of the land use/cover changes using satellite sensor data is important advantages of the science of remote sensing.

Using this technique, land use/cover changes in the large areas can be determined rapidly and easily.

Obtained results are reliable and can be analyzed.

Discussion and Conclusions

Spatial distribution of land use/cover of a city could be determined quickly and economically using multispectral satellite imageries.

In this study Landsat 5 TM satellite imageries were used to determine land cover changes in Istanbul based on V-I-S model.

This study demonstrated that remotely sensed data could be successfully used to determine urbanization induced environmental changes.

Vegetation, Impervious Surface and Soil components were determined for Istanbul using Landsat 5 TM satellite imageries dated 1987 ad 2011.

Discussion and Conclusions

Percentage distributions of these three components were displayed on V-I-S diagram. In this study only impervious surface areas were evaluated.

Results show that, there was only three district which have more then %70 of impervious surface in 1987, number of districts reached to 11 which has the same level of impervious surface in the year of 2011.

This study also indicated that the V-I-S model can be applied to satellite images for the analysis of spatial changes and their trends.

Let's meet in Istanbul

FIG2018

Thank you very much for your attention...

kayasina@itu.edu.tr
sertele@itu.edu.tr
seker@itu.edu.tr