MERGING SPOT P AND LANDSAT TM THERMAL BAND FOR DETECTION OF LAND USE/COVER

Sinasi KAYA, Dursun Zafer SEKER

Istanbul Technical University, Civil Engineering Faculty, Department of Geomatics, 34469 Maslak-Istanbul, TURKEY; Tel: +902122856100;Fax:+902122856587
E-mail: kayasina@itu.edu.tr , seker@itu.edu.tr

KEY WORDS: Remote Sensing, Land use/cover, Istanbul, Merge

Abstract: Istanbul is the largest city of Turkey covering a total area of ~ 57 500 km^2 and having a population of about 12.8 million according to the population census of 2011. Population of Istanbul was only 4.7 Million in the year of 1980. As a result of the rapid population growth and urbanization, the city has extremely expanded causing many changes in land use/cover. Remote sensing data provides very important information in determining changes in land use/cover changes. In this study, the possibility of using the combination of thermal bands with the satellite sensor imageries which has higher spatial resolution for land use/cover changes classes between the year 1992 to 2011 were examined. SPOT Panchromatic band in 1992 (10 m) and 2011 dated Landsat 5 TM data (all bands including thermal band) was merged for determine the changes in land use/cover in the metropolitan area of Istanbul. At the end of the study, it is evaluated that this combination can easily be used for determination of land use/cover changes in both the city and its surrounding. In addition, obtained results were verified with the recently obtained satellite sensor imageries.

INTRODUCTION

Population of Turkey is still has increasing trend. The population increase rate of Turkey is approximately %2.2 per year. The city populations of the country are also increasing rapidly such as developing countries all over the world. According to the statistical studies realized between 1990 and 2010 the population increase was %2.9 in urban areas and %–0.75 in rural areas. While the urban population was %24 in 1945 it increased to %58 in 1985 and reached to % 68 in 2010 of whole population of Turkey. One of the most important problems of Turkey is the migration from rural part of the country to the metropolitan cities. This migration causes a rapid changes and unplanned development in the land use/cover of the surroundings of metropolitan cities. It is not easy and possible to solve this rapid urban spatial growth problem because of socio economic reasons while it is already covering the whole metropolitan area. The statistics just depend on the population census results which are realized only every 5 years. These data do not include the current population information and unfortunately do not present any information about land use/cover.

Istanbul is one of the biggest metropolitan in the world which is in the 21st place in the most populous cities in the world. 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 (Kaya, 2007). 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 was conducted in Istanbul, which is one of the world's major metropolises. The objective of this study is rapidly determination of the land use/cover changes using merged image of old dated SPOT panchromatic (1992) image and Landsat TM (2011). In particular using different band combination option of the Landsat TM data, the contribution of the 6th band of this image was determined. Significant changes were obtained especially in the surrounding areas of the city.

DATA AND METHODOLOGY USED

In this study, due to maximum changes occurred central section of the Istanbul metropolitan area was selected for the study as displayed in Figure 1. In the study, merging of the 6 September 1992 dated SPOT panchromatic data which has 10 m resolution and all bands of the Landsat TM image dated 06 July 2011which has better radiometric properties was used. All satellite sensor data sets have been registered to the UTM projection. Root Mean Square Error is considered less than ± 0.5 pixel.

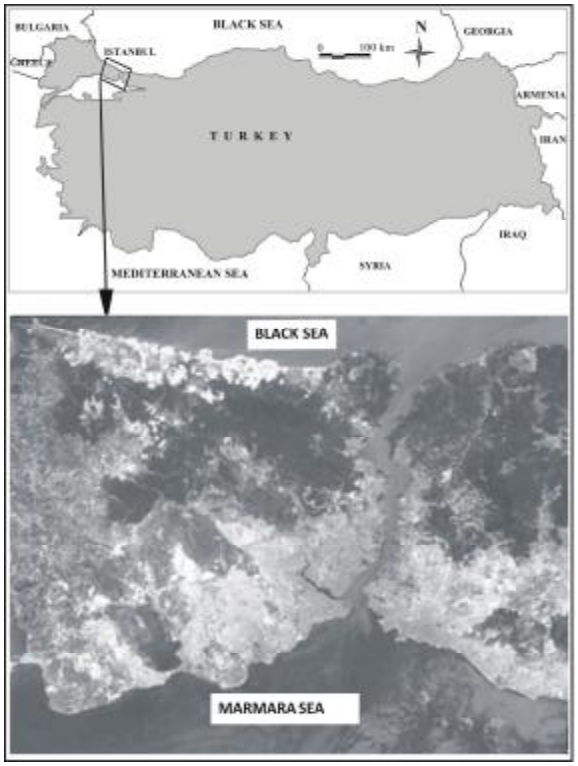

Figure 1: Study Area

In this study, the Gramm-Schmidt method is used as an algorithm to merge the two data sets. Here, using 6th band of the Landsat 5 TM with the panchromatic band (which affects the whole bands) with the band combination such as 6, 3, 6 which is selected from the visible region visually extracted the changes occurred in the land use/cover (Figure 2).

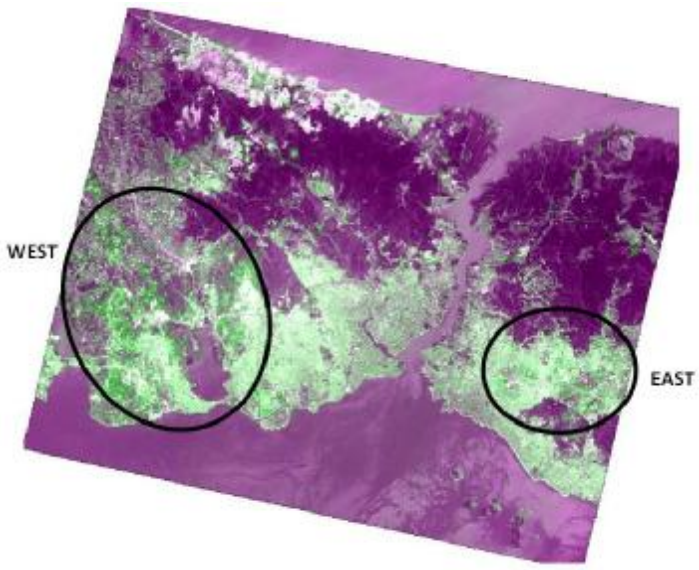

Figure 2: Image of Merged data set (band combination 6, 3, 6)

In Figure 2, the green areas represent the changes in the years between 1992 and 2011. Generally, the city has spatially grown in the western and the eastern axis. Forested areas of the north were seriously damaged by the open mining activities and quarry enterprises which supply stone for the concretes which are used for the new building. Suburban areas were classified using ISODATA method to verify the used methodology.

RESULTS

Due to the lower resolution 6th band of the Landsat 5 TM data is not widely used for land use/cover data studies. For this reason, they haven't been widely processed in the image processing programs. In recent years, with the help of new algorithm, using availability of this band is increasing. In this study, the Gram-Schmidt method was used as a new data fusion method to merge old-dated high-resolution SPOT image with the Landsat 5 TM data. In general, using 6th band combinations (e.g. 6, 3, 6 - 1, 6, 6 - 6, 6, 2) land use/cover changes were determined as seen in Figure 2. While changed areas have different colors according to band combinations unchanged areas are displayed in the form of grey color. Currently, Istanbul Ikitelli industry and new residential areas which has been started in the year of 1988 as a development axis, has the greatest changes (Figure 3). The land use/cover changes were easily calculated using this method. This data is classified (Figure 4) and the amount of changes were calculated.

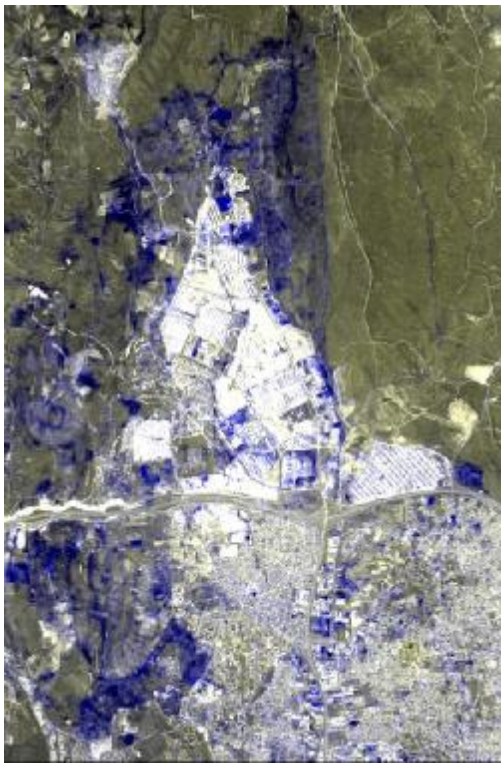

Figure 3: Merged data bands 6,6,1

DISCUSSION AND CONCLUSIONS

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. If the thermal band (6th band) of the Landsat 5 TM were realized obtained results can be used for the land use/cover change analysis using thermal changes in the land use/cover. This study has shown that using integration of an old dated high resolution data with the thermal band of Landsat TM data has brought a new dimension to the land use/cover change analysis. The test area in Istanbul Ikitelli area was 7509.0 hectare as seen in Figure 3. As a result of the classification of the image using ISODATA method, changes areas were calculated as 1459.0 hectare. The area has been changed was calculated as %19.4 of total area. In the future studies similar researches will be done for the different land use/cover changes. In addition, classified data will be analyzed statistically and the classification accuracies will be supplied.

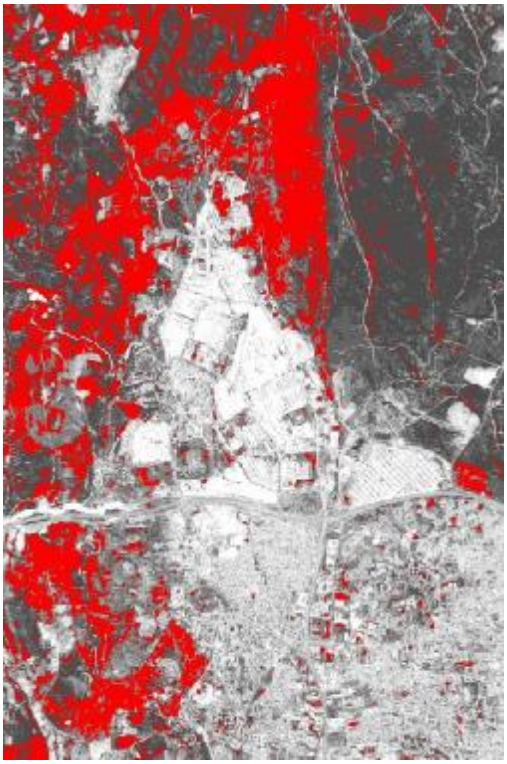

Figure 4: Classified merged data (Red, Urban Changed areas)

REFERENCES

Kaya, S. and Curran, P.J., 2006. Monitoring urban growth on the European side of the Istanbul metropolitan area: A case study, International Journal of Applied Earth Observation and Geoinformation 8, pp. 18-25.

Kaya, S., 2007. Multitemporal Analysis of Rapid Urban Growth in Istanbul Using Remotely Sensed Data. Journal of Environmental Engineering Science. 24, pp. 228-233.

Ridd, K.M., Liu, J., 1998. A comparison of four algorithms for change detection in an urban environment. Remote Sensing Environment, 63, pp. 95–100.

Ridd, M.K., 1995. Exploring a V-I-S (Vegetation-Impervious surface-Soil) model for urban ecosystem analysis through remote sensing: Comparative anatomy for cities. *International Journal of Remote Sensing*, 16, pp. 2165–2185.

Southworth, J., 2004. An Assessment of Landsat TM band 6 thermal data for analyzing land cover in tropical dry forest regions. İnternational Journal of Remote Sensing, 25 (4), pp. 689-706.

Tapiador, F., Casanova, J.L., 2003. Land cover mapping methodology using remote sensing for the regional planning directives in Segovia, Spain. Landscape and Urban Planning, 62, pp.103–115.

Taubenböck, H., Esch, T., Felbier, A., Wiesner, M., Roth, A., Dech, S., 2012. Monitoring urbanization in mega cities from space. Remote Sensing Environment, 117, pp. 162-176.

Weng, Q., 2012. Remote sensing of impervious surfaces in the urban areas: Requirements, methods, and trends. Remote Sensing Environment, 117, pp. 34-49.