Chapter 60
Detection of Urban Expansion by Using DMSP-OLS, Landsat Data and Linear Spectral Unmixing Method

Cihan Uysal
Istanbul Technical University, Turkey

Derya Maktav
Istanbul Technical University, Turkey

ABSTRACT

Urbanization has been increasingly continuing in Turkey and in the world for the last 30 years. Especially for the developing countries, urbanization is a necessary fact for the sustainability of the urban growth. Yet, this growth should be controlled and planned; otherwise, many environmental problems might occur. Therefore, the urban areas having dynamic structure should be monitored periodically. Monitoring the changes in urban environment can be provided with land cover land use (LCLU) maps produced by the pixel based classification methods using 'maximum likelihood' and 'isodata' techniques. However, these thematic maps might bring about inaccurate classification results in heterogeneous areas especially where low spatial resolution satellite data is used since, in these approaches, each pixel is represented with only one class value. In this study, considering the spectral mixture analysis (SMA) each pixel is represented by endmember fractions. The earth is represented more accurately using 'substrate (S)', 'green vegetation (V)' and 'dark surfaces (D)' spectral endmember reflectances with this analysis based on linear mixture model. Here, the surrounding of Izmit Gulf, one of the most industrialized areas of Turkey, has been chosen as the study area. SMA has been applied to LANDSAT images of the years of 1984, 1999 and 2009. In addition, DMSP-OLS data of 1992, 1999 and 2009 has been used to detect urban areas. According to the results, the changes in LCLU and especially the urban growth areas have been detected accurately using the SMA method.

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INTRODUCTION

Urbanization has been rapidly increasing in the world since 1950s. While 30% of the world's population was living in urban areas in 1950s, this number has exceeded 50% in 2010 (http://www.un.org/2012). Urbanization in Turkey has gained acceleration after 1980s. The population living in urban areas in Turkey was 25% in 1950 and it increased to 43% in 1980 and it became 76% in 2010 (TUIK, 2014). Accordingly, Turkey is one of the world's leading countries with its urban population and the rate of urban population growth. This growth in urbanization usually results in some problems such as unplanned infrastructure and uncontrolled urban growth. Furthermore, the unplanned and uncontrolled urbanization might cause the natural resources such as green areas, agricultural lands and water resources to be misused and damaged (Al-Rawashdeh et al., 2006). Therefore, urban environment, particularly natural resources, should always be monitored and kept under control. Remote sensing data and technologies are indispensable sources for the managers and decision makers in monitoring the urban environment for the reason that they provide current spatial information (Maktav et al., 2005). 'Isodata' and 'maximum likelihood' classification techniques are usually used in obtaining LCLU maps. Yet, each pixel is represented with only one class in these techniques. Although it is accurate for the pure pixels corresponding to homogeneous areas in the earth, it might result in low accuracy classifications for mixed pixels corresponding to heterogeneous areas (Jensen, 1996; Palanisamy et al., 2006). The accuracy of these maps is limited because of low spatial resolution of satellite data used to obtain the LCLU maps on global scale. Therefore, there are various approaches to map LCLU changes in low pixel level. Among these approaches, the model of linear spectral mixture has been internalized as the most common approach (Adams et al., 1995; Quarmby et al., 1992; Settle et al., 1993). SMA method has been built on this model and mixed pixels are expressed by calculating it in chosen endmember reflectances as percentages (Adams et al., 1993; Gillspie et al., 1990).

The aim of the study is to detect and analyse the urban growth areas and changes of LCLU in the surroundings of Izmit Gulf using SMA method. The DN (digital number) values have been converted first to radiance values and then to reflectance values by applying radiometric calibration to LANDSAT TM and ETM images. SMA method has been applied to the radiometrically calibrated images by using global endmember reflectances. Urban expansion areas have been detected by producing SVD, δSVD (difference SVD) and tri-temporal substrate maps from calibrated LANDSAT data of the years 1984, 1999 and 2009.

STUDY AREA AND DATA

In the study, Izmit Gulf and its surroundings which is situated in the east of the Sea of Marmara in Marmara Region in Turkey have been selected as the study area (Figure 1). The city of Izmit lies on latitude 40^0 41' and longitude 29^0 31'.

LANDSAT images of 25 September 1984 (TM), 27 September 1999 (ETM) and 30 September 2009 (TM) having 30 m spatial resolution have been used. This data has been processed as Level 1 terrain-corrected (L1T) data and they are available in GeoTIFF format in the UTM map projection with WGS84 datum. L1T processing includes radiometric correction, systematic geometric correction, precision cor-

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