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REMOTE SENSING ANALYSIS OF URBAN EXPANSION AND LOSS OF AGRICULTURAL LAND IN TEHSIL MULTAN CITY PAKISTAN

SABA AKRAM*, SAIMA SIDDIQUI**
[1] *Department of Geography, University of the Punjab, Lahore*
Email: saimagct@gmail.com

ABSTRACT

Multan is known as an important urban settlement of Punjab-Pakistan due to industrial, commercial and service activities. To find out rate of urban expansion and loss of agriculture land various geospatial techniques are used in this study, by analyzing spatial and raster datasets. Landsat data with spatial resolution of 30 m is processed and analyzed in this work. Three classes e.g. vegetation, urban area and water are designed based on spectral signature or spectral response curves of features. Furthermore, topographic sheets of year 1993 and 2001, and Google Earth time series imagery for the year 2012 are analyzed to indicate the direction of urban growth. Results depicts that 97 km^2 areas has been converted from agricultural to urban area. The direction of urban growth were towards the south west during 1993 to 2001 and towards north east during 2001 to 2012. With this dramatic change, it is assumed that urban expansion will become a serious issue to the people of Multan.

KEYWORDS: Urban expansion, Agricultural land, Landsat data, Topographic sheets, Multan

INTRODUCTION

Satellite remote sensing has been considered an ideal source of technology and data for large areas of land cover classification and change detection (Bayarsaikhan *et al.,* 2009; Jat *et al.,* 2008). Remote sensing has witnessed a series of improvements in spatial and temporal resolutions spectral possibility (Lunetta *et al.,* 2004). Remote Sensing technology in combination with Geographic Information System (GIS) can render reliable information on vegetation cover (Lillesand *et al.,* 2004, Antrop, 2004).The current level of world urbanization and size of the largest cities in the world are unprecedented (Angel *et al.,* 2005). In the early twentieth century, only 16 cities in the world in the most advanced industrial countries-contained one million people or more (Hoselitz, 1957). Despite its low level of urbanization in 2009, Asia was home to about half of the urban population in the world. Europe had the second highest %age of 16 % (Angel *et al.,* 2005). In south Asia urbanization is high due to mega cities expansion (Heitzman, 1992). Migration and natural increase are major factors of urbanization in this region that are also seen in Pakistan, for example migration generally takes place for economic reasons, from rural to urban areas, resulting in a higher growth rate (Jan and Iqbal, 2008). The

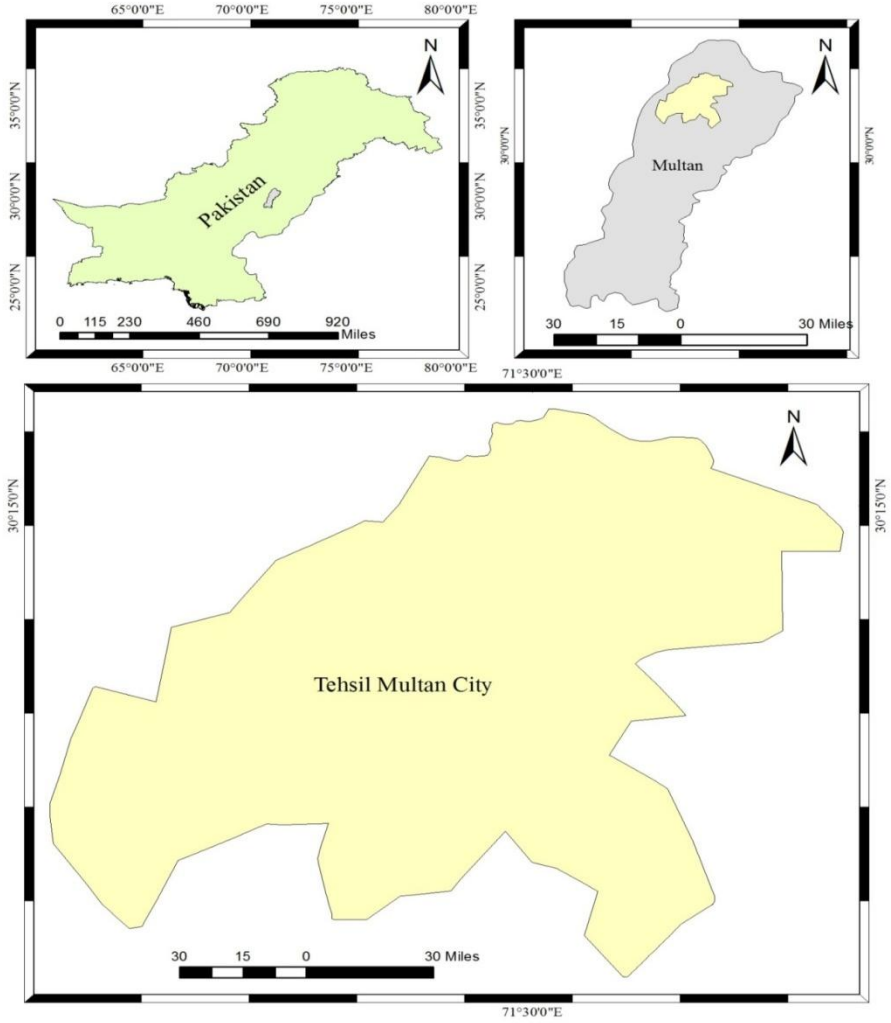
growth rate of the urban population in Pakistan during the census conducted in 1972 and 1981 was 4.4% while the rural population grew by 2.6% during the same period (GOP, 2000a). Therefore, due to the continued high rate of growth of the urban population the %age increased from 18% in 1951 to 28% in 1981 and to 32.52% in 1998. Currently, 35% of Pakistan's population is estimated to live in urban areas. The phenomenal growth of a few large cities is another aspect of Pakistan's urbanization (GOP, 2000a, Bhalli and Ghaffar, 2015). Multan is one of the largest cities of Pakistan with an estimated population of over 1.2 million. It accounts for 2.8% of the urban population of the country, and 6% of the urban population of Punjab province (GOP, 2000a). It is the industrial, commercial, financial and service center of the country. In recent years, the urban infrastructure has become overburdened and the city has been subjected to considerable urban conflict. In this context, the main objective of the present study is to gauge the loss of agriculture land by temporal study and to find future urban growth direction.

MATERIAL AND METHODS

Study Area

Multan is a historical city of great antiquity and is one of the oldest human settlements in the Indo-Pakistan sub-continent. It is situated between 29°-22' north latitude and 71°-03' to 72°-28' east longitude (Figure 1). District Multan is spread over an area of 3,720 Km^2 with population density of 838 persons per Km^2. Population of Multan is increasing continuously from 1931 to 1998 with 1,970,075 to 3,116,851 persons respectively. The urban population grew at the rate of 2.9 % during 1981 to 1998 (GOP, 2000b).

Figure 1: Location of study area in Pakistan.



Data Collection

The use of satellite-based remote sensing data has been expedient to analyze changes over large geographic regions (Lunetta *et al.,* 2004; Mundia and Aniya, 2005). Satellite data is collected from online source http://www.usgs.gov. Landsat images of 1987 (Landsat 5, TM, 30m) and 2013 (Landsat 8, OLI, 30m) of path 39 and row 50 are used for the analyses with time span of 26 years.

Topographic sheets at scale of R.F. =1:50,000 with index number 39N/08 and 39N/12 are collected from Survey of Pakistan (2012), Rawalpindi head office. These sheets are first scanned by scanner and then geographic

coordinates of WGS 1984 are assigned by absolute geo referencing. After this step, point, line and polygons entities are digitized to build the database of urban area. These entities are used to perform overlay analysis (Fahim *et al.,* 1999, Fazal, 2000). Google Earth time series imagery was also used for the year 2012 to digitize the shapefile of urban areas of Multan. Image mosaicking and georeferencing was done after image downloading.

Data Analysis Techniques

Layer stacking is an important work done in present study after acquiring required images (Bhalli *et al.,* 2012). The process of layer stacking was done in ERDAS Imagine 9.2 software package. Through band combinations technique, required bands of Landsat Imagery were stacked. In this process, the imageries were extracted according to study area by converting digitized boundaries into AOI format. Different land use classes were distinguished, so that it will be possible to look changes over 1987 to 2013 (Table 1). During supervised classification across range of wavelengths, the % reflectance values for landscape features such as water, build up and vegetation can be drawn and compared. Such values are called “spectral response curves” or “spectral signatures”. Differences among signature of spatial feature are helpful to classify the image and these are used in work. Supervised classification is done by various steps after drawing classes. Maximum-likelihood method was used to classify the pixels. The output file was a .tiff file with a thematic raster layer (Dewan and Yamaguchi, 2009). Absolute Georeferencing is done on topographic sheets in ArcMap by using “Degree Minute Second Coordinate system”. Then topographic sheets of Multan are digitized in Arc Map and urban area is extracted. Overlay analysis is done on spatial data and map layout is designed in layout view of ArcMap. Final map output is designed in ArcMap for presentation of data.

Table 1: Description of categories used in classification

Classes	**General Description**
Build-up area	All buildings, roads and sealed surfaces
Vegetation	Cropland, horticultural farms, greenhouses, other agricultural crops
Water	Chenab River

RESULTS AND DISCUSSIONS

ANALYSIS OF TOPOGRAPHIC SHEETS

Urban expansion during 1993-2001

In 1993 urban area covered inner city and Multan city was growing to all directions. That time new colonies had started to appear around the city center and due to natural increase and migration it seems to expand very fast. In 1993 urban area in Multan city was about 76 Km^2. Later the urban area extends to 119 Km^2 in 2001 (Figure 2). According to 1998 census, population of Multan was 1.5 million that continuously increased rapidly in coming years, this become the major factor to bring change in study area. In 2001 a clear direction of urban growth were observed towards the south-west direction. Mainly industrial estate develops along this direction.

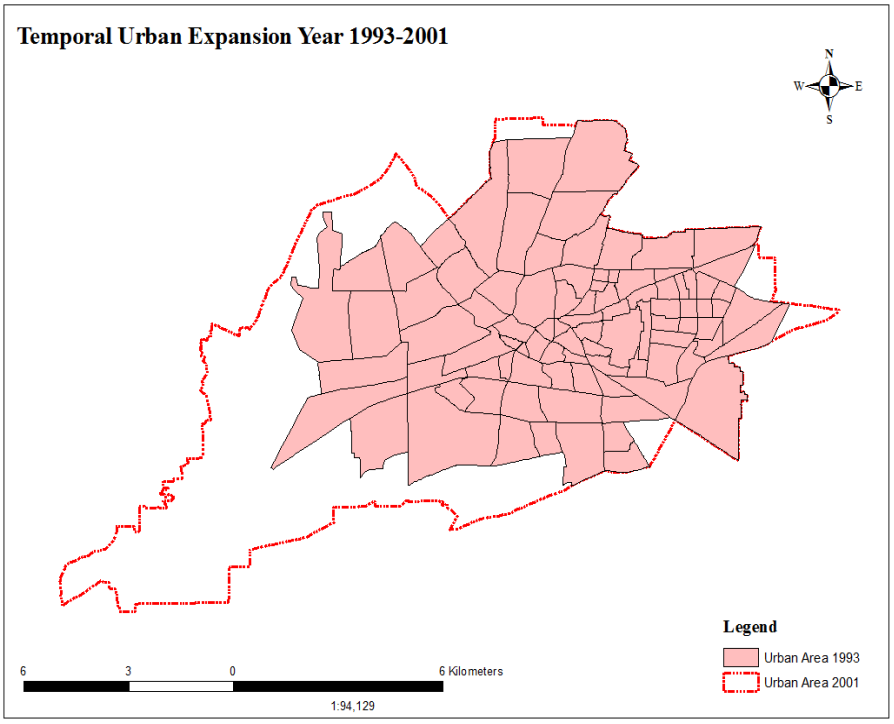


Figure 2: Urban expansion during 1993-2001.

Urban expansion during 2001-2012

In 2001, the rate of urban expansion increased. The establishment of new colonies like Multan industrial Estate and Piran Ghab along the major roads caused expansion outside from city at opposite directions (Figure 3). According to data digitized from topographic sheets, in 2001 Multan

covers total 119 Km^2 area and in 2012 it covers the 194 Km^2 of urban area. According to Punjab development statistics (2012) Multan population was 1.7 million. In 2012, the urban direction was towards the north-east and mostly new housing schemes were established in this area

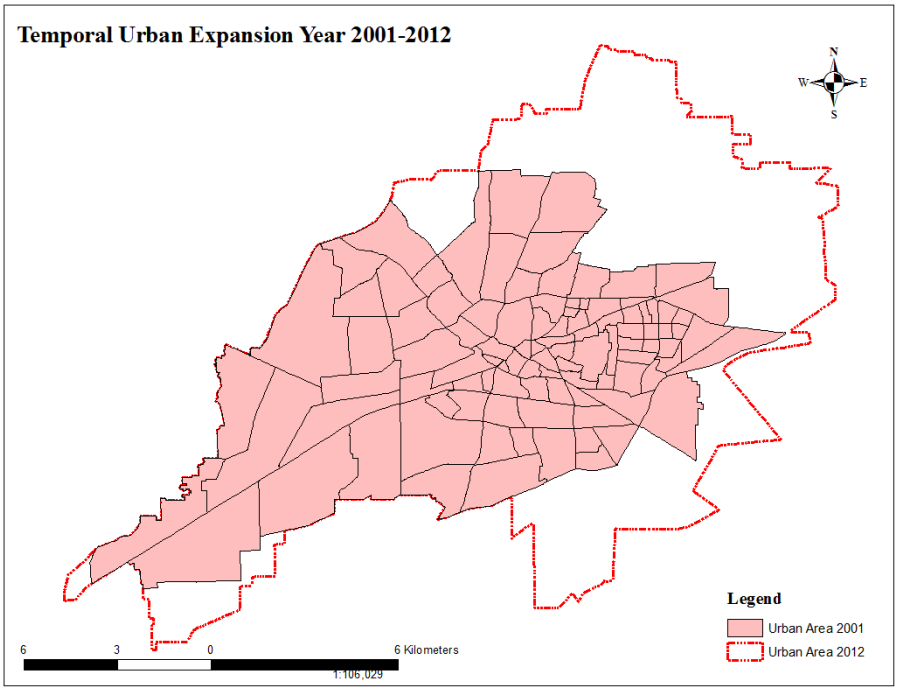


Figure 3: Urban expansion during 2001-2012.

Urban expansion during 1993-2012

Temporal change based on topographic sheets was calculated by change in total area. In 1993 urban area was 96 Km^2. In 2001 it increased to 119 Km^2 and finally 2012 it increased to 194 Km^2. Due to limited resources exact number of population data of Multan in 1993 was not known. But according to Census Report (1998), population of study area was 1.5 million and in 2012 estimated pollution was calculated as 1.742 million. This shows that population increase is a major factor to bring the change in urban area. The main factors of urban area expansion are population growth, establishment of new housing schemes and business centers. This factors causes the loss of agriculture land due to increase in the vacant area (for residential societies) and built up area in Multan.

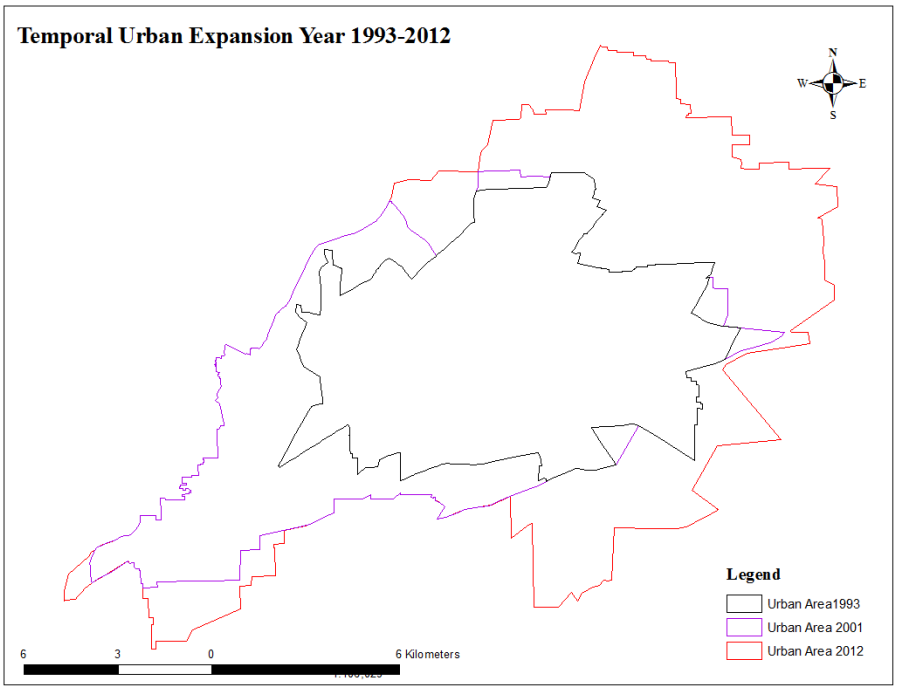


Figure 4: Urban expansion during 1993-2012.

ANALYSIS OF LANDSAT IMAGERY

Urban expansion in 1987 and 2013

To check the urban expansion during 1987 to 2013 remotely sensed data of Landsat images is processed. Supervised classification of two images was performed to build the spectral signature of three classes' e.g. urban area, vegetation and water. Results represent that in 1987 urban area was 109 Km^2 while in 2013 urban area increased to 206 Km^2. In 1987 vegetation cover was 215 Km^2 while in 2013 it reduced to 118 Km^2 and water in both images remains one Km^2 (Figure 5).

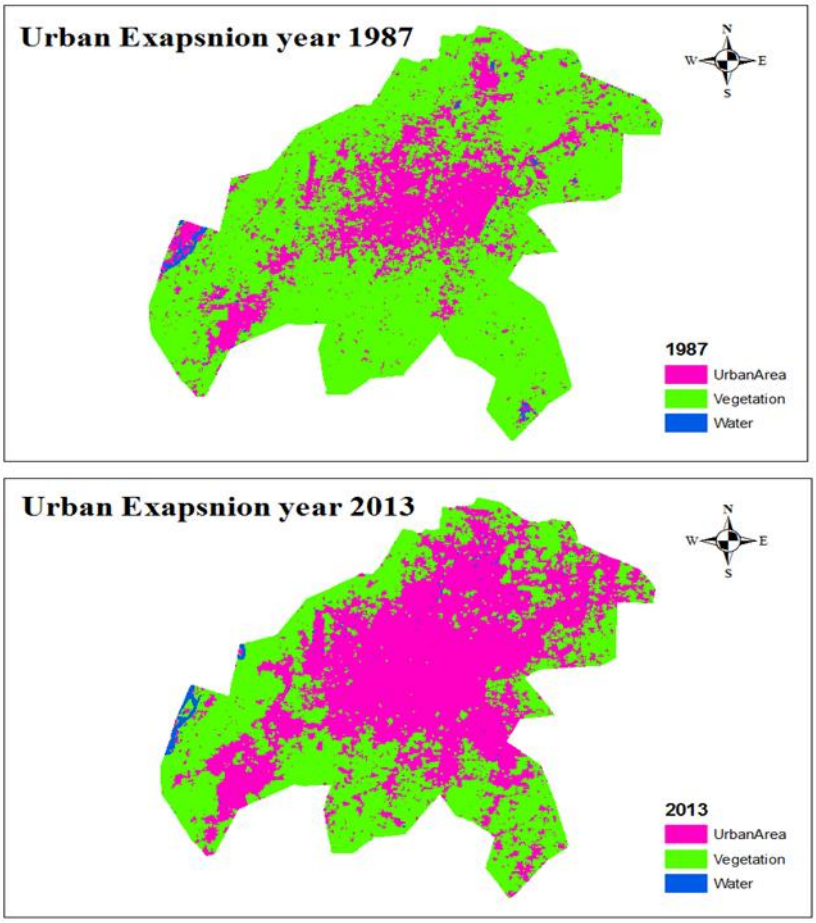


Figure 5: Urban expansion in 1987 and 2013.

Urban Expansion and loss of agricultural land from 1987 to 2013

To assess the temporal change weighted overlay technique in Arc Map was used (Figure 6). In 1987 urban area was 109 Km^2 and in 2013 urban area increased by 206 Km^2. In 1987 vegetation cover was 215 Km^2 and in 2013 it reduced to 118 Km^2. The result is showing that about 97 Km^2 areas have been changed from vegetation (agricultural land) to urban (built-up) area. With this drastic increase in built-up urban area, loss of agriculture land is evident, that would become a serious socio-environmental issue in future (Figure 6).

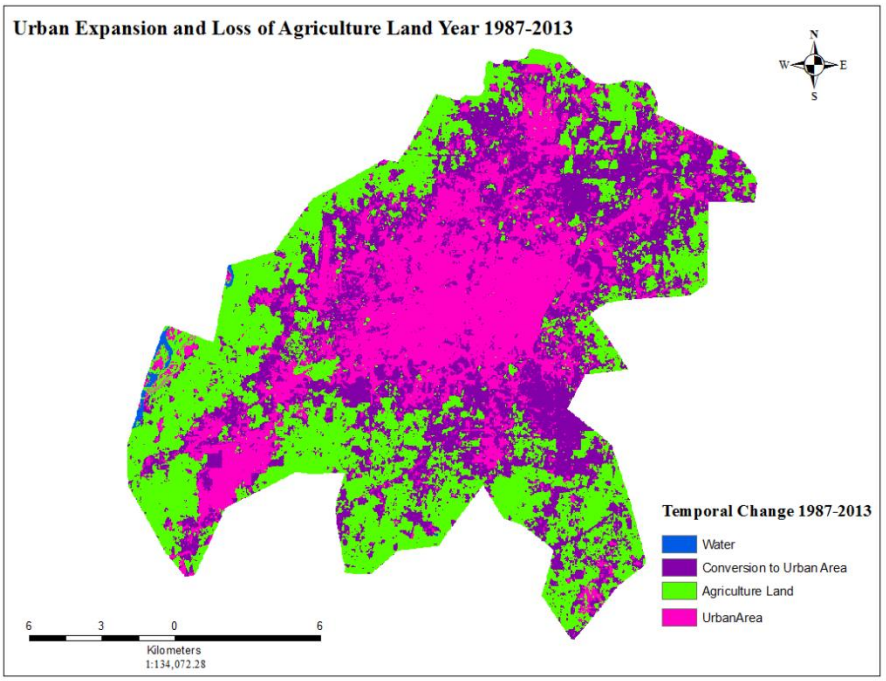


Figure 6: Urban expansion and loss of agricultural land during 1987 to 2013.

CONCLUSION AND RECOMMENDATIONS

The present study has presented the dynamics of urban sprawl, the loss of productive (agricultural) land, physical location and socio-economic features that are responsible for the growth of Multan city. Moreover, satellite remote sensing, digital image processing and GIS employed for the assessment of the change in the land use land cover and to assess the loss of agricultural land which is very valuable for planning and research purposes. In 1993 urban area was 96 Km^2 while in 2001 it increased to 119 Km^2 and in 2012 it inflated to 194 Km^2. According to census report in 1998 population of Multan was 1.5 million and in 2012 estimated pollution was calculated as 1.742 million. This shows that population increase is a major factor to bring the change in urban area development. According to Image analysis in 1987 urban area was 109 Km^2 and in 2013 urban area increased by 206 Km^2, which cause 97 Km^2 decrease in vegetation cover.

This study contributed to the emphatic spatial and temporal undercurrents of urban growth of Multan city, for its effective planning and spatial organization of urban activities, which are necessary for future development of Multan. The nature of the approach in this study can be used for land use/ land cover change analysis in other cities of Pakistan and in developing countries where the quantity and quality of geographic

information and other ancillary data is often outdated and inaccurate, or very partial where they occur. To minimize the loss of agricultural land government must take step and number of housing schemes must be controlled. Future studies are recommended to do work on arable land loss with high resolution satellite imagery.

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