

## **IMPACT OF URBAN EVOLUTION ON LAND-USE CHANGE OF SARGODHA CITY, PAKISTAN**

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**Abstract:** Sargodha is the 11th largest city of Pakistan with a population size of 0.7 million. This comparatively small size city is expanding faster. The objective of this work is to the impact of rapid urbanization on land-use change of Sargodha city. For this purpose to check out the extension of the built up area of Sargodha city due to urbanization four satellite images for the years 1980, 1992, 2000 and 2013, Arc GIS software was used for mapping and analysis through land-use classification. The results showed the regular increase in built-up are of the city while vegetation cover and bare land is gradually reducing due to expansion of the city.

**Keywords:** Urbanization, land-use change, built-up area, Sargodha, Arc GIS.

### **Introduction**

The process of urbanization is one of the most important dimensions of economic, social and physical change in developing countries, when growth rate is higher in cities than rural areas, it is called urbanization. Indifferent countries of the world if half per cent of total population live in towns, country is considered urbanized. European countries were first, which became urbanized, each state used exceptional criteria to define built up area like population size and space. Round about 97% population lived in rural areas in 1800. In 1900 only 5.5 per cent lived in urban areas and half of the total world's population lived in urban area in 2002 (Long, 1998). The urban population of developing nations was 300 million in 1950, at present which has increased more than 1.7 billion. The growth in urban population is three times faster than surroundings. It is expected that the population of urban areas of the world will be twice in the next 25 years, reaching nearly up to four billion.

Because of the migration of the people from one place to another and the increased birth rate.

Rapid growth of human population is the cause of environmental change, deforestation and desertification. The process of urbanization produces change in land surface and atmospheric properties area, because vegetation decreased and replace into asphalt and concert (Oke, 1987). Land-use and land-cover (LULC) change is a noticeable effect of human's alteration in the global ecological unit, and it has a major impact on the local, regional atmosphere (Weng, 2001). Changing land-use of the city and rapidly increasing urbanization has large impact on environment, in urban areas use of energy increase and reduces incoming radiations (Stanhill & Kalma, 1995). In cities non porous surfaces e.g. walls, roads absorb the incoming solar radiations and change into sensible heat, which increased temperature in urban areas. Built up area due to high building density generate the heat than surrounding air temperature that is

caused urban heat island (Kimura & Takahashi, 1991).

Because of increasing use of air conditioner rise, global warming and air problems are common in cities (McCarthy *et al.*, 2001). When in metropolitan cities, vegetation cover decreases and it is convert into asphalt structure, these hard surfaces hold heat for long time than rural area. It is because of it that less vegetation cover in urban areas than rural areas is the major contributing factor for the phenomenon of urban heat island (Sailor, 1994). Above the last decade, major impacts is anthropogenic heat, which change land cover and change climate variables, the contribution to surface warming was not received more attention (Zhang *et al.*, 2005).

Urbanization is a long-term form of land-use and land-cover change and its extent of increase are linked to population growth and economic development. Extension of the built-up area rapidly changed because of socioeconomic activities which have numerous impacts on urban atmosphere e.g. water and air pollution. The growth rate of urban population of Pakistan is higher than the other regional countries of South Asia.

**Table 1 Population growth Sargodha city**

1998	2011	Future's estimated population		
		2016	2018	2020
531,896	692,250	789,729	825,182	862,227

Source: Urban unit, 2011

The urban population growth rate of Pakistan is 3.5 per cent while it is 2.8 per cent for other South Asia. Sargodha is one of the largest cities that is considered 11<sup>th</sup> largest city of Pakistan (PDS, 2007). The population of the city will keep on growing (Table 1). The growing population of the city not only causing to increase the demand of new infrastructure (roads, buildings), it

also has greater effect to reduce the vegetation cover, which reduces photosynthesis and changes the surface roughness, albedo and hydrology (Bounoua *et al.*, 2009).

Part of this study explains the study area and methodology, part 3 elaborates the land-use change during different years and in part 4 discussions and conclusion is given.

## Materials and Methods

### *Land use change*

For the land-use change detection, post-classification comparison change detection method is applied. It requires rectification and classification of each remotely sensed image. A change detection matrix is used to compare the resulting maps on a pixel-by-pixel after the classification of each image separately. The following image processing procedures were employed in this study: 1) data collection; 2) data preparation; 3) supervised image classification; 4) analysis and 5) preparation of change detection maps. These applications were carried out using ERDAS imagine and Arc Map software. For this purpose, land sat satellite images for the years given in table 2 were downloaded from USGS website (<http://glovis.usgs.gov/>).

### *Study area*

Sargodha which is located between 72°38" N and 72°43"N and between 32°3" E and 32°7"E. It is located on flat surface with an altitude of 190 meter (Topo Contour, 2015). Sargodha (city of Eagles) is the 11<sup>th</sup> most populated metropolitan city in Pakistan and the 5<sup>th</sup> largest in Punjab (Iqbal *et al.*, 2009) and 11<sup>th</sup> largest city in Pakistan with population of 0.7 million (Urban Unit, 2013). Covering an area of 52 km<sup>2</sup>

(Demographia, 2013), the city is connected with all the major cities of the country by road and rail. The city has hot and cold climate. The residential areas of the city were developed in a series of blocks (Punjab Development Statistics, 2011) which titled it as a plan city.

**Table 2 Detail dates of the satellite images considered for classification of land use change of Sargodha city.**

Serial No	Satellite Images
1	16th May 1980
2	31st May 1992
3	25th Aug 2000
4	12th July 2013

### **Data Preparation**

For the case of land-use change detection it consists of geo referencing and sub-setting of images. Sub setting of an image is done to clip study area from a complete scene. Figure.1 shows the original image and subsets of study area that belong to four different years as a sample.

### **Supervised Image classification**

Supervised Image Classification is used that is the process of sorting pixels into a finite number of individual classes, or categories of data, based on their data file values. In this process pattern recognition technique which is essential to find the patterns in data, supervised training technique which is closely controlled by the analyst and signature evaluation methods are considered.

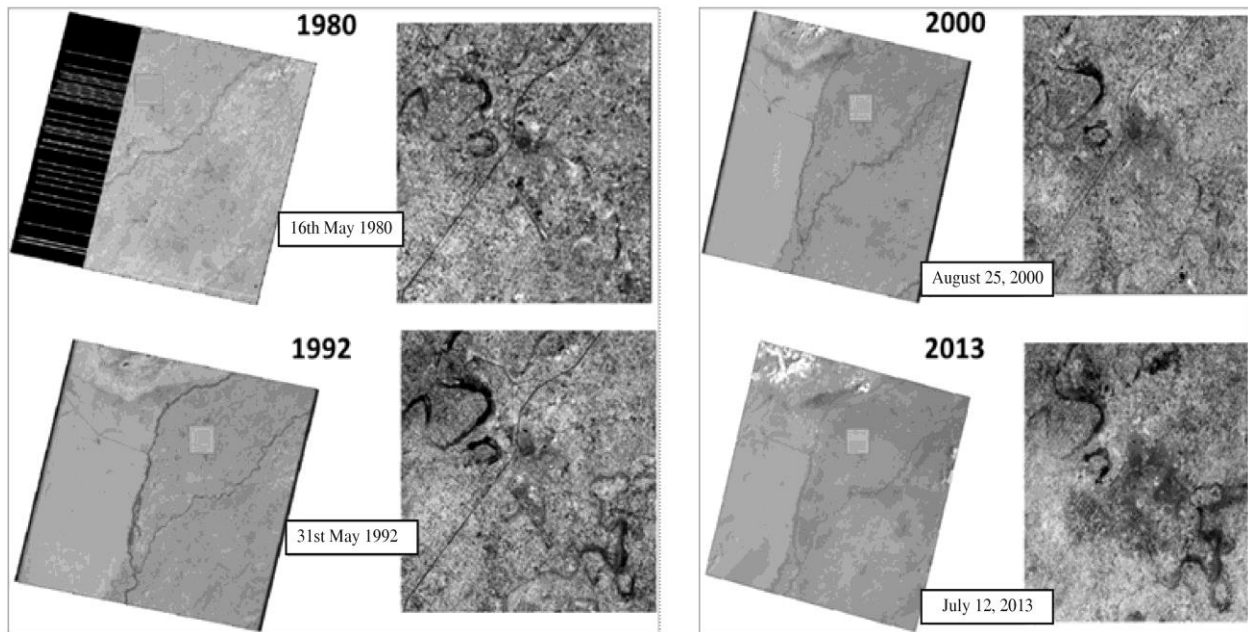


Fig.1. Original images and subset study areas of 1980, 1992, 2000 and 2013

The result of training was a set of signatures that defined a training sample or cluster. Each signature corresponded to a class, and was used with a decision rule to assign the pixels in the image file to a class.

Based on the on the signatures by use of a classification decision rule, the pixels of the image were sorted into classes after the signatures were defined. To classify the pixels in which unknown pixels were assigned to classes using contours of probability, maximum-likelihood statistics was used. Maximum likelihood method was used to classify the pixels in which unknown pixels were assigned to classes using contours of probability around training areas using the maximum-likelihood statistic. The output file was informed of image file with having thematic raster layer. In this file the data about class name, class table, class values, their statistics and histogram was automatically noted.

### **Data analysis**

Data was analyzed into the following steps:

- (i) Calculation of respective area of all land-use classes after the classification of all the maps into six land-use classes by using reclassification tool in ARC map.
- (ii) Preparation of graphs of all the land-use types of each year (given in combine in figure 5).

## **Results and Discussion**

### **Urban land-use/land-cover change**

In this work Arc GIS software is use for mapping and analysis which gave us batter way of image classification into shape file to visualize in better and attractive approach than other software packages. To check out the extension of the built up area of Sargodha city due to urbanization four satellite images for the years 1980, 1992, 2000 and 2013 were obtained and classified to take out the desire results. The output of

the classified maps helped to find the change pattern from 1980 to 2013 in a visual technique in which the built-up area, dense and sparse vegetation cover, bare soil and deep and shallow water bodies were found separately. Figure 2 represents the evolution in built up area resulted from urbanization in Sargodha city from 1980 to 2013. In 1980 the total built up area of the Sargodha city was only 61.86km<sup>2</sup> (Table 4) and it is further increased to 102.22km<sup>2</sup> in 1992. During 1980 to 1992, the built up area of the city increased 3.36 km<sup>2</sup>per years and the trend of urban expansion is observed to north and eastward. From 1992 to 2000, the urban land covered area was 122.84km<sup>2</sup>. During this period; the urban sprawl is measured 2.57 km<sup>2</sup>per year. During 1992 to 2000, most of the expansion of the city is seen toward east and south of the urban center and less expansion observed to other two sides. In 2013, the urban built-up area reached to 152.07km<sup>2</sup>. During 2000 to 2013, the expansion of the city is measured 2.24km<sup>2</sup> per year. During this period, most of the expansion of the city is observed toward eastern side of the city and somehow miner growth toward other sides is also measured.

The Sargodha city expands faster during 1980 to 1992 as compare to other selected years. These facts shows physical areas expand frequently. Figure 3 shows the combined map to show the evolution of land-use change of study area during different years. It helped to understand the urban sprawl and its spatial trends. Table 3 given below summarizes the built-up area of Sargodha city during 1980, 1992, 2000 and 2013.

**Table 3 Evolution in built-up area of Sargodha city**

<b>Year</b>	<b>Built up area (Km)</b>
1980	61.86
1992	102.22
2000	122.84
2013	152.07

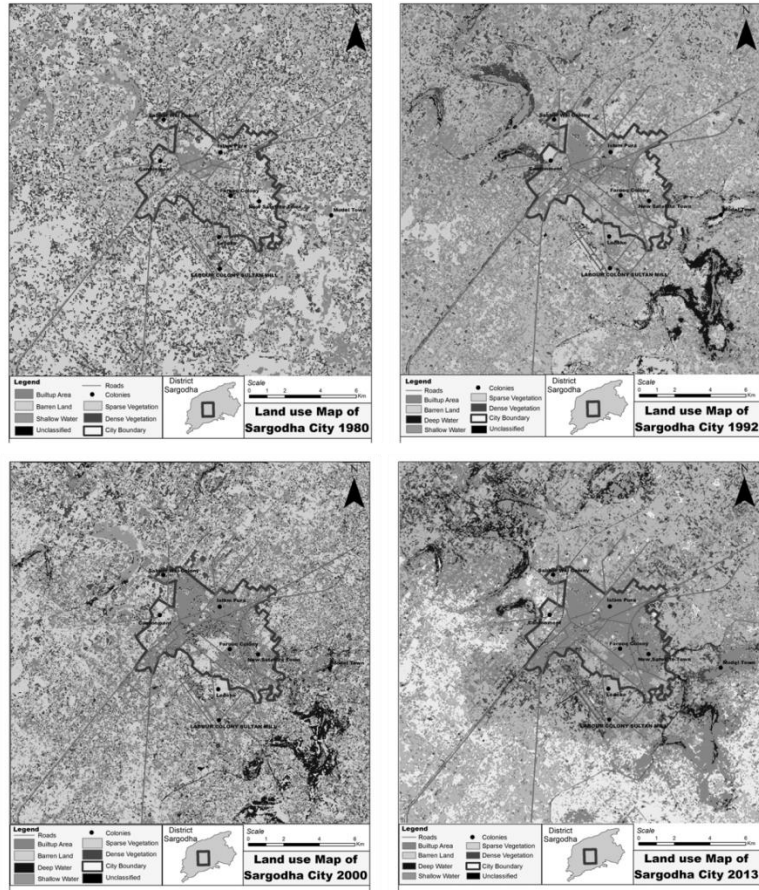


Fig.2. Classified image of land-use/land-cover of Sargodha city in 1980, 1992, 2000 and 2013

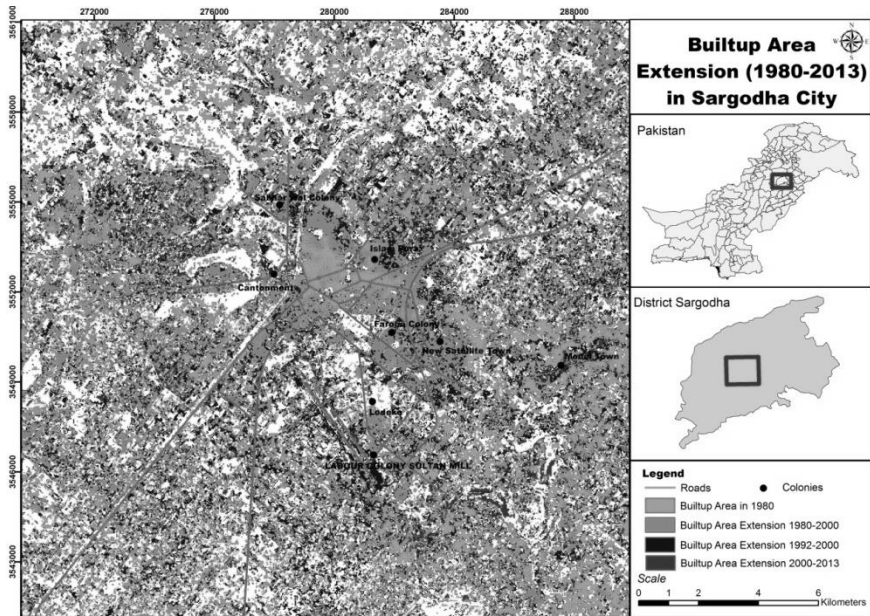


Fig.3. Combine map of Sargodha city for 1980 to 2013 to show the extension of built-up area during the study period

Table 4 summarizes the total land-use classes classified from landsat images. The given data in table shows the variation in land-cover changing over time starting from 1980 to 2013. It highlights that the built-up area had been increasing while vegetation cover had been decreasing

(Figure 4). Due to increasing built-up area of the city, the adjacent bare soil within in and out of the city decreased. However, the area of water body did not change a lot. Figure 5 highlights the percentage of land-use change of Sargodha city during the studied period.

**Table 4 Land use /land-cover change in Sargodha city in 1980, 1992, 2000 and 2013**

Class		1980	1992	2000	2013
1	Build-up	61.86	102.22	122.84	152.07
2	Dense Vegetation	64.47	58.81	30.85	37.93
3	Sparse Vegetation	148.88	152.11	164.29	149.41
4	Bare Soil	137.75	71.32	56.17	56.94
5	Deep Water	0	19.46	23.68	6.8
6	Shallow Water	6.82	16.01	21.78	16.63
<b>Total</b>		420	420	420	420

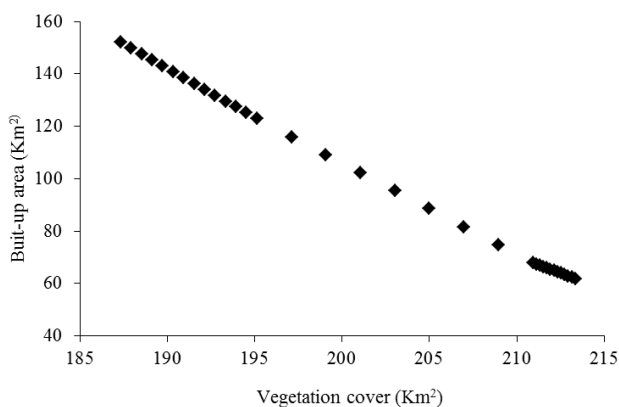


Fig.4. Relationship between built-up area and vegetation cover of Sargodha city for the period of 1980 to 2013.

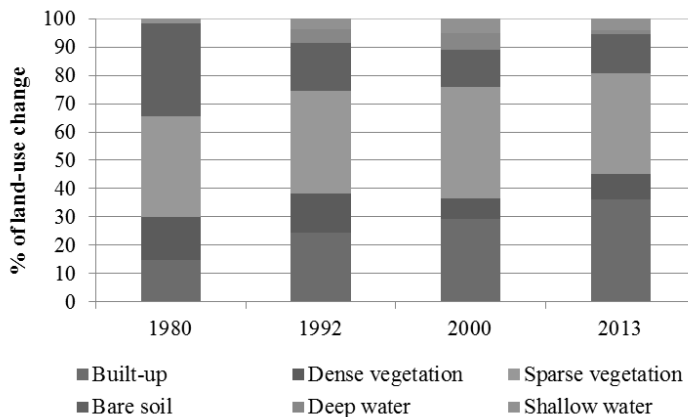


Fig.5. Percentage of land-use /land-cover change of Sargodha city in 1980, 1992, 2000 and 2013.

## **Conclusion**

In this study the evolution of urbanization and land-use change of the city was investigated. Urban extension examined through six classified images for the years of 1980, 1992, 2000 and 2013. The study highlighted that how the Sargodha city expanded during last four decades. The study explained that Sargodha city is rapidly urbanizing and urban sprawl toward south and east of the city is frequent and regular trends of spatial expansion of the city are observed. From 1980 to 2013 the built-up area of the city increased from 61.86 km<sup>2</sup> to 152.07 km<sup>2</sup> that is 90.21 km<sup>2</sup> raise during last 33 years. The most extension of the city during the selected periods observed from 1980 to 1992. During this period the dense vegetation cover of the study area reduced from 64.47 km<sup>2</sup> to 37.93 km<sup>2</sup> and sparse vegetation area reduce from 148.88 km<sup>2</sup> to 149.41 km<sup>2</sup>. During recent period the Sargodha city becomes rapidly urbanized and the natural land converts into built-up area. So this reduction of natural vegetation land leads to disturb the energy balance within the city area. This reduction of vegetation covers also cause to increase the urban temperature from its surrounding rural areas which is known as urban heat island.

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