MONITORING LAND-USE CHANGE AND ASSESSMENT OF URBAN EXPANSION OF FAISALABAD, PAKISTAN USING REMOTE SENSING AND GIS

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ABSTRACT

At present, due to rapid increase of population, changes are being witnessed in the earth planet in which great agriculture and barren land are converting into land use areas. Majority of the people lives in the cities and this boosted the buildup in that areas Faisalabad is the third-most-populous city in Pakistan, and the second-largest in the eastern province of Punjab. The cause of this rapid increase is rapid growth of population but on the other hand, this expansion of urbanization is causing loss of agricultural land due to construction of urban-infrastructure to meet increasing population demand. The study has been conducted is to map the changing land use patterns of the study area. For the purpose of getting the full scenario, trajectory coats related to Faisalabad and Sadar were utilized to get the imageries. For further studying colored images were subdivided. So, moving ahead in analysis, classification of images was used as a tool to study the changing patterns. Images driven from the satellite are essential for analysis. In 2000 built up covered approximately 222.81 square kilometer, in 2010 built up expand up to an area approximately 281.01 square kilometer. In 2018 expansion further leads to cover about 308.88 square kilometer area. In the Faisalabad City and Sadar, the analysis makes the argument that in all the directions whether North, North-West, South and South West, The urban built-up area and uncluttered swathes of land and urbanized developed area has soared. Which may keep on increasing until proper management and legal laws are not established by the government on national, provincial and on district level. Regarding these managements, one thing which should be applied is avoidance of horizontal expansion of buildings on land, by increasing vertical expansion of buildings will help in preserving agricultural land areas.

KEY WORDS: Land-use, Change Detection, Urban Expansion, GIS-RS, Faisalabad

INTRODUCTION

At present, due to rapid increase of population, changes are being witnessed in the earth planet in which great agriculture and barren land are converting into land use areas. Majority of the people lives in the cities and this boosted the buildup in that areas (Shirazi & Kazmi, 2014). Land cover and land use is an item of relationship between the society and cultural trends, piece of land and its own materialistic needs from the one

side in addition to congenital implicit of land cover in other side (Ram & Kolarkar, 1993).

The land use analysis tasks are now quite easy and accurate as a result of the utilization of satellite images and advance software like EDRAS IMAGINE and GIS. There are numerous classification method are widely used to find out of the change in land use and land cover however some important methods are unsupervised classification, supervised classification and object based classification (Sateesh & Sandip, 2011). To get ready to create maps of land use by using satellite data, classification of the image is a robust approach to information extraction (Karteris, 1990).

In collaboration with geographic information system that delivers better platform for the analysis of data, update and recovery of data (Star et al., 1997; Cihlar, 2000). Remote sensing application data make it able to analyze an alteration in land cover in a shorter time period, at very low priced in accordance with improved accuracy (Kachhwala, 1985).Using the invention of RS and global information system technologies, the land use and land cover change mapping is very helpful and detailed option to increase the variety of areas built to agricultural, urban and industrial aspects of a spot (Selçuk et al., 2003).

Change detection data getting from different remote sensing images that usually elaborates the impact of different activities either these are human and natural (Rao, 1991). Another technique which is digital change detection technique predicated on multi-temporal and multi-spectral remote sensing data have established a good work as a method to understand landscape change detection, identification of map and monitor variations in land use and land cover patterns with time, aside from the casual factor.

The developed cities had the greater capacity to foster industrial development, prospects of employment and better health and the educational uplift (Ghaffar, 2007). These factors lure the people towards big cities like Faisalabad city and Sadar. Faisalabad City and Saddar Tehsils have been replaced by four Towns, covering four quadrants of the city and area of Saddar tehsil (PUSP, 2014). Faisalabad is the 3rd biggest City of Pakistan (Bhalli, Ghaffar, & Shirazi, 2012). The City is second largest in the province with fast growing population.

At present its estimated population is about 6.7 million, out of which about 40 per cent or 2.7 million lives in Faisalabad city with a growth rate just below 3 per cent In future with a continuous decline in birth rates in Pakistan, the rate of population growth is likely to be under 2 per cent per

annum. However, it is estimated that by the year 2025, Faisalabad will be a city of over 4 million people (CDGF, 2010). The study has been conducted with three objectives in mind: firstly to define the nature, trend, rate, location and scale of land use change in the Faisalabad City and Sadar through geo-informatics techniques secondly to compare the past data with present changing patterns data. Third is to map the changing land use patterns of the study area.

Study Area

Faisalabad (Lyallpur until 1977) is the 3rd most-populous city in Pakistan, and the 2nd largest in the eastern province of Punjab. It has been speak of to as the "Manchester of Pakistan" (Abbas, 2013). As popularly known, the city has flourished in the textile units over four decades due to its cotton and textile industries (GOP, 2004). Faisalabad has grown to become a major industrial and distribution center because of its central location in the region and connecting roads, rails, and air transportation (CDGF, 2010). Today, Faisalabad enjoys a strong industrialized base, containing factories producing textiles, home furniture, jewelry, and food supplies, pharmaceuticals etc. The soil of Faisalabad consists of alluvial deposits mixed with loess having calcareous characteristics. The soil is commonly fertile (PUSP, 2014).
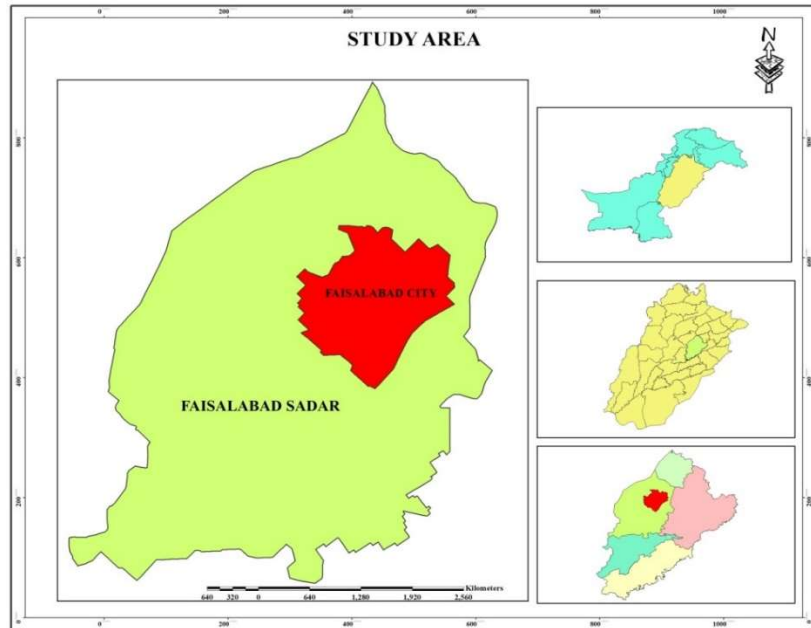
Figure 1: Location of the study area   Source: Naeem (2018)

Faisalabad City is located at latitude of 30°42' to 31°47' North latitude and 72°40' to 73°40' East longitudes (Bhalli et al., 2012). It is bounded on the North by Gujranwala and Sheikhupura Districts, on the East by Sheikhupura and Sahiwal districts, on the South by Sahiwal and Toba Tek Singh districts and in the West by district Jhang. It is situated in the upper Indus plain of Punjab at an average height of 184 Meters above the sea level. Its city Tehsil covers an area 168 sq. Km, The total area of district Faisalabad is 5,856 sq. km (2,261 sq. mi). Most of its Area Irrigated by Rakh branch, Ghoghera Branch and Jhang branch. Faisalabad is situated in the systematic smooth plains of northeast Punjab, at 184m above sea level. The river Chenab movements nearby 30 km and the river Ravi meanders 40 km to the southeast. The lower canal Chenab runs water to 80% of agriculture lands making it the chief cause of irrigation (PUSP, 2014)

MATERIAL AND METHODS

In order to get LU/LC fluctuations in Tehsil Faisalabad city and Sadar, there is a need of the three Landsat images for the thorough study for 2000, 2010, 2018 having the resolution of 30m (Row 150-39) and Bands 1,2.3,4,5,6,7 and 8. These imageries were obtained from USGS earth viewpoint website. All have been prepared land use change maps and used as a basic data Sources and classifications were established for this determination.

Table 1: Characteristics of Remotely sensed data:

Year	Satellite	Sensor	Spatial Resolution
2000	Landsat-5	(TM)	30m
2010	Landsat-5	(TM)	30m
2018	Landsat-8	(OLI)	30m

Pre-Processing

Layer stacking: Layer stacking is an important operation done in current study after obtaining the necessary images. The different band is always acquired by Satellite image. The layer stacking is known as the process of combining these images of different bands. It was completed by Erdas Imagine 2014.

Sub-setting: Image sub-setting was done after the procedure of layer stacking. In Sub-setting the imageries were subset to include only study area by changing properly the whole outlook of the AOI having the digitized boundaries format and then moving ahead for the purpose of getting the images. The changes in the land use/land cover on time-based basis from 2000-2018 were calculated through the help of Nearest Neighbor classification method.

Mosaic Making: After collection Mosaic Making was a main process and this is done on Erdas Imagine 2014.

Table 2: Accuracy assessment of Land-Use classification of all Landsat images

Image Acquisition Year	Accuracy Assessment (%)
2000	86.23
2010	89.12
2018	93.78

Classification: For the purpose of getting the full scenario, trajectory coats related to Faisalabad and Sadar were utilized to get the imageries. For further studying colored images were subdivided. So, moving ahead in analysis, classification of images were used as a tool to study the changing patterns. Images driven from the satellite are essential for analysis (Bhandari, 2010). The classified image is got by the way of dividing the total pixels which one image has into various factions like land use or theme (Lillesand and Kiefer, 2000). As in the study of this project, assiduously we have endeavored to apply the Digital Image Classification Pattern over the images got through Landsat Satellite relating to the year 1980, 1992, 2000, 2005 and 2010. The method that we have applied is used as an instrument to ascertain the analysis of the images. Finally,

images are passed through process of the clipping in which trajectory path of Faisalabad city (Nasar-u-Minallah, 2011). Images passed through the clipping method are further categorized by the way of mathematical formulas like algorithm and nonparametric parallelepiped categorizer to attain the developed section of the City out of the research(Almeida et al., 2005). As the main focus of this research is the spiraling of the urbanization in the Faisalabad city so for this purpose the simple method to analyze is binary classification that is more than enough (Bhatta, 2009). The results gained from the assessment attained about the Landsat images regarding the five time periods 1980, 1992, 2000, 2005 and 2010 whose outcomes are 73, 76, 75, 85 and 86 per cent respectively and this is not much different from the researches done earlier. As its sure that results which we sought through the digital image classification had greater degree of significance. The figures relating to this method boost the confidence as producers accurateness calculation had points rang 206 from 55 per cent to 100 per cent while the user's accuracy assessment with to results encompassed the range from 71 per cent to 100 per cent.

ANALYSIS AND RESULT

In 2000, the major area of Tehsil Faisalabad city and Sadar was covered by the husbandry having the significance even to these figures like 65.57% of all the land Use. This is mainly because Faisalabad city and Sadar is a luxuriant terrestrial valuable with suitability making of sugarcane along with Wheat. Another factor area is occupied by the bare soil which is 19.64%. This class includes all the vacant factions of land. In this year 2000, Faisalabad city and Sadar Tehsil appeared to be a smaller amount proper area as built-up class only covers 14.65% of the whole area the water has a share is only 0.14%. As is consists of only a rare canal system which are mostly used for irrigation purpose.

Table 3: Land use distribution for each study year

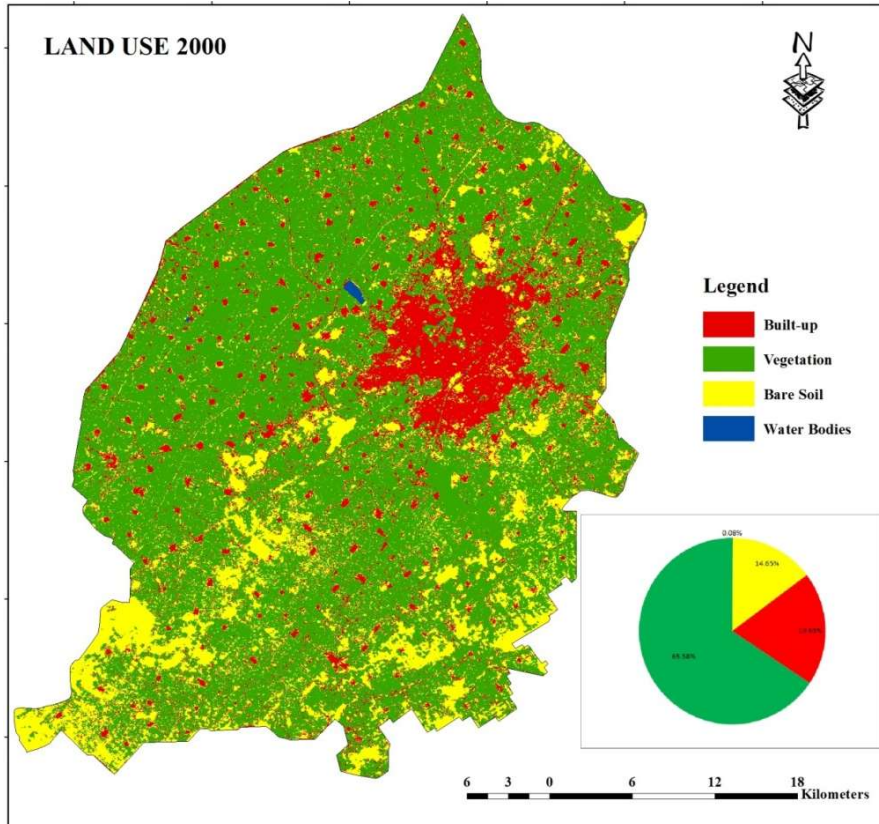| Land Use	2000		2010		2018	
	Area (sq.km)	Area (%)	Area (sq.km)	Area (%)	Area (sq.km)	Area (%)
Agriculture Land	997.55	65.53	925.43	60.86	804.13	52.86
Built-up Land	222.81	14.61	281.01	18.49	308.88	20.3
Bare Soil	298.66	19.72	310.34	20.37	406.95	26.76
Water Bodies	2.14	0.14	4.38	0.28	1.2	0.08
Total	**1521.16**	**100**	**1521.16**	**100**	**1521.16**	**100**

Figure 2: Land use of Faisalabad city and Sadar, 2000

In 2010, the agriculture land shows a decline in its area by 4.74% ten yearly annual and generates a share of 60.83% among the factions who had land. The soil that is bare the bare soil has enhanced its portion from 19.64% to 20.4% as some of spots seem to be occupied in past along the soil that is bare and had vitality soil that was bare had agrarian land. Though, so yearly witnesses smallest enhances in developed area by 3.83% only. Water bodies show a minor increase by 0.29%.
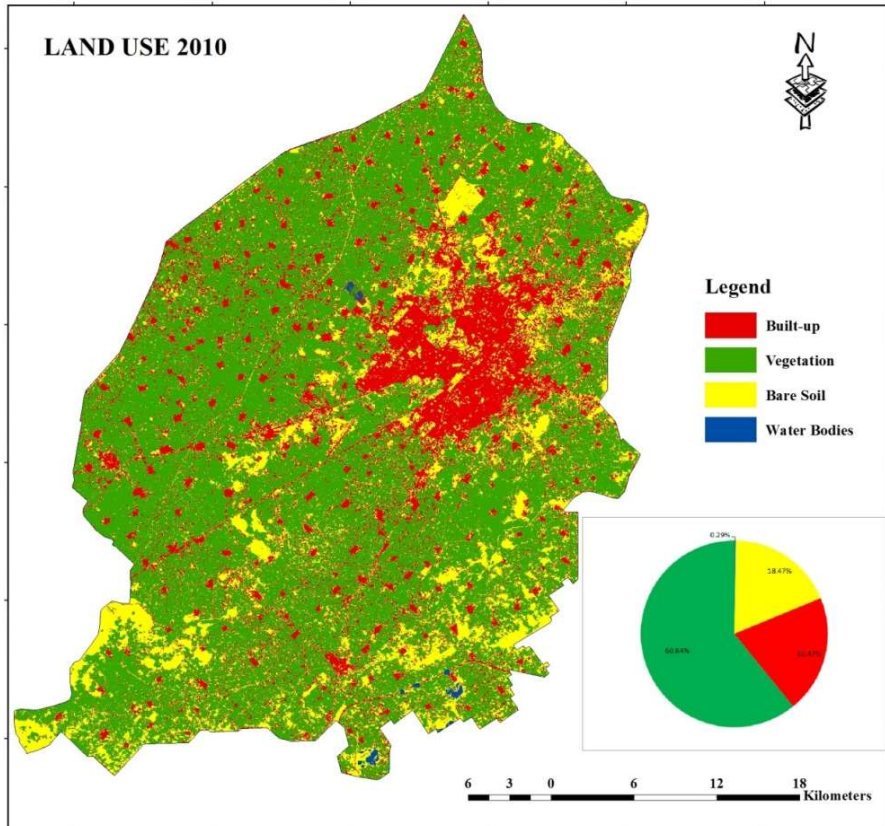
Figure 3: Land use of Faisalabad city and Sadar, 2010

Agriculture land still covers the major share of land use 2018 but it has by 7.97% in its share, making it 52.86% in 2018 from 60.83% in 2010. This may be because the agriculture land is reduced due to city has started its drive towards the expansion. Built-up is display a growth, as it rises from 14.65%-20.3% in the year 2018. Bare soil has again increase of 6.36% in 2018 as compared to 2010 which was 20.4% then now it is at the result of 26.76%. Water quiet holds the smallest share. Nevertheless, it has abrupt fallen to 0.08%.
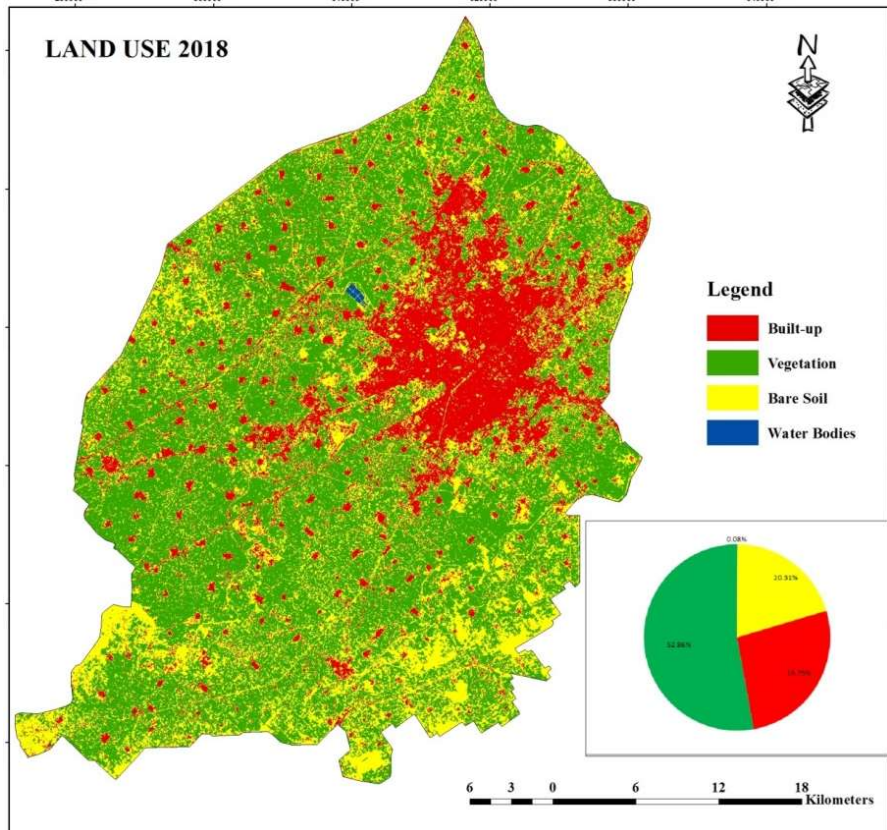
Figure 4: Land use of Faisalabad city and Sadar, 2018

CHANGE DETECTION

The purpose of change detection is to know that which land use has increased or decreased from the past and which land use is converted into what. Change detection seeks to extend a crystal marks about the ratio zone have the intensity of transforming of LU. Landsat imageries and cataloguing analysis, researcher detected with huge vegetation area has now been converted into soil that is bare in addition having the sufficient piece of land is change into developed area. The changing trend about the land that is barren has to developed area and would have the water habitation resorting to decrease in trend. The subsequent statistics shows changing trend of every class furthermore huge level of change.

Table 4: Land Use change detection Rate and Magnitude:

Land Use	2000-2010		2010-2018		2000-2018	
	Area (sq.km)	Change (%)	Area (sq.km)	Change (%)	Area (sq.km)	Change (%)
Agriculture	-72.12	-4.74	-121.3	-7.97	-193.42	-12.71
Built-up	58.2	3.82	27.87	1.83	86.07	5.65
Bare Soil	11.68	0.76	96.61	6.35	108.29	7.17
Water	2.24	0.14	-3.18	-0.2	-0.94	-0.06

Agriculture land: Assessment of the years 2000 and 2010 displays not positive but negative changes in agrarian land class. Since then the agrarian land has witnessed decline by 4.74%. So it is expected that there would be same decrease of agricultural mass despite the fact that, between all the land swathes under study. That's why it is being assumed as a greater dominant in northern and north eastern sides. Some parts of the agriculture Land have converted into barren land arid some Part is also converted in built up area as well the total area which is converted in this time period is 72.21 Sq.km. A total decrease in agriculture land is seen during year 2000 and 2018. Agrarian land has witnessed the reduction by 12.71 %. So the decline of this kind in the agricultural land has the reasons lie in the spiraling developed construction. Agriculture has mainly vanished from northern and western part and from Some Southern parts. The main reason behind such reduction is the growth of city in terms of commercial and residential activities. From last many years, the Faisalabad city and Sadar tehsils is facing the problem of residential activity which is very high some parts of the tehsils. Basically there are many factors that are changing agriculture area into other land use classes. These factors are elaborate below: Industrial development in these areas, population increase and need of new residential colonies and a very big and vital factor is salinity increase in this area. In my survey of the tehsil Faisalabad city and Sadar Tehsil I observe that there is a big change of agriculture area into built up class but this change is only along the big roads. Only a big change into built up class is around the city and city is now four times bigger as compare to 2000. The main reason which is destroying the crops and real fear for the farmers is salinity of this area. In the northern and western part of the study area, the salinity in the soil is on its peak and a large agriculture area is nowadays turned into bare soil.

Built-up Area: The construction expansion in the city witnesses not the negative but rising trend in the positive sense as the figures suggests that it increases to 3.82% in subsequent years from 2000 and 2018. In the research, we have found that new areas appears in the images that were

not present prior these are in central and western directions. The images that shows about the central area definitely links with Faisalabad city and Sadar Tehsils city. It we assumes from this ratio that it is not spiraling at greater rate. In the positive sense it is just the spur in the developmental process that began in the city so it earns no concern.
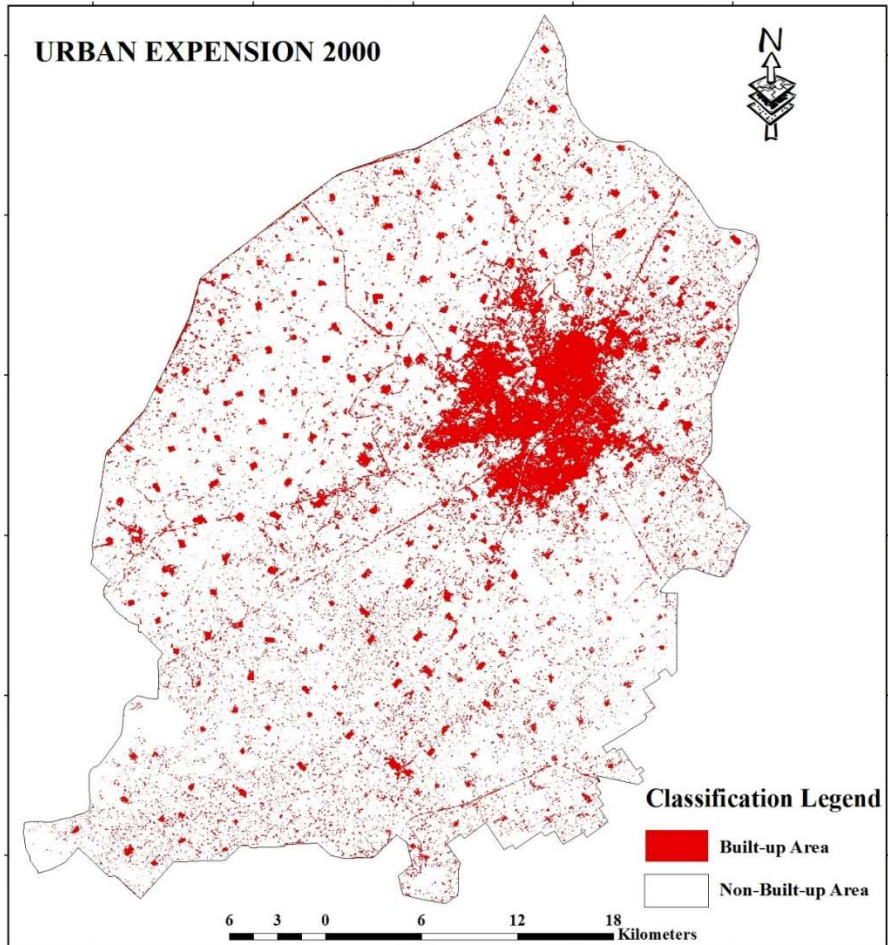

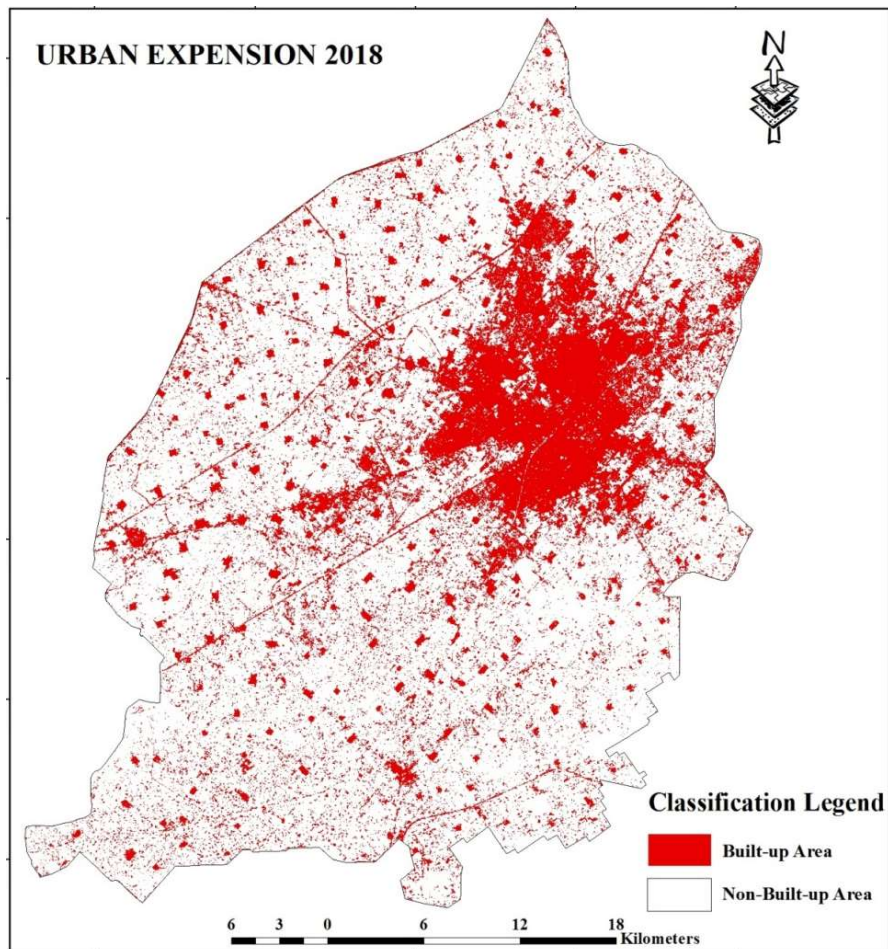**Figure 5a**: Expension of built-up in 2000

Figure 5b: Expension of built-up area in 2018

The 2 decades beginning from the 2000-2018 which is 5.65% has witnessed the greater construction. This process took place more vigorously in the unified manner in the greater extent in central along with north and south western directions. The built up area in 2000 was 14.61% and now in 2018 the built up area is 20.3% in 2018. The Central city areas are increasing very fast and a very rare and very slow increasing of built-up Area in other parts of the study area because all other areas are rural settlements.

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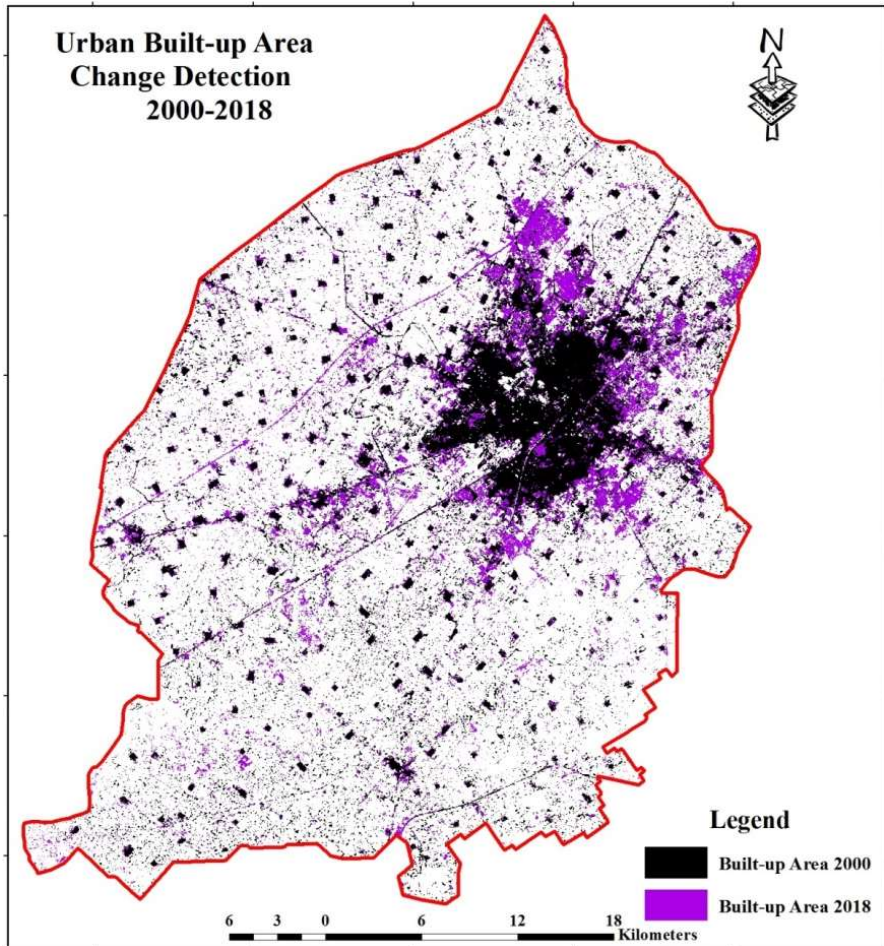

Figure 6: Change detection of built up (2000-2018)

Reasons: Basically there is a big expansion of built up area around the main city. There is a kind of spiraling of construction in the name of commercial purpose and also about the residential purpose. Along the land related to the City, we found many kinds of the residential schemes underway expanding rapidly. These enormous efforts for the residents to build a colonies included Colonies are Bilal town bhai Wala, Aliwat town Salehpu town and bahria town are newly built Colonies On western side of the city. Duglus pura, faiza abad, allied colony, bawa chack, jamil town, lasani garden, sidhu pura, raza abad, shabaz town, Sant Nagar, Dhobi Ghaat, and Islam Nagar etc. dated back to pre-independence and 1947-1970s such as Ghulam Muhammadabad, Muslim Town, Behria Town, Saman Abad, Ameen pur Bangla, Fareed Town, and various other older communities in the Northern part of the city. Whereas the Railway line and Rakh Branch Canal bisects the city and in Southern side, areas like Sarfraz

Colony, Peoples Colony No. 1 and Peoples Colony No. 2, Madina Town, Muhammadabad etc. South Western side is also expanding due to Hassan Colony, Shalimar town and muhallah Danish pura town. These are major flew Colonies around the City which Contribute largely in built Up area increase of the study area. Along the main road that cannot be under estimated in the sense of the spiraling commercial activities that has given fillip to the construction. Faisalabad enjoys a strong industrial base, comprising factories producing clothing, textiles, jewelry, home furniture, pharmaceuticals and food supplies etc. There is a big commercial construction in main city area. Many new plazas and new shops are come into observation which is recently constructed or else under construction.

Bare soil: In the first decade of the 21st century from 2000-2010, the soil that is barren has given positive picture and has also gave figures in the rising 0.76%. however this increase can be attributed to host of factors agriculture land has decreased because of main reason Which is water logging and salinity of the soil in this Study area Much of the area of agriculture was Under effect of Water logging but used as Agriculture land because only agriculture is the main Occupation of the majority people in the study area. The first two decades of the century beginning from Period of 2000 to 2018 has have shown a transformation in the land that is barren. It has a big increased by 7.13 % which is not negligible; however the bare soil got clustered mainly in all parts of the study area while it has great effect on south western and south eastern parts. The main reason of the huge increase in bare soil is salinity and water logging in many parts of the study area.

Reason: The main reason of bare soil increase in this area is salinity and water logging. The new bare soil patches was mostly agriculture land in the past but due to continuous salinity in the soil, a big agriculture land is now converted into bare soil. Some built up areas are also converted into bare soils which were small industries and mills in the study area. The ratio of built up area change is very low as Compare to the agriculture class change. A small contribution also came into observation in water body class. In north and south of the study area, there is a clear Change in water body class which is now part of bare soil.

Water Bodies: The lowest level of the change that was witnessed in the study area was of the water section throughout these sporadic times. As the first 2 decades under study made no positive change in this regard and also witnessed the plummeted ratio by 0.14% it is the forth and important class of land use but it has very less contribution in change of land use area. Because of salinity in many years there is no remarkable change in this class but a minor trend in decrease of water body is observed in some

area of Faisalabad city and Sadar Tehsils. Water shows a total negative trend for the time period of 2000-2018, during which it has decreased by 0.06%. In last 20 years, the total change of water bodies is less Than 1% of the total land use area and map Shows only in central and southern part of the area is effected change. The area of southern tip also shows a visible change in study area.

Reason: The reason behind this change is the topography of the land. As the whole tehsil is a plane area but there is very little variation in northern and southern parts of the study area. In very north and very of the study area, the land elevation is higher than the central and western parts. So many water ponds are now convert into bare soil. Every village was carried 3 or 4 big dirty water ponds which were used for sewerage system but due to Development and advancement in every village these dirty ponds are vanished and some these areas are now part of barren land.

CONCLUSION

The outcome of this assiduous effort to analyses the city throughout the 2 decades ranging from 2000 to 2018 shows the trend of the progress. Areas under study were the Tehsil Faisalabad city and Sadar. Our effort to study this area has also unraveled on us the usage and vitality of the satellite information system through which we got the information and other modern techniques for getting the relevant information with the aide of the GIS tools for accurate imaging of the concerned parts of the land. The urbanization has spiraled to all the surroundings of the city that are North, North West, South and South West of Tehsil Faisalabad city and Sadar. During this period that was studied 2000 to 2010, agrarian land has gone through rise by 4.74% at the same time this era is marked with little upward growth in the construction. But during the years 2010 to 2018, agrarian land plummeted by 12.71% but on the contrary to it, built up areas witnessed the spiral with greater pace by 5.65%.Which may keep on increasing until proper management and legal laws are not established by the government on national, provincial and on district level. Regarding these managements, one thing which should be applied is avoidance of horizontal expansion of buildings on land, by increasing vertical expansion of buildings will help in preserving agricultural land areas. The underlying factors of this spiral of the urbanization in all the directions is the industrial growth that took place also in our neighboring countries and they also passed through the same process.

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