



RESEARCH PAPER

Urban Expansion and Remote Sensing Techniques: An Assessment of Multan City during 2008-2018

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PAPER INFO	ABSTRACT
<p>Received: June 24, 2021</p> <p>Accepted: September 13, 2021</p> <p>Online: September 16, 2021</p> <p>Keywords: Change Detection Population Growth Remote Sensing Urban Expansion</p> <p>*Corresponding Author:</p> <p>basitnadeem@bzu.edu.pk</p>	<p>This paper presents an incorporated study of urban growth and expansion of Multan City, by using remote sensing techniques, and discussed the temporal and spatial characteristics of urban expansion and land use land cover change from 2008 to 2018. Multan, city of Pakistan, has been facing rapid urban evolution the last eras. The progress of socio-economic development and urban growth has concluded in the quick change of urbanization. Temporally, urban expansion shows rapid and sluggish growth stages, with the high-speed growth shifting to all the directions. The result shows the detection of this decay from 2008 to 2018 of Multan city. In 2008 built up area covered 47.4 sq km that increased rapidly till 2018 that is expanding up to 70.3 km. A key effect of this urbanization is actually detected in the practice of a rise of growth of population. Due to urban expansion, Multan has moved out under extensive Land use changes the last decades. Being the agricultural landscape over all, instead of progress in agricultural activities, the district of Multan has shown a decrease in the agricultural land. Loss of agricultural land has resulted into the increase of urban land area. In other words the inhabited area has been increased at the cost of decrease of food required for the growing population. The major factors influencing urban expansion and land use/cover change are also discussed. In general, the traffic conditions, population, industrialization, and policy are the major factors that influenced the urban expansion.</p>

Introduction

Abundant and compact populace shows urban zone that occurs under effect of a city commission (Olofin 2017). During the last century, urban growth and expansion varied due to the migration, increase speedily generally in continent Europe then into the south Asian areas. Urbanization touched its topmost in advanced countries in as directed by UNFPA a huge part of the cities are organized at the main of the suitable agricultural parts and the designs of the urban area epicenter everywhere fringe zones. Agarwal intelligences that 6.75 million km of backwoods. In Pakistan, according to GoP 2017 the percentage of urban expansion has increased from 17.8% in 1951, to 32.5% in 1998 and 39.2% in 2017. The ratio of urban expansion in Pakistan is annually nearly 3 percent, the

rapidest place in South (Araya, environment of the city zones (Farah et al. 2016), natural and environmental issues by increment LST and decrease in flora (MutanI and Todeschi 2010).

The main causes of urban development are similar with the causes of urban progress due to expanding population and interest for the job of market. Effects of urbanization on the city Multan are; common increment in population, movement to urban zones, absence of laws and guidelines to minimize extension of city which reduces the negative effects on agricultural land.

The using of Geographic information system and remote sensing has been shown as an active process of assessment of urban expansion. Observing of urban growth and expansion and assess its effect through multi-temporal, multisource remote detecting have declare great interest in the current decade. Remote sensing is the supreme operative instrument in observing urban growth and expansion and identifying Landuse changes with assessment of time-based changes of land surface. The objective of current research is to inspect spatio-temporal urban growth, expansion, and pattern and to suggest issues of urbanization in Multan city. For accomplishment of objective, the current research based on the hypotheses, due to urban growth there is a tendency of loss of agrarian land and growth of industries and manufacturing activities in the rapidly growing regions of Southern Punjab in general and the study area in particular.

To accomplish objectives of current study, city Multan was selected as study area. City Multan is also district and divisional headquarter with areal expansion of 133 sq km². City Multan Geographically located between 30°11'50 North Latitudes & 71°28'13 East Longitude. The elevation of Multan city is 414.8 feet from the sea level. Multan city the highly urbanized area of the Multan district, consist of sixty-eight union councils. According to the koppen classification. The climatic situation of the city is B.sh (Dry, deserted and hot .with average annual rainfall less than 200 mm. The maximum stately high temperature is almost (122degree F) and the lowermost measured is nearly (30 degree F).

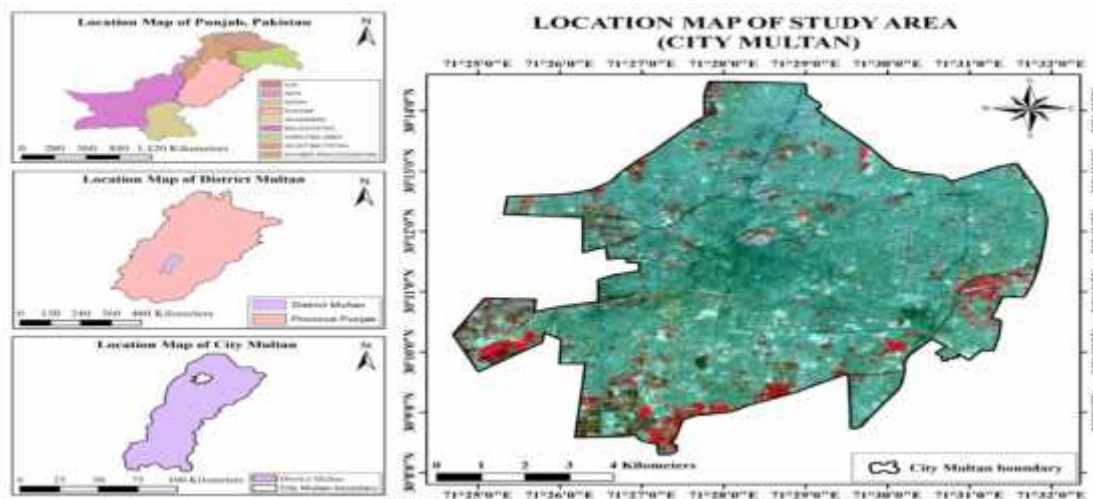


Fig. 1 Location map of study area city Multan

Literature Review

Dong et al. (2011) has assessed the impacts of fast urbanization on access to enough lodging in Kakamega Town. The analyst in this manner finish up by proposing proposals to change the negative impacts of urbanization on access to enough lodging in the meantime energize/advance the agglomeration advantages of urbanization. The analyst further prescribes the execution of positive land, lodging and urban advancement arrangements and survey territories with disparities to address the current land residency issues, the foundation of techniques for growing minimal effort rental lodging and supporting the private area to grow better than average and reasonable asylum for all.

Suen (2018) has expressed that the investigating the impacts of urban sprawl on the physical condition on account of Karenina. The development of urban arranging can be going back to the essential urban areas in earlier hundreds of years. All through the most recent decades, urban populace has been quickly expanded because of urbanization in creating nations. Inordinate development of populace because of urbanization prompted upward development of urban areas, which as result urban areas missed their domains and limits and created assortment of urban structures that took a little consider of their effects upon the earth. Therefore, this century encountered the supernatural occurrence of urban sprawl as the underlying essential urban structure. The urban sprawl and the expansion of urban zones are the worries of the present urban areas because of social, ecological and monetary negative effects that has in the urban areas.

Saqib et al. (2016) have assessed the measure of settlement and urbanization in Sindh, Pakistan. Country to urban movement is one course to urbanization. Another is the expansion in size and change in intricacy of littler country settlements, as they obtain urban qualities. The inclination towards 'divided' settlements, in this manner, should be compared close by the more regular pattern towards combination. There are unmistakable verifiable and sociological clarifications for this settlement design, just as clear ramifications for the directions of urbanization in Sindh. The note will represent this issue just as the difficulties for solid documentation, information accumulation, and programming, utilizing contextual analyses of individual income towns in Sindh. Suggestions for research just as approach influencing will to be illuminated.

Minallah et al. (2012) evaluation of urban sprawl of Faisalabad, Punjab, Pakistan utilizing multi-arrange remote detecting information examine on the quick utilization of land. It describes the urban sprawl, its spatial and urban characteristics. Satellite image techniques have been used in this paper. This paper analyses the year-to-year greenness of Faisalabad and increasing urbanization. It discusses this expansion from 1991 to 2013.

Materials and Methods

Multan city has been chosen as a study area, keeping in view the availability of the remote sensing and ancillary data, and rapidly changing status of urban population. This research is try to estimate urban growth and expansion and its impact on Landuse changes of Multan, Pakistan, through combination of remote sensing and census data to analyses the association with the changing aspects of urban growth and expansion relative to the Land use change.

The satellite imageries are used to make a map of supervised classification, unsupervised and normalized difference vegetative index of Multan, that turn is used to approximation the Landuse changes of Multan. The association between Normalized difference vegetative index and Landused changes indicates high negative correlation which mirrors the flora cover can expressively decrease from 2008 to 2013 but also increase from 2013 to 2018.

To analyze the effect of built up area on land cover by using two different sets of data in research: satellite image data applying three different times of Landsat 7/Enhance Thematic Mapper+ and 8/Operational Land Imager imagery/OLI attained in 2008, 2013 and 2018, respectively and the population data acquired from the population census beauru Multan City Reports and Survey Of Pakistan over a period (1998 to 2018).

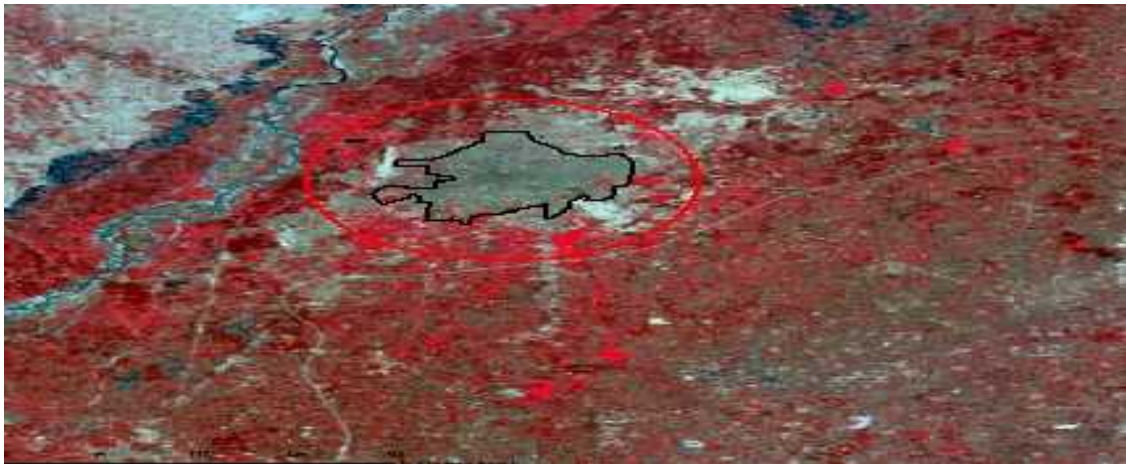


Fig. 2 Image showing extent of city Multan on Landsat image on path 150/row 39 Source: <http://earthexplorer.usgs.gov>.

In command to enhance the visual description of the images, all the subset images of the study area were enhanced. The histogram levelled section was nominated with the ERDAS Imagine's 9.3 histogram calculation instrument to improve the satellite images between all the accessible image. Three different spectrally enhanced satellite images of the years 2008, 2013 and 2018 were used for the classification and reclassification of the built-up area (Momeni et al. 2016).

Image classification

For the Spatial-time based scrutiny of the research, data is attained via multi date satellite images. Urban expansion and subsequent variation in Land use are judged via Landsat 7 (Enhance Thematic Mapper) and Landsat 8 (Operational Land Imager) images with path 150 and row 39 for the year 2008 to 2018 respectively (Bagan and Yamagata 2014). These Landsat images were downloaded freely from the website of U.S. Geological Survey (<http://earthexplorer.usgs.gov>).

Table 1
Description of landsat images used for urban expansion

Landsat	Year	Sensor	Spectral Resolution	Spatial Resolution
Landsat 7	2008	ETM+	8	15 (Pan), 30 MS
Landsat 8	2013	OLI	11	30 m
	2018	OLI	11	30 m

Source: <http://landsat.usgs.gov/>

Preprocessing (Layer stacking, Mosaicking and image subset) of data was done by using ERDAS Imagine 14. Then supervised image classification (Fig. 2) was done in Arc GIS 10.1 (fig. 3).

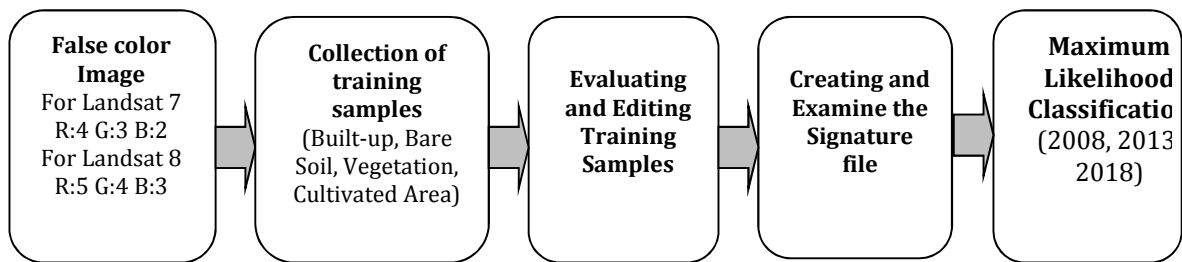


Fig. 3 Basic Steps in Supervised Classification

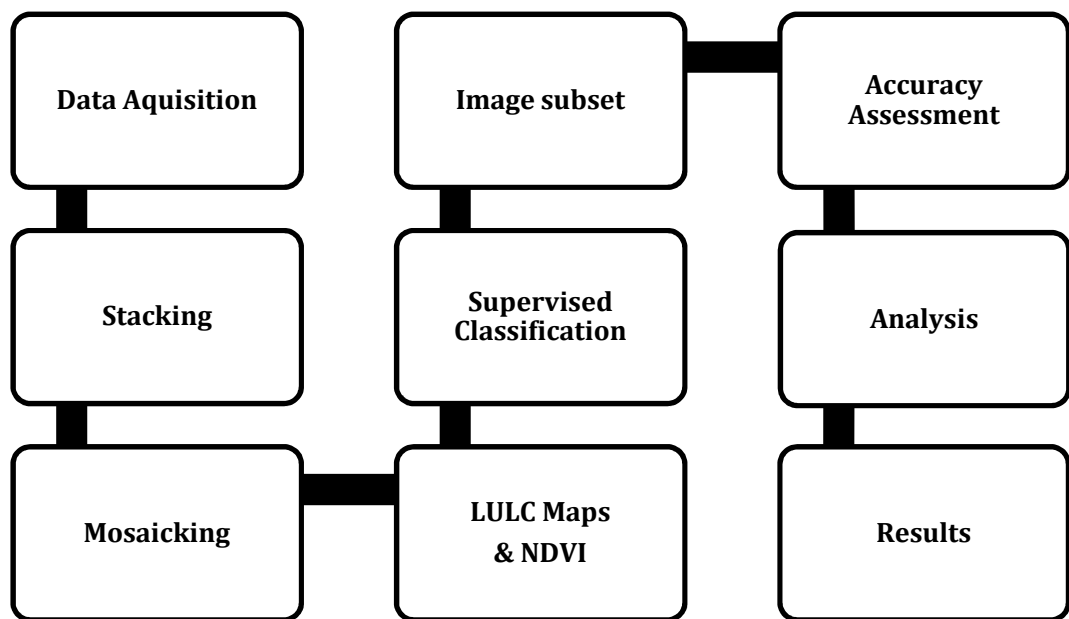


Fig. 4 Flowchart of reaserch methodology

Normalized difference vegetation index (NDVI)

NDVI becomes useful in evaluating vegetation from other features because of its prominent reflection in red and blue bands in visible spectrum (Neil-Dunne et al. 2014). Procedure of classification was also assisted by NDVI through multispectral and multi-temporal satellite images of years 2008, 2013 and 2018 (Eq. 1). ERDAS Imagine 2014 was used to perform NDVI and ArcGIS 10.3 used for making maps.

$$\text{NDVI} = \frac{\text{NIR}-\text{RED}}{\text{NIR}+\text{RED}}$$

(Eq. 1)

Where; NDVI represent normalized vegetation index, NIR as near infrared band and RED indicate red band.

Accuracy Assessment

For accuracy assessment, map data and reference data is compared by creating confusion matrix or error matrix (Chen et al. 2013). To estimate classification accuracy, an error matrix was organized using reference data (ground truth). Following equations facilitated in finding map accuracy or overall accuracy and Kappa coefficient. According to Neil-Dunne et al. (2014), overall accuracy represents the ratio of summation of diagonal and total number of samples classified (Eq. 2), whereas kappa coefficient gives quality of map (Eq. 3).

$$\text{Map accuracy or Overall accuracy} = \frac{\sum_{i=1}^p x_{ii}}{N} \quad (\text{Eq. 2})$$

$$K = \frac{N \sum_{i=1}^r x_{ii} - \sum_{i=1}^r (x_{i+} x_{+i})}{N^2 - \sum_{i=1}^r (x_{i+} x_{+i})} \quad (\text{Eq. 3})$$

K = Number of columns and rows, in error matrix

N = Number of observations in error matrix

n_{i+} = Total number of observations in row i (right)

n_{+i} = Total number of observations in column i (bottom s)

n_{ii} = Main oblique component in class i

Results and Discussion

Land Use/Land Cover Classification

Significant changes were observed from classified images of the year 2008, 2013 and 2018. By LULC analysis it can be seen as there is shift of built up are on vegetation cover and forest to vegetation cover and built up area. If different land use types of city Multan

in years 2008, 2013 and 2018 are compared, it showed extreme difference in aerial analysis (Table 2). In 2008, builtup part was 47.4 square kilometer which enhanced near to 67.8 square kilometer and further expanded up to 70.3 sqkm varying bare soil and cultivated area in to builtup. In 2008 soil was 30.3 sq kilometer and it increased up to 29.4 sqkm till the year 2013 which was also increased up to 20.2 square kilometer till 2018 changing cultivated part into bare soil. Vegetation covered area also showed negative change in its coverage from 2008 to 2018. As in 2008 vegetated area was 38.7 sqkm that reduced to 18.7 square kilometer in 2013 and further reduction caused 39.1 square kilometer till 2018, conversion to other type of land. Similar as to flora cover, refined area also displayed reduction in its type as in 2008, 16.6 sqkm area was under cultivation, 7.1 sq km the year 2013 and in 2018 only cultivated area was 3.4 sq km (Fig. 4).

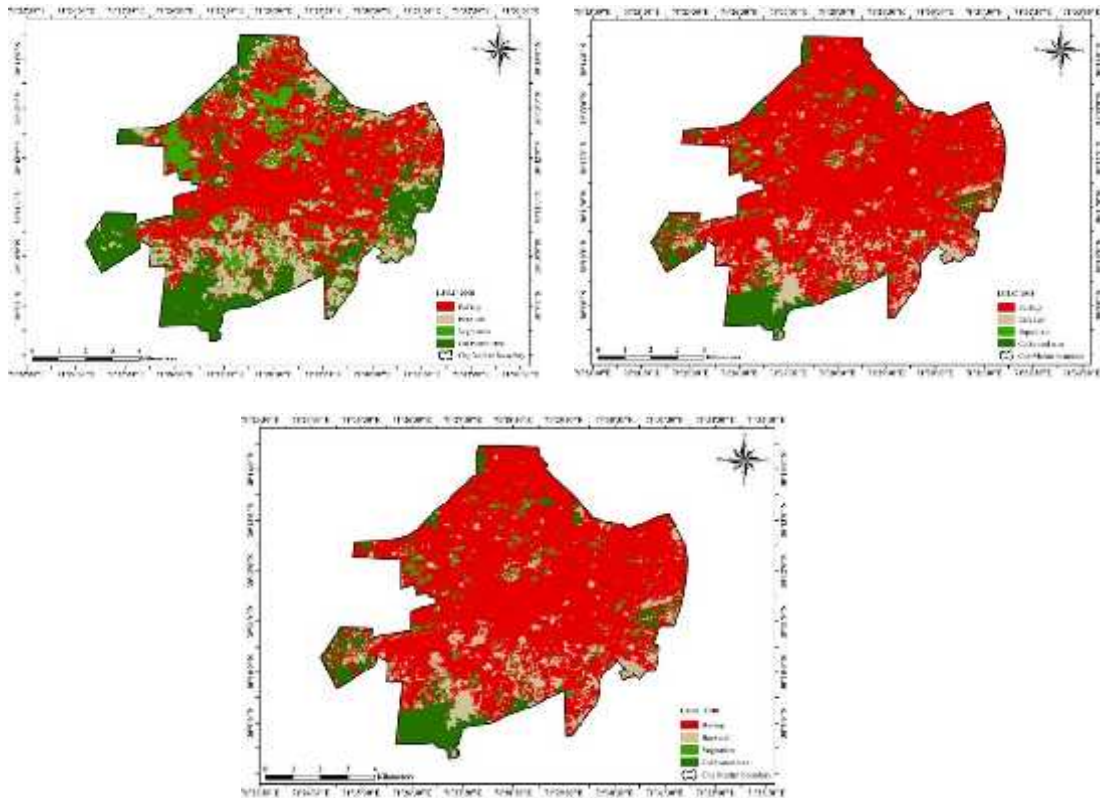


Fig. 5 Map showing land use land cover map of city Multan of the years 2008, 2013 and 2018

Table 2
Change detection of past 10 years in city Multan from the years 2008 to 2013

LULC	LULC area distribution						Change detection					
	2008		2013		2018		2008-2013		2013-2018		2008-2018	
	Area Km ²	Area %	Area Km ²	Area %	Area Km ²	Area %	Area Km ²	Area %	Area Km ²	Area %	Area Km ²	Area %
Builtup	47.4	35.6	67.8	51.0	70.3	52.9	20.4	15.3	2.5	1.9	22.9	17.2
Bare soil	30.3	22.8	39.4	29.6	20.2	15.2	9.1	6.8	-19.2	-14.4	-10.1	-7.6
Vegetation	38.7	29.1	18.7	14.1	39.1	29.4	-20	-15	20.4	15.3	0.4	0.3

Cultivated area	16.6	12.5	7.1	5.3	3.4	2.6	-9.5	-7.1	-3.7	-2.8	-13.2	-9.9
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Between the years 2008 and 2013, builtup covered land was 20.4 square kilometer which increased by expanding upto 2.5 square kilometer during 2013 to 2018. From 2008 to 2018, change in built rapidly reached the value 22.9 square kilometer. Bare soil area also showed variation in change detection by converting vegetated land area into bare soil. From the year 2008 to the year 2013 change detection showed increase in bare soil was 9.1 square kilometer which decreased between the years 2013 to 2018 by covering 19.2 square kilometer. During the last decade between the year 2008 to 2018, total change detection of bare soil soil was calculated as 10.1 square kilometer.

Vegetation cover in city Multan showed change of 20 square kilometer during 2008 to 2013 which was expanded upto 20.4% during the 2013 to 2018. Change detection from 2008 to 2018 reveals 0.4 square kilometer of total coverage area. as vegetation cover, cultivated area was also decreased during last 10 years. From 2008 to 2013, 9.5 square kilometer area was under cultivation which decreased to 3.7 square kilometer from 2013 to 2018. From the year 2008 to the year 2018, change detection showed remarkable decrease in its coverage as only 13.2 square kilometer (Fig. 6 & Table 2).

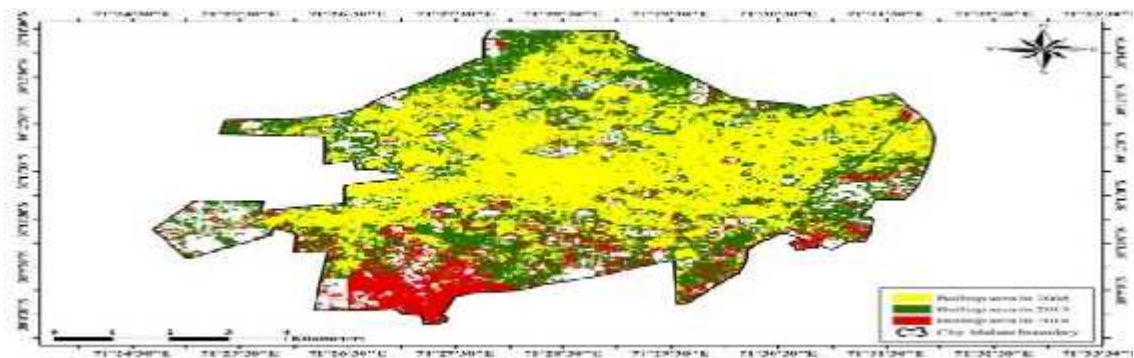


Fig. 6 Map showing variation in builtup area in 2008 to 2018

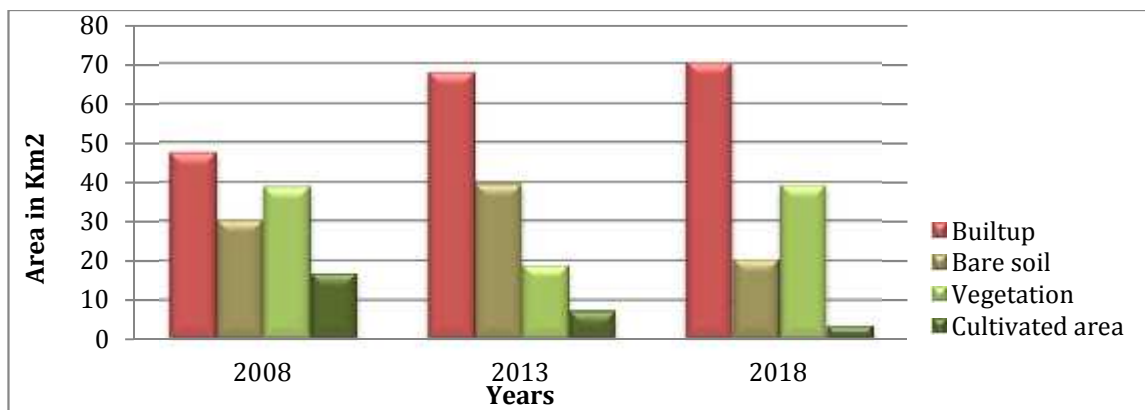


Fig. 7 Graph representing comparison in landuse of city Multan from 2008 to 2018

Normalized Difference Vegetation Index (NDVI)

Normalized difference vegetation index shows chlorophyll content in vegetation where highest and lowest values represents healthy and low vegetation covered area (Viana et al. 2019). Due to non-systematic difference, all vegetation indices can be analyzed through NDVI (Jibo et al. 2019). Significant changes in NDVI were observed in 2018 rather than in 2008. Therefore, from 2008 to 2018, analysis showed continues decrease in vegetative area (productive area). According to fig 5 NDVI values are ranging from 0.11 as minimum value to 0.55 as a maximum value in 2008 expressing healthy and less vegetation. This proportion of slightly increase in builtup decreased NDVI values in 2013, from -0.02 as low value to 0.36 as high value and in 2018, increase in built area further decreased vegetation index from -0.01 as minimum value to 0.47 as maximum value. Maximum value of NDVI shows high vegetative areas while low value represents least productive area, bare soil, builtup areas or water.

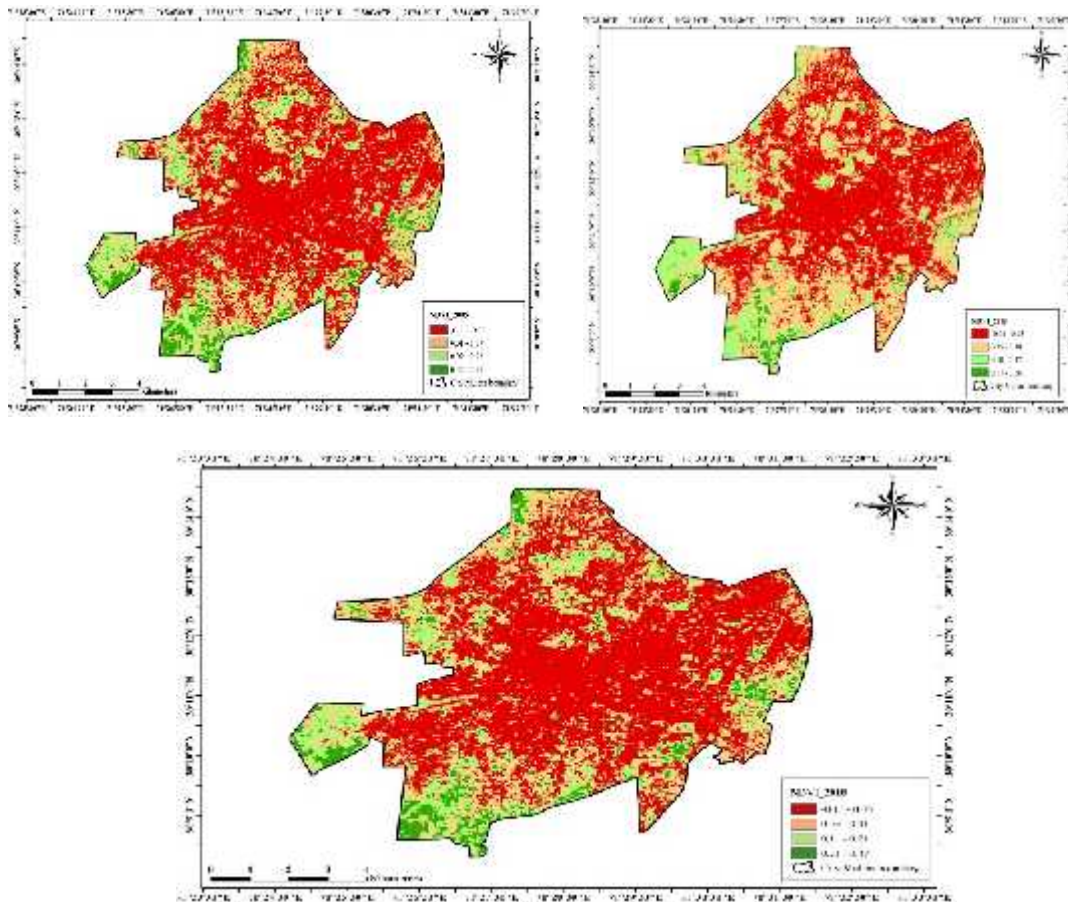


Fig. 8 Map showing NDVI map of city Multan of the years 2008, 2013 and 2018

Accuracy Assessment

According to table 3 producer’s accuracy and user’s accuracy of built up are 84% and 89.36%. Highest and lowest producer’s accuracy of land use land cover classification was observed in bare soil (86.7%) and vegetation (75%). While highest and lowest user’s

accuracy was found in builtup (89.36%) and cultivated area (66.67%). Overall accuracy calculated as 82.72% while kappa coefficient as 0.74.

Table 3
Accuracy assessment of LULC

LULC	Ground reference data					User Accuracy (%)
	Builtup	Bare soil	Vegetation	Cultivated area	Total	D.V/Total*100
Builtup	42	3	2	0	47	89.36
Bare soil	5	26	0	1	32	81.25
Vegetation	2	1	15	1	19	78.95
Cultivated area	1	0	3	8	12	66.67
Total	50	30	20	10	110	
Producers Accuracy (%) D.V/Total*100	84.0	86.7	75.0	80.0		82.72

Conclusion

The loss of developed land which is related with population development requires the anticipating new metropolitan advancement to be moved to locales which are less significant for food creation. Refreshing the metropolitan information base utilizing Remote Sensing techniques to identify the new changes, which rely basically upon the recurrence and event of metropolitan changes and the socio-practical improvement of the locale. The primary driver of urbanization is the quick population development. This difficult should be truly considered, through multi-dimensional fields so as to safeguard the valuable and restricted rural land and increment food creation.

Through this examination, the metropolitan extension of the Multan study zone over various periods utilizing multi-transient satellite images (Landsat – Google Earth) was accomplished. The characterization had the option to portray soil, water, vegetation and metropolitan unambiguously. The fundamental comportment of metropolitan development is extension and expanded development on the North and South of the city. The predictable and excellent impenetrable surface information gave the Landsat characterizations is basic to growing new flood the executives systems for assurance just as for recovery. Data from far off detecting information can assume a critical part in evaluating and understanding the idea of changes in land spread and where they are happening. Such data is basic to making arrangements for metropolitan development and improvement.

General examples and patterns of land use change were assessed by depicting the measure of land territory that was changed over from agrarian, woods and rangeland use to metropolitan use (impenetrable zone) during the period from 2018 to 2018; looking at the aftereffects of Landsat-got insights to gauges from different inventories; quantitatively evaluating the precision of progress location maps; and examining the major metropolitan land use change designs comparable to populace development.

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