APPRAISAL OF LAND USE PATTERNS OF DERA GHAZI KHAN, PUNJAB-PAKISTAN

M. Khurshid[*], S.S. Wahla[**] and K. Sharkullah[***]

[*]Department of Geography, University of the Punjab, Lahore-Pakistan
[**]Department of Geography, Govt. Postgraduate College for Women, Bahawalnagar-Pakistan
[***]Department of Geography, Forman Christian College (A Charted University), Lahore-Pakistan
Corrosponding author's E-mail: mareenakhurshid@gmail.com

ABSTRACT: Land-use changes and consequent urban growth is a cyclic process of transforming from predominately agrarian to urban land use of an area with the passage of time. Without proper urban planning urban development and expansion showed the adverse impact on the city and its residents. The same was the case with Dera Ghazi Khan, an important city of south Punjab, Pakistan. The present study has been carried out to have an insight into implementable urban planning and temporal analysis of urban growth patterns of Dera Ghazi Khan-an expanding city of Punjab. In this paper, land-use change pattern of Dera Ghazi Khan City is investigated by using multi-temporal satellite data along with RS and GIS techniques. Data was obtained from the free web of USGS and satellite images of Landsat 5 TM (1998); Landsat 7 ETM (2000) and Landsat 8 OLI (2016) were downloaded. Different land uses were devised with supervised classification to design analyse the temporal change studies. Remotely sensed images have been analysed by comparing post-classification methods. This study demonstrated that built-up areas have increased from the period 1989-2000, 2000-2016 and 1998-2016 is 180.64 Km^2, 95.00 Km^2 and 275.64 Km^2 respectively. By applying post-change detection techniques, the study explored that from the period 1989 to 2016, 5.29 percent vegetation class had been converted into built-up class and bare soil. Bare soil class is the principal class of the study area and it showed a growing tendency with 7.78 percent increase in last 28 years. The water body class showed a negative tendency in change i.e. 0.04 percent area was changed into bare soil class categories. It was concluded that the study area has experienced rapid urban growth and was in a developmental phase. The results indicated that there had been an apparent and uneven urban growth pattern in Dera Ghazi Khan in terms of its use from1989 to 2016. The study identified that the geospatial techniques such as remote sensing and GIS are highly effective in analysing rate and spatial pattern of urban growth and land-use change in an area.

Keywords: Land Use, Urban Development, Urbanization, GIS, RS, Change Pattern**,** Landsat

(Received 25-10-19 Accepted 03-12-19)

INTRODUCTION

Urbanization, urban growth, and consequent land-use changes are global concerns and have researched extensively since the advent of the Industrial Revolution in the 17th Century. Unchecked population growth (both natural increase and rural-urban migration) is always followed by urbanization(Bhatta, 2010, Nilsson *et al.,* 2014). Presently the population of the world is more than 7.6 billion and more than half of it lives in cities. As the world population is growing and it is believed that future growth will likely to take place in developing countries of the world (Shahraki *et al.,* 2011, Miao, *et al.,* 2016).

On continental level, Asia is second in rank after Europe in terms of the degree of urbanization. This rapid urbanization has engulfed precious agriculture lands all over the world and Pakistan is no exception. At present Pakistan's population is growing rapidly with increasing people living in defined urban areas. Due to rural to urban migration; out of the total population more than one-third (34.9 per cent) is urban in nature. However, it is believed that this figure will rise to nearly 50per cent by 2025. This is because of the multifarious drivers of Pakistan's urbanization and has both the positive and negative implications of the country's transition to a more urban country (Kugelman, 2013). The growth of a few large cities and consequent urbanization is another aspect of Pakistan's urbanization. This has also brought visible and social change in Pakistani society and culture.

Land use and land cover (LULC) is attributed to the use of land of an area while land cover comprised of built-up area, vegetation, bare soils and water bodies present in an area (Lillesand *et al.,* 2003, Ahrends, *et al.,* 2017). Consequently, the transformation of land use from agriculture to urban has imparted negative effects on urbanized areas (Albersen, *et.al.,* 2002, Li and Yeh, 2004). The process of converting agricultural lands into other land use has fostered the developing of new cities which has led to LULC (Cohen, 2006, Hu, *et.al.,* 2019).

Urbanization is associated with population growth and urban development is a process thereby transforms City's land use with the passage of time (Shirazi and Kazmi, 2014). It is also necessary to study the population trend of the study area to highlight growth corridors. The continuous process of urbanization results in urban sprawl and changes the function of land use of the City. Due to urbanization, the quality of the environment is also affected in many cities of the world (Chen, 2007 and Hu, *et al.*, 2018).The loss of urban greening was deducted and barren land changes in the urban area of USA cities have been witnessed using multi-temporal satellite data of Landsat (Weng and Bhatta, 2009).

The agricultural land in the fringe area of the city when converted into build-up area generally creates environmental degradation and related issues. This change of land cover, as well as urban growth, can be deduced by Remote Sensing and Geographical Information System (Jat, *et al.*, 2008, Batunacun, *et al.*, 2018) in cost-effective manners.

MATERIALS AND METHODS

Before discussing material and methods of the present study, it is pertinent to mention the study area. Dera Ghazi Khan (D G Khan) is an important city of the south of Punjab, Pakistan lying at 30°1′59″N, 70°38′24″E (Fig.1) . It comprises of four tehsils i.e. Dera Ghazi Khan , Taunsa Sharif,Kot Chutta and Koh-e-Sulaiman (GoP 2017).According to the Census of Pakistan conducted in 2017 the population of DG Khan is 2872201 persons. With the increase in population size since 1947, the urban growth rate of Dera Ghazi Khan is also increasing day by day due to the increment of civic facilities and establishment of industrial sectors which provide more economic opportunities for the rural population. This has led to an influx of population from surrounding areas into D G Khan.

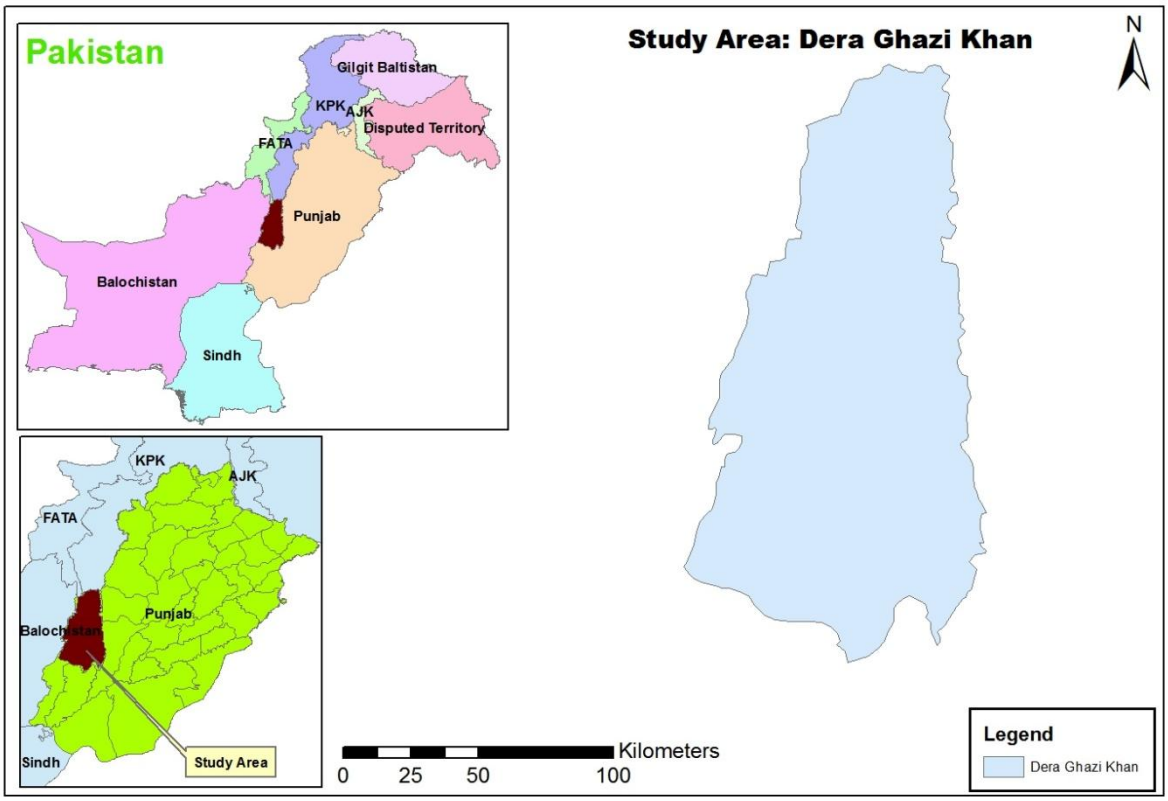

Figure.1 Study area-Dera Ghazi Khan

The main objective of this research is to appraise change in land use and land cover in the region of D.G. Khan over a period of 1998-2015 and to evaluate change in various class categories using geospatial techniques and remote sensing digital data. In order to achieve set objectives multi-temporal remote data has been used to study temporal analysis of urban growth patterns in D G Khan District. The change in land use (LU) patterns has also been studied and made comprehensive comparisons for the years of 1989, 2000 and 2016. Three Landsat images were obtained from USGS for the research with a resolution of 30 meters and bands were 1 to 8. Land-use change patterns have been categorised into four classes such as vegetation, built-up area, bare soil and water

bodies in D G Khan. These are evaluated with the help of supervised classification to represent the change as have shown in table 1.

A layer stacking is a very important procedure carried out in the present study after acquiring suitable imageries. The satellites images have been acquired in disconnect bands time after time in a set temporal sequence (Hu and Batunacun, 2018). The process of stacking these bands was completed out in software ERDAS imagine. The formulas of layer stacking, image subsetting were executed. The imageries were downloaded to make difference for study area by converting digitized shapefiles into an area of interest (AOI) and format after that subset of the study area was achieved (Shi, *et al.*, 2018). Image enhancement is used to enhance the important geographical dissimilarity of various features or classes contained in the specific image. Image enhancement is most special that contains a set of technologies to enhance an image. In selected research contrast stretching technique was applied to enhance the quality of image followed by brightness/compare method to trace out the difference. The supervised classification method has been used for computing the results to acquire accuracy.

RESULTS AND DISCUSSION

The distribution of land use and urbanization patterns deducted in the study area maps for different years (1989, 2000 and 2016) have been given in table1 in Km^2 and percentage. The graphical presentation is also given in figure 2. The urban growth patterns as a result of LU changes have been shown from 1989 to 2016 with the help of Fig.2.

Table 1: The land use of the study area 1989, 2000 and 2016.

Land Use Category	1989		2000		2016	
	Area (Km^2)	**Area (per cent)**	**Area (Km^2)**	**Area (per cent)**	**Area (Km^2)**	**Area (per cent)**
Vegetation	1799.80	32.11	816.66	14.54	1205.61	21.41
Built-up	470.78	8.39	290.14	5.17	195.13	3.46
Bare soil	1240.81	22.13	2413.12	42.97	2114.73	37.55
Water bodies	104.41	1.86	95.73	I.70	100.28	1.78
Total	**5604.82**	**64.51**	**5615.67**	**64.39**	**5631.76**	**64.20**

Table 2: Landsat images used in study and associated characteristic.

Imagery acquisition date	Accuracy assessment (per cent)
April 26, 1989	99.95 per cent
May 23, 2000	99.96 per cent
Octber12,2016	99.94 per cent

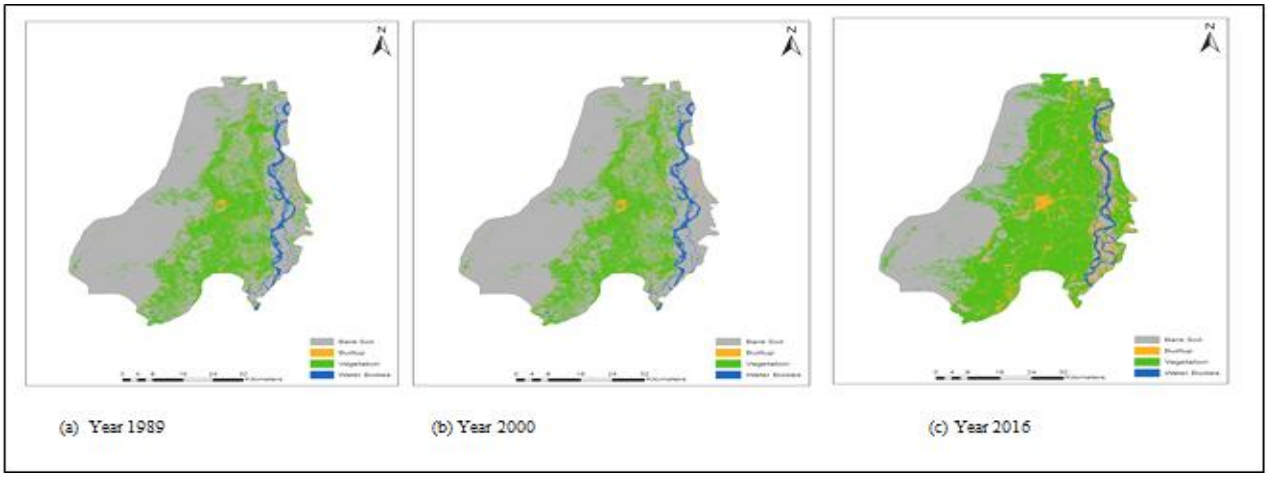

Figure 2: Land use for the years 1989, 2000, and 2016.

Figure 2 (a) showed that Dera Ghazi Khan was a less developed area with only 8.39 percent built-up area in the year 1989. The map shows a class of empty areas with no vegetation cover as it is bare soil which is 22.138per cent while the class of agriculture is occupying the land area of 32.11 percent with water class 1.86per cent i.e. canal. It was the only water body to use for irrigation purposes.

The results show that (Fig.2 b) vegetation area has been reduced in 2000 i.e. 17.55 percent. D G Khan has lost 14.54per cent of its vegetation area in just 12 years. On the other hand, bare soil land class has been increased from 22.13 percent to 42.97 percent. The reason for this increase was the increased number of muddy houses roofs that come into the class of bare soil cover. Though, there was the least change deducted in built up area i.e. 5.17per cent. Aquatic class has been also reduced by 0.1 6per cent from 1.86per cent to 1.70 per cent in 2000. A very little reduction was seen in agricultural land classes which still the largest class with 14.45 per cent land cover.

The results of the map 2016 in figure 2 (c) show the journey towards the developmental era in study area. Consequently, the vegetation of the AOI has been reduced up to 21.41per cent from 32.11per cent. Although the condition has been improved from 2000 the reason might be a slight increase in the land cover area of water i.e. 0.08 per cent from 2000. Dramatic decreased is deducted in build-up area from 5.17 % in 2000 to 3.46 in 2016. The reason might be the migration. Bare soil has been shown decline too again in the year 2000 i.e. from 42.97 % to 37.55 % in the year 2016.

By using multi-temporal RS data with tools of GIS the results are computed by means of the supervised classification method. The results analysis shows the pattern of land use change in D G Khan. Some classes show a drastic reduction and increase in land use patterns. It is observed that a big agricultural land cover is converted into bare soil and built up area. The trend of the change of bare soil is toward the build-up area and water body. The following table shows the changing pattern of each class category with its magnitude.

Table 3: Land use change detection pattern and magnitude.

Land use Categories	1989-2000		2000-2016		1989-2016	
	Area (Km^2)	per cent change	Area (Km^2)	per cent change	Area (Km^2)	per cent change
Vegetation	983.14	8.76	-388.94	-3.46	594.19	5.29
Built up	180.63	1.61	95.00	0.84	275.64	2.45
Bare soil	-1172.3	-10.45	298.39	2.65	-873.91	7.78
Water bodies	8.67	0.08	4.54	-0.04	4.13	0.04

The table 3 indicates the trend and pattern of land use change by dividing them into the intervals of the years between 1989-2000, 2000-2016 and 1989-2016. For each interval, every class is showing a positive or negative trend. Graphical presentation made this description comprehend (Figure 4).

ii) Vegetation: From 1989 to 2000, the vegetation class shows the trend of 8.76 % and in the interval of 2000-2016 the result shows a negative trend of -3.46 % while again positive from 2000 to 2016,however there is an overall decline in vegetation class from 1998 to 2016 i.e. 3.47 %. The change is deducted dominantly in the eastern and southwestern parts of the study area. Because many parts of vegetation class have converted into build up and bare soil classes. The total converted area from 1998 to 2016 is 8.76 per cent Km^2 the rate of reduction was 5.29 %.

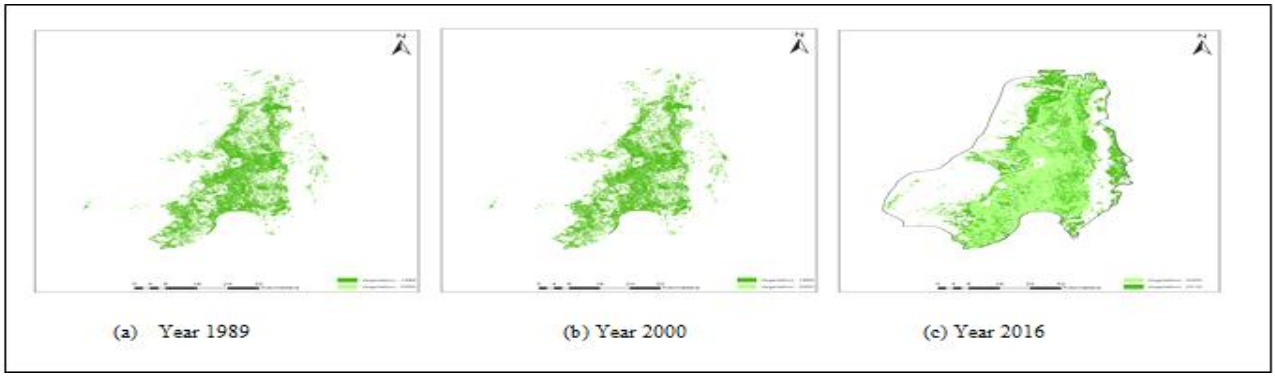

Figure 3 : Change deduction in vegetation class in D G Khan for the years 1989, 2000, and 2016.

Basically, there are many factors which are bringing change in vegetation cover of this area into other land-use class. This could be because of industrial development in the study area, population increase and need for new residential neighbourhood and to some extent due to increase in salinity which has turned the green productive agricultural fields into bare soil. This, in turn, has increased rural-urban migration.

iii) Built-up area: Temporal investigation of the urban change pattern of built up area of D G Khan in figure 3 has shown a positive trend from 1998 to 2016. The rate of change of built up class was i.e. 1.61 % in 1989-2000 (Fig.3 a). It has reduced up to 0.84 % the years of 2000-2016 in (Fig.3 b). The main reason of this reduced rate was migration in study area due to push factors like lake of clean water facilities, lack of earning opportunities and harsh weather conditions. But, there are huge changes that occur in built up class which is 2.45 % in the time of 2000 to 2016 (Table3).

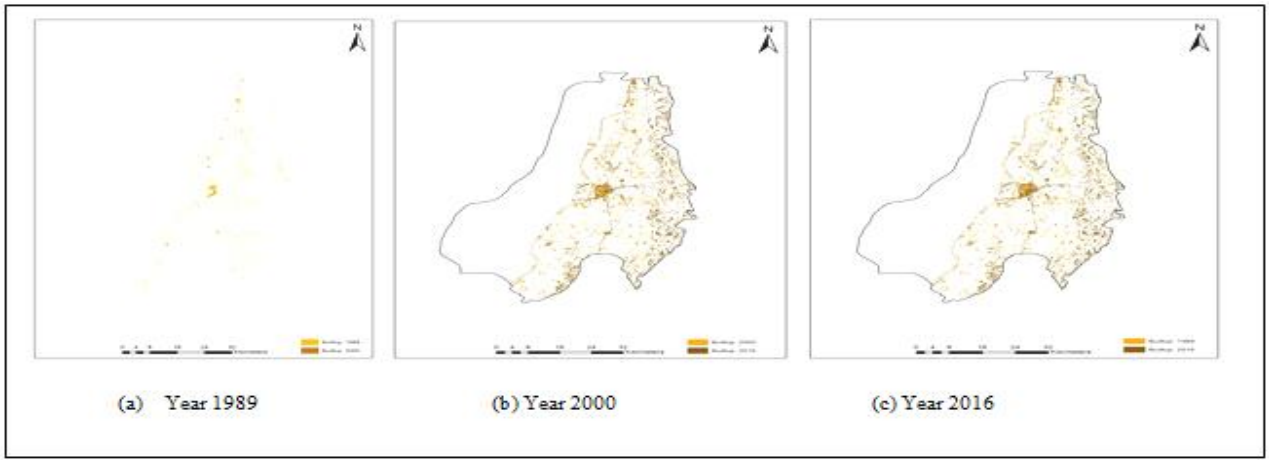

Figure 4 : Change deduction in built up class in D G Khan for the years 1989, 2000, and 2016.

The change in built up class is traced in the core of the city while urban sprawl is seen in south and southwestern parts of the study area. This expansion is due to the construction of new residential colonies, which has into built up from vegetation class (Fig. 4). Other causes of the increase of this class are commercial expansion and industrialization, while constructions of southern road networks make the study area accessible with other cities. The built-up area of D G Khan has become almost double from 1989 (Fig. 4a) to 2016 (Fig 4 c).

iv) Bare Soil: The bare soil class has badly affected by the reduction in agricultural class over all. The bare soil class shows negative trend in the period of 1989 – 2000. The reduction was by 10.45 % in bare soil because of water logging and salinity in study area (fig 5a).

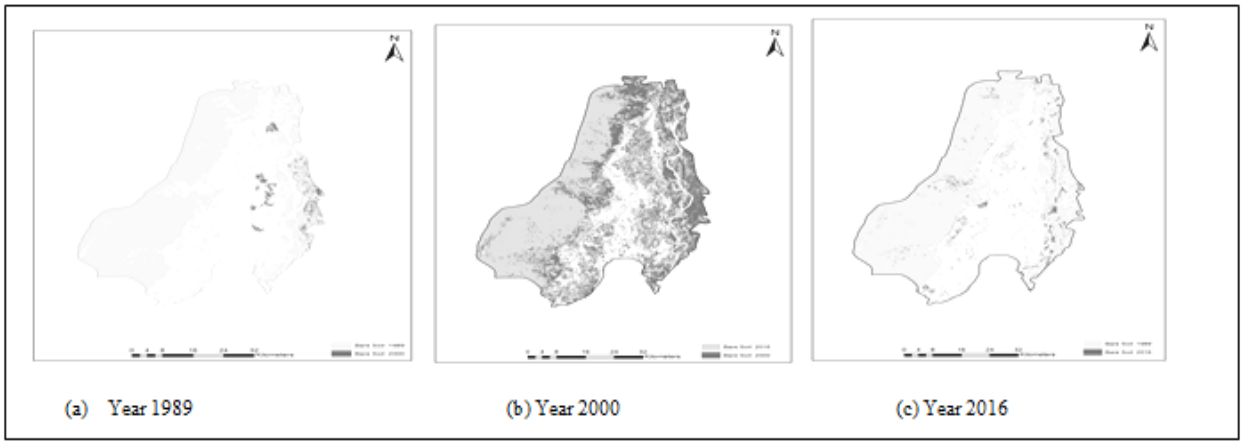

Figure 5: Change detection in bare soil class in D G Khan for the years 1989, 2000, and 2016.

However, bare soil has shown a gain during the next period of 2000-2016. It has increased by 2.65 %. This increase is seen as some of the vegetative land has been reduced during this period. The loss of vegetative land was 3.46 % in only 15 years. In 2016 the situation becomes more adverse (Fig. 5c). By comparing the results of the figure 5 (a) and figure 5 (c) the bare soil class has increased by 7.78 % which is alarming for an agrarian region like DG Khan as well as for the Punjab region. Bare soil class can be observed in almost all the parts of the study area especially in southern and south eastern parts (Fig. 6 c).Changing trend can be deducted more broadly by bar graph in figure 10. An apparent increase in the bare soil class can be seen.

v) Water Bodies: Water body class also shows a negative pattern from 0.08 % to 0.04 % in 28 years from 1998 to 2016. Although it has shown negligible changes but no one can ignore as it is an important resource for the population to sustain. It is an important land use class. It shows negative trend.

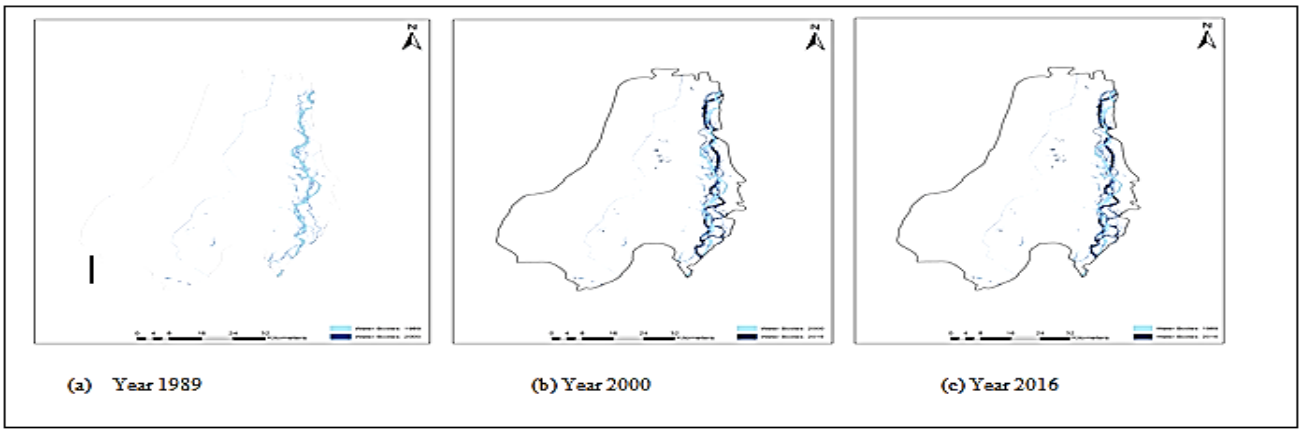

Figure 6 : Change detection in water body class in D G Khan for the years 1989, 2000 and 2016.

Water body class occupies the least share as compare to all other classes, in all the temporal analysis of land use change detection pattern. During the time of 1989-2000, water class witnesses a negative trend and has decreased by 0.08 % (Fig. 6a and 6 c). However, water class has experienced a slight drop in its share from 2000 to 2016 by 0.04 % which is insignificant the reason of its decline is again salinity in study area. This change is more visible in some southern and northern parts of the study area (Fig. 6 b). This shows a negative trend overall in the duration of 28 years (1989-2016).

Topography of study area is the major cause behind this change in water body class. As the northern and southern land elevation is higher than the central and western lands and also the active flood plain of Indus River. Therefore, many water pounds have been converted into bare soil or puddles.

It has been concluded that there is a persistent but uneven urban growth pattern of as well as land use from 1989 to 2016 in Dera Ghazi Khan. It revealed that in 2016 the city area is four times larger than in the year of 1989. Vegetation class around the city converted into build up class which is in general experienced by many other cities of the Punjab.

This study demonstrated that built up class enhanced from period 1989-2000, 2000-2016 and 1998-2016 is 180.64 Km^2, 95.00 Km^2, and 275.64 Km^2 respectively. By applying post change detection techniques, the study explores that from the period 1989 to 2016, 5.29 % vegetation class has been converted into built up class and bare soil. In order to decrease the spatial configuration and inherent property of all image data, the ground truthing assessment was also under undertaken in the study area. This was very helpful information deduced from present investigation. The study area is mostly consisting of villages and roofs while the houses in villages are made up of mud, so satellite images took it is bare soil, but it is the part of built up area. Identical tribulations were come in to inspection in bare soil and water body class and consequence actual proportion of each class. Therefore, bare soil class is the principal class of the study area and it shows a growing tendency with 7.78 % increase in the last 28 years. This enhances in bare soil land class due to lessening in farming class. The major affected class is vegetation class. The survey of the study area on ground-truthing survey provides a very important cause of this change, which is increasing salinity and waterlogging, due to which soil are converting in the form of unproductive land. The water body class has shown an unconstructive tendency in change discovery maps which is just 0.04 % in area of land use change into exposed soil class or built up class. On the other hand; built up class enhanced from the duration of 1989-2000, 2000-2016 and 1998-2016, which are 180.64 Km^2, 95.00 Km^2 and 275.64 Km^2respectively. By applying post change detection

techniques, the study explores that from the period 1989 to 2016, 5.29 per cent vegetation class has been changed into built up class and bare soil. Although the Dera Ghazi Khan is concerning with the development phase as it is experiencing a little but gradual increase in built up and infrastructure establishment during past decades.

The study has attempted to discover and appraise the urban development in terms of its land use transformation in all union councils of Dera Ghazi Khan from 1989 to 2016 by using Landsat digital data,GIS and ground-truthing. The study reveals that the by using multi-temporal satellite images and geospatial techniques such as Remote Sensing and Geographical Information System as used in the present study are highly effective in analysing rate and spatial pattern of land-use changes and urban growth in cost effective manners.

REFERENCES

Ahrends, A., P.M. Hollingsworth, P. Beckschäfer, H. Chen, R.J. Zomer, L. Zhang, W. Mingcheng and J. Xu (2017). China's fight to halt tree cover loss. *Proceedings of the Royal Society B: Biological Sciences* 284, 20162559

Albersen, P., G. Fischer, M. Keyzer and L. Sun (2002). Estimation of Agricultural Production Relations in the LUC Model for China. https://doi.org/3-7045-0142-5

Bhatta, B. (2009). Analysis of urban growth pattern using remote sensing and GIS: a case study of Kolkata, India. Int. J. Remote Sens., 30(18), 4733–4746. https://doi.org/10.1080/01431160802651967

Bhatta, B., S. Saraswati and D. Bandyopadhyay (2010). Urban sprawl measurement from remote sensing data. Applied Geography, 30(4), 731–740. https://doi.org/10.1016/j.apgeog.2010.02.002

Batunacun, C., Nendel, H., Yunfeng & Lakes, T. (2018) Land-use change and land degradation on the Mongolian Plateau from 1975 to 2015 — a case study from Xilingol, China. *Land Degradation & Development* 29, 1595–1606

Cohen, B. (2006) Urbanization in developing countries: current trends,

future projections and key challenges for sustainability. Technol Soc 28(1):63–80

Hu, Y., Batunacun, L. Zhen and D. Zhuang (2019) Assessment of Land-Use and Land-Cover Change in Guangxi, China. *Sci Rep* 9, 2189

doi:10.1038/s41598-019-38487-w

Hu, Y. and Batunacun (2018) An Analysis of Land-Use and Land-Cover Change in the Zhujiang–Xijiang Economic Belt, China, from 1990 to 2017. *Applied Sciences* 8, 1524

Hu, Y., Y. Dong and Batunacun (2018). An automatic approach for land-change detection and land updates based on integrated NDVI timing analysis and the CVAPS method with GEE support. *ISPRS Journal of Photogrammetry and Remote Sensing* 146, 347–359

Jat, M.K., P.K. Garg and D. Khare (2008). Monitoring and modelling of urban sprawl using remote sensing and GIS techniques. International Journal of Applied Earth Observation and Geoinformation, 10(1), 26–43. https://doi.org/10.1016/j.jag.2007.04.002

Kugelman, M. (2013), Urbanization in Pakistan: Causes and Consequences. NOREF Expert Analysis https://www.files.ethz.ch/isn/159296/4c5b5fa0ebc5684da2b9f244090593bc.pdf

Accessed on 1st Dec.2019

Li, X. and A.G.O. Yeh (2004). Analyzing spatial restructuring of land use patterns in a fast growing region using remote sensing and GIS. Landscape and Urban Planning, 69(4), 335–354. https://doi.org/10.1016/j.landurbplan.2003.10.033

Lillesand, T.M., R.W. Kiefer and J.W. Chipman (2003) Remote sensing and image interpretation. Wiley, New York, pp 1–7227-003-0288-7

Miao, L., F. Zhu, Z. Sun, J.C. Moore and X. Cui (2016) China's Land-Use Changes during the Past 300 Years: A Historical Perspective. *Int J Environ Res Public Health* 13

Nilsson, K., T.A.S. Nielsen, C. Aalbers, S. Bell, B. Boitier, J.P. Chery, C. Fertner, M. Groschowski, D. Haase, W. Loibl, S. Pauleit, M. Pintar, A. Piorr, J. Ravetz , M. Ristimäki, M. Rounsevell, I. Tosics, J. Westerink and I. Zasada (2014). Strategies for Sustainable Urban Development and Urban-Rural Linkages. European Journal of Spatial Development,1–26. Retrieved on 12-6-2018 from http://www.nordregio.se/Global/EJSD/Research briefings/article4.pdf

Shahraki, S.Z., D. Sauri, P. Serra, S. Modugno, F. Seifolddini and A. Pourahmad (2011) Urban sprawl pattern and land-use change detection in Yazd. Iran. Habitat International 35(4):521–528

Shi, G., N. Jiang and L. Yao (2018) Land Use and Cover Change during the Rapid Economic Growth Period from 1990 to 2010: A Case Study of Shanghai. *Sustainability* 10, 426

Shirazi, S.A. and S.J.H. Kazmi (2014). Analysis of Population Growth and Urban Development in Lahore-Pakistan using Geospatial Techniques : Suggesting. South Asian Studies, 29(1), 269–280.

Weng, Q., D. Lu and J. Schubring (2004). Estimation of land surface temperature-vegetation abundance relationship for urban heat island studies. Remote Sensing of Environment, 89(4), 467–483. https://doi.org/10.1016/j.rse.2003.11.005