ASSESSMENT OF LAND USE CHANGES AND URBAN EXPANSION OF BAHAWALNAGAR THROUGH GEOSPATIAL TECHNIQUES

AQSA AZIZ* AND ABDUL GHAFFAR**

Department of Geography, University of the Punjab, Lahore

Corresponding Author Email: aqsa_khan84@yahoo.com

ABSTRACT

Land use changes are one of the global changes and it put enormous effects on human and natural environment. Pakistan facing the great change in land use patterns from the past three decades without any proper planning. For this purpose the land which was previously used for agricultural activities is now converted into urban zones. This study has evaluated the changing patterns of land use in Bahawalnagar city and its effects on environment. Satellite data was collected from the USGS earth explorer to observe and analyze the patterns of land use change. For this perspective four satellite images were taken for the years 1990, 2000, 2010 and 2015. Four land use classes were formed to compare the changes during the time spam of 25 years. These classes were Built- up, agriculture, water and open land. The work has stacked chiefly by high resolute maps of Google as reference for grouping & evaluating. Coaching samples obtained from the Landsat images. All the pixels of image were ordered into land use categories and theme. After that the aspects and classes of every form of land cover were more visible from images severally. After the area calculation of each class in map different code schedules were accustomed on the personas to need accurate investigation results. It was resulted from the study area that the overall population increased so the built up land area also increased whereas the agricultural area decreased to 28%. The result of study gives an idea about the rapid progression in densely populated use from 1990 and 2015. The main reason for this change is the increase in the population by adjacent areas from where people migrated towards city area.

KEY WORDS: Land use, change detection, Remote sensing, Bhawalnagar, Lansat images

INTRODUCTION

It's revealed that the urban sustainable development is a major key to concern of decision makers and policy Ying Zhang *et al.,* (2006). Land is the most significant feature of nature. To understand it's important and status globally we can witness the dynamics resources present on it. There are mainly two for word landscape, first it can be related to the visible patterns of a land area or the landform and how they could be relate with natural attributes or man-made features Zubair (2006). Land use and land cover change is an important and major factor because it can affect all the ecosystem processes, climate, biodiversity, energy balance, biogeochemical cycles, hydrology and human activities globally Pabi 2007).

For the planning and management of water resources hydrological process of urbanized watershed, urban recline and LULC effects included. By using multi digital satellite, the study presented imagery analysis of LULC and the changes that occur from 1992 to 2006 in the Kucukcekmece Watershed (Turkey, Metropolitan Istanbul) H. Gonca Coskun et al., (2008). For subsequent research work, for when and how urban growth is occurring and for urban successful planning; the modeling output providing a successful building block Yikalo Hayelom Araya (2009). Large impact on the regional ecosystems and strong changes in the nature of the land surface occur due to urbanization. Original forest and fertile cropland are often demolished in the process of urbanization Yu Deyong*et al.,* (2009). The urban expansion has been fully associated with urban recline and decrease of agricultural land that revealed by output land use/cover maps Bayan Alsaaideh *et al.,* (2011). In the Sukinda valley between 1975 and 2005 land use and land cover change analyzed by using Remote Sensing data and GIS that map land cover and land use. With help of ERDAS and Quantum GIS LANDSAT mapping, data in three different years (1975, 1992, and 2005) used for land cover and land use was regulated. Findings of his work between 1075 and 2005 showed that the rapid growth at cost of decrease seen in the forest area Biswajit Majumder (2012). Through the many periods of remote sensing data, characteristics, processes of surface changes and quantitative analysis was identified. Apart from the change detection using multi spectral remote sensing images, it was based on the elevation change information of digital surface models Kaja Kandare (2012). ErmiasTeferi *et al.,* (2013) provided an objective to quantify for the period 1957 to 2009 in the Upper Blue Nile Basin (Jedeb watershed) for the purpose to find out long-term land use, land cover changes and to find the spatial factors of location with most systematic transitions.

Nowadays, the rapid growing population of urban areas creates pressure on city infrastructure, resulting land degradation and also low man land ratio, therefore the need for most accurate utilization of land assumes much greater significance for the better development Bhalli *et al.,* (2012). It is the need of advanced era to carry out the study about land use as well land cover for the appropriate planning to sue the God gifted resources in different manners in s systematic way Kumar (2013). It is necessary to stimulate environmental changes because land use is a dynamic and important component for the understanding of the interactions of human activities with environment Suparn Pathak (2014).

Recent study in Sargodha reveals the built up patterns and trends in the urban area and land use system which actually started with fast growth in population and this trend to urban growth as well. All the development in

the city take place mostly along with roads this in return suggest that it is important to plan about better use of land for equal growth in all directions of the city. New building in that area show remarkable change in 30 years Raza and Shirazi, (2014). It is only increasing the built up area but also created the uneven distribution of land. It's becoming difficult to control for managing departments as recently it's been witnessed in Lahore which is one of big city in Pakistan. It results negative effects on regional and city planning becoming part of era Mohsin and Bhalli (2015). The technique of digital change discernment by using multi temporal satellite imaginary helps in understanding landscape forces Rawat *et al*., (2015).

JovanovićA *et al*., (2015) researched in Zlatibor, Serbia from the time period of 1985 to 2013 for the purpose to study the land cover changes. In Arc GIS 10 different types of maps like land use/land cover and overlay are prepared Amna Butt *et al*., (2015). By using ERDAS Imagine supervised and unsupervised classifications can be done RizkHegazy (2015). Merging, extract AOI (Area of Interest), layer stacking and supervised classification adopted for methodology. Urban area, barren land, vegetation and water bodies were the four classes of Land use changes Shahzad Khattak *et al.,* (2015). It showed that due to urban sprawl and loss of agricultural land; areal expansion has been attributed while in built-up and agricultural areas major changes in the land use has taken significant place Bhalli and Ghaffar *(*2015). This study suggested the effective colony strategy on unguided nature of built up development whose effects on land use and land cover are very prominent in the specific area. The adequate monitoring by the stakeholders, the Development Control Department as well in urban planning sectors was suggested to less the incompatible land use change in the study area OlurantiOwoeye *et al.,* (2016). For calculation procedure, the best available data sets take into account in the area Grunewald *et al.,* (2017).

STUDY AREA

Bahawalnagar was originally known as Rojjhanwali. It changed name Bahawalnagar took place in 1904. Nobody could ever imagine that this area would be developed as a district and a big trade market. The Tehsil lies between the 20˚51' and 30˚20'north latitude and 72˚17' to 73˚58'east longitude. It is about 130 meters above sea level. Bahawalnagar is situated on the south east region of Pakistan. It is 192 miles south of Lahore and 120 east of Bahawalpur (TMA BWN, 2015). It is connected to Lahore via Sahiwal and Sulemanki head works. The boundaries of Bahawalnagar in the East and South touch the Indian territory and river Sutlej flows on its Northern side across which are situated Okara, Pakpattan, Sahiwal and

Vehari districts. The climate of Bahawalnagar city is hot and dry in summer and cold in winter. Winter season is very short like its starts in December and continue till mid of February. Hot and dusty storms are common during hot months while cold breeze blow in winter with regular intervals. The city receives about 11.2 Inches rainfall annually. Patterns of land used in Bahawalnagar are mixed with planned and unplanned areas (outline Development Plane, BWN). The southern part of the town has a massive area under commercial activity. The educational institutions are spread over the town in all directions. The town has developed its residential area more on the southern side. The population of city was 133,785 persons as per 1998 Census with a visible growth rate of 2.39 percent per annum. The estimated population for year 2008 was 165,472 persons, which is expected soon to grow about 265,385 persons for the year 2028.

MATERIAL AND METHODS

In this study abstraction information relating to the written account nature of urban landscape change has been obtained from the satellite images, Geographic's maps and aerial photographs. Primary information came by different dates and different source of Landsat images from 1990 till 2015 deliver the information supply for the examination. The dates were 1990, 2000, 2010 and 2015. This satellite representation was extracted from GLCF means Global Land cover Facility web site and additionally recovered largely from divergent agencies' websites. GLCF furnish information on science. It`s attributes provide everybody to hold environmental systems of the world in a very higher and superior manners. Vector information has additionally been uninheritable for the study space from urban unit Lahore. Dependencies of Secondary information additionally play a major role in analysis. Varied books were used as supply for secondary information, articles, annual reviews and reports. Statistical information about population data got from the DCRs additionally contributed to attest the results derived from abstraction analysis. To get information about Population: Census of Pakistan: town Reports of Bahawalnagar, Economic Survey of Pakistan and Punjab Development Statistic. For urban landscape change: Survey of Pakistan Top sheets, revealed Maps/Reports of Bahawalnagar Development Authority (BDA), territorial dominion Govt. of Bahawalnagar and concrete The Unit Urban Lahore.

An important phase of data observation was established that encircles the conversion and facade process, whereas spatial examination and terrestrial mapping were the crucial building blocks of the mechanism method. The basic ways of quantitative examination were the spatial design analysis, land cover changes examination related to structure and learn of all the changes along the applied math analysis. Satellite imageries of Landsat by 1990-2015 were created for the utilization of research. The

succeeding remote sensing persons are utilized to extricate the settled space of Bahawalnagar town. All the details and elucidation of Landsat persona and dramatic personae has been showed in Table 1.1. These personas area unit generally used as satellite perceived data. As these images supply useful information for mapping and town designing due to their temporal, spatial and spectral resolutions.

Table1.1: METADATA of Landsat Satellite Images

Year	Satellite	Sensor ID	Resolution	Path/Row	Date of Acquisition
1990	Landsat 5	TM	30 m	149 / 39	16-03-1990
2000	Landsat 7	ETM+	30 m	149 / 39	19-03-2000
2010	Landsat 5	TM	30 m	149 / 39	19-02-2010
2015	Landsat 8	OLI_TIRs	30 m	149 / 39	21-03-2015

Landsat Satellite Images used for landscape Analysis
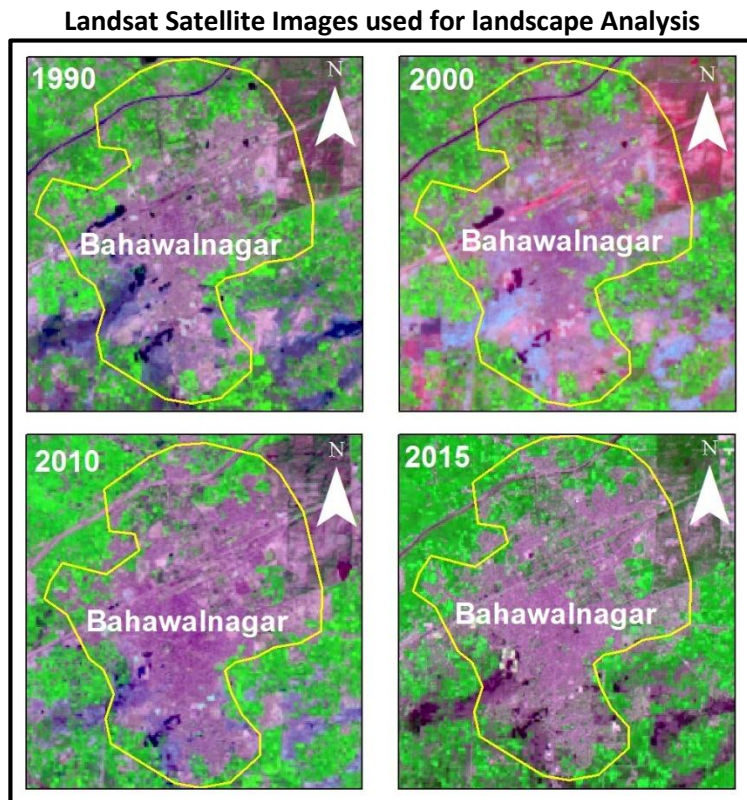

Figure 1: Landsat Satellite Images used for landscape Analysis

Processing of image

Spectral details of the said imageries are shown by the given table below (Table 1.2). It should be taken into account that thermal bands of the Landsat ETM+ and OLI_TIRs, TM were unbroken out of investigation.

Table 2: Spectral Resolution Description of Landsat Images

Satellite	Sensor	Band #	Spectral Range	Pixel Res
L 4-5	TM multi-spectral	1,2,3,4,5,7	0.45 - 2.35 µm	30 meter
L 4-5	TM thermal	6	10.40 - 12.50 µm	120 meter
L 7	ETM+ multi-spectral	1,2,3,4,5,7	0.450 - 2.35 µm	30 meter
L 7	ETM+ thermal	6.1, 6.2	10.40 - 12.50 µm	60 meter
L7	Panchromatic ETM+	8	0.52 - 0.90 µm	15 meter
L8	OLI	1-7,9		30
L8	TIRs	10 & 11	10.6-11.2 11.5-12.5	100
L8	Panchromatic	8	0.503-0.676	15

Enhancement

Filter operations, general distinction and linear stretching, were performed for image sweetening, which is used for analysis, in Landsat imageries. Then the Principal part analysis for all 4 images was done. For exact accuracy measurement, the classified images and geography sheets were compared, suggested Land use maps of the study area with current ground checks and for the relevant period of time. .
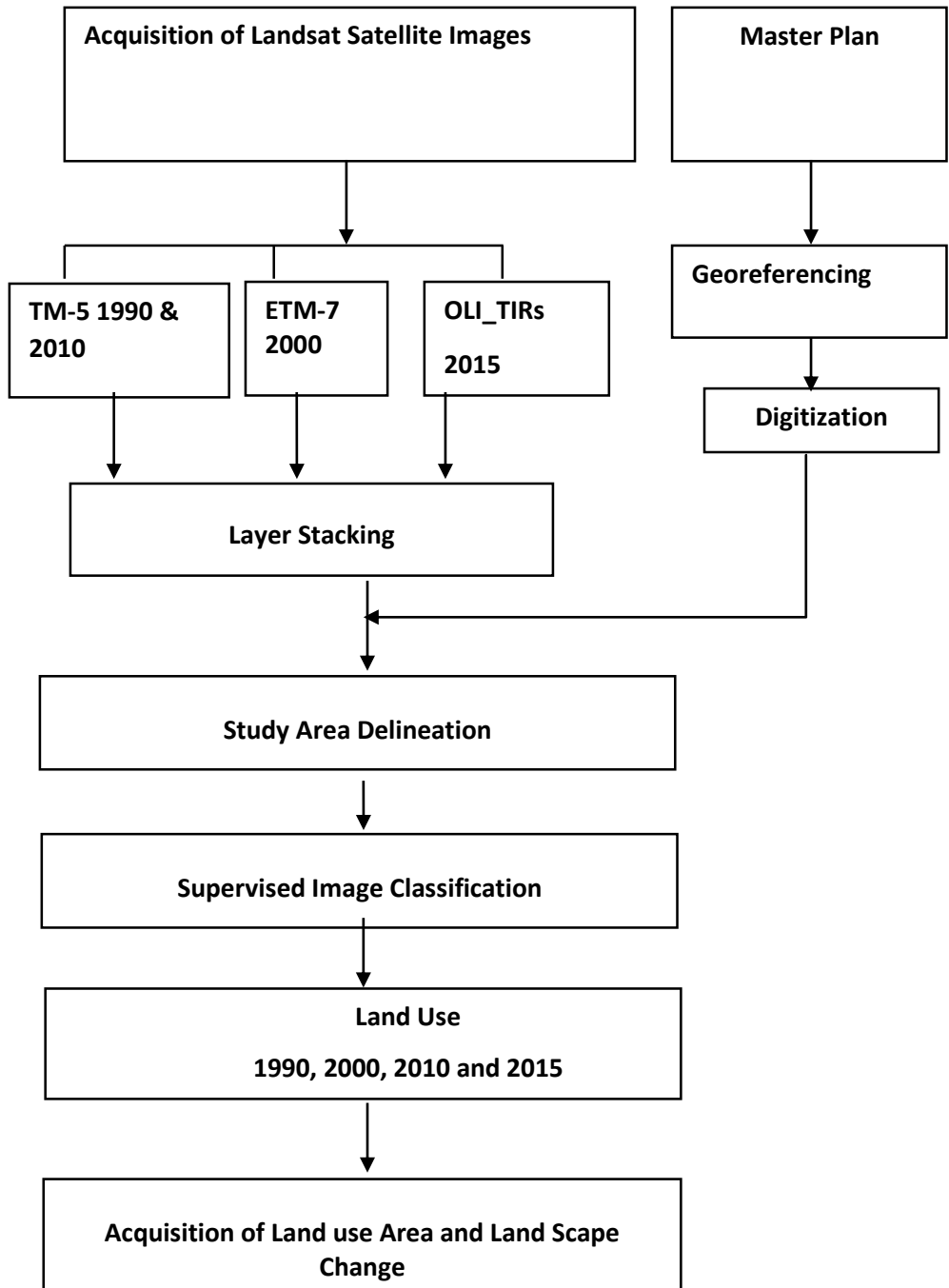
3.2 Visual elucidation

Completely different color combos were occupied to spot various land cowls. For example, for the accurate identification of vegetation and water RGB 543 were used. Water and Settled spaces were identified by RGB 743. Same like the substitute combos of band RGB 321 and 741were additionally analyzed to succeed in accurate selections regarding completely different land cover changes.

Classification of Supervised image

The classified theme about supervised image, adopted by the present analysis, for the Landsat satellite Imageries of 1990, 2000, 2010 and 2015. These statistic images were non inheritable set ahead like data base specifically for the analysis aim.

Assessment of Land Use Changes and Urban Expansion of Bahawalnagar through Geospatial Techniques

Figure 1.1: Flow Chart of Image Classification

```
┌──────────────────────────────────────┐   ┌──────────────────┐
│ Acquisition of Landsat Satellite      │   │   Master Plan    │
│ Images                                │   │                  │
└──────────────────────────────────────┘   └──────────────────┘
                  │                                   │
                  ▼                                   ▼
  ┌──────────┐ ┌──────────┐ ┌──────────┐   ┌──────────────────┐
  │TM-5 1990 │ │ ETM-7    │ │ OLI_TIRs │   │ Georeferencing   │
  │& 2010    │ │ 2000     │ │ 2015     │   └──────────────────┘
  └──────────┘ └──────────┘ └──────────┘            │
       │            │            │                   ▼
       ▼            ▼            ▼          ┌──────────────────┐
  ┌──────────────────────────────┐         │  Digitization    │
  │      Layer Stacking          │         └──────────────────┘
  └──────────────────────────────┘                 │
                  │◄────────────────────────────────┘
                  ▼
  ┌──────────────────────────────┐
  │   Study Area Delineation     │
  └──────────────────────────────┘
                  │
                  ▼
  ┌──────────────────────────────┐
  │ Supervised Image Classification│
  └──────────────────────────────┘
                  │
                  ▼
  ┌──────────────────────────────┐
  │          Land Use            │
  │   1990, 2000, 2010 and 2015  │
  └──────────────────────────────┘
                  │
                  ▼
  ┌──────────────────────────────┐
  │ Acquisition of Land use Area │
  │ and Land Scape Change        │
  └──────────────────────────────┘
```

Classification Stage

Table 3: Description of Land Use classes

LU classes	General Description
Built-up area	All the roads, buildings and sealed surfaces found are included in this class.
Agricultural land	This class includes all the cultivated and arable land.
Open Land	All the vacant areas, abandoned fields and patches of bare soils are included in this class.
Water bodies	Areas that are covered by water are denoted as water bodies such as rivers and streams.

RESULTS AND DISCUSSIONS

The only authentic way of describing population is through the population censes. The change in the city population by last few decades is in the following table.

Table 4: Population of city Bahawalnagar

Year	Population (thousand persons)
1972	309
1981	367
1998	542
2015 (estimated)	720

Source: (Punjab Development Statistics 2015)

Here is the interesting thing that there had been very noticeable change in positive increased during the years 1972-2015. The significant reason is that thousands of people from other areas migrated into Pakistan during this time as power of refugees.

The distribution of land use resulted from different maps for specific study year shown in the table 5.

Table 5: Land Use Distribution of Bahawalnagar

Assessment of Land Use Changes and Urban Expansion of Bahawalnagar through Geospatial Techniques

Land use	1990 Area Hectare	1990 Area (%)	2000 Area Hectare	2000 Area (%)	2010 Area Hectare	2010 Area (%)	2015 Area Hectare	2015 Area (%)
Built-up Area	796.73	43.95	933.50	51.50	992.61	54.77	1015.87	56.05
Agricultural Land	602.64	33.24	589.77	32.54	523.58	28.89	510.23	28.15
Open Land	353.89	19.52	242.65	13.39	260.72	14.38	245.72	13.56
Water bodies	57.62	3.17	46.59	2.57	35.59	1.96	40.68	2.24
Total	1,812.51	100	1,812.51	100	1,812.51	100	1,812.51	100

Source: Aziz, 2017

. All the final four maps of desired selective classes are reclassified.
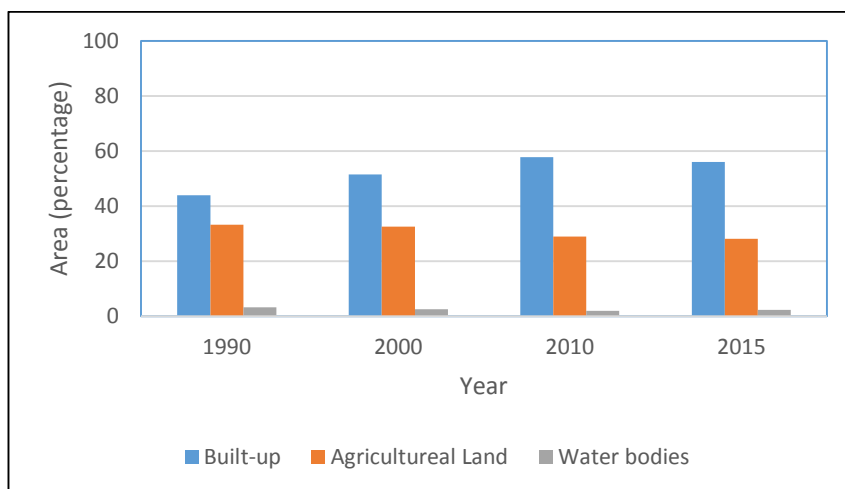
Figure 2: Relative land use change from 1995-2010 of city Bahawalnagar

The above graph shows the relative land use change from 1995-2010 of city Bahawalnagar. There were significant increasing trends present in the areal distribution, also increase in the built up area. During the study period, different land use changes have taken the place whereas during the four periods of agricultural land use decreased continuously. It is noted

that all the other distributed graphs are showing the declining trends during the study time.
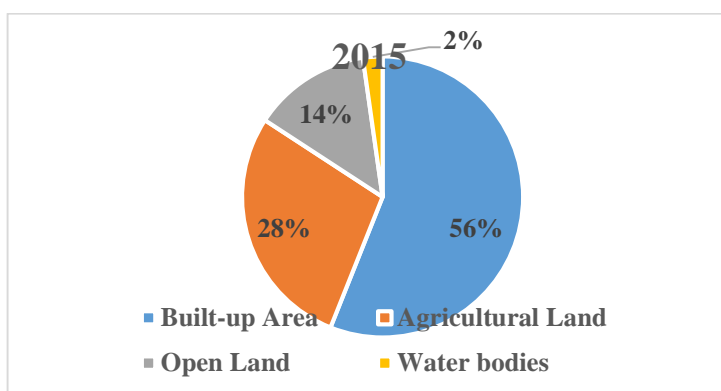

Figure 3: Land use distribution of Bahawalnagar by area for 2015

Table 6: Land use change detection rate and magnitude

Land use	1990-2000		2000-2010		2010-2015		1990-2015	
	Area Hectare	Area (%)	Area Hectare	Area (%)	Area Hectare	Area (%)	Area Hectare	Area (%)
Built-up Area	136.77	7.54	59.11	3.27	23.26	1.28	219.14	12.09
Agricultural Land	-12.87	-0.71	-66.19	-3.65	-13.35	-0.74	-92.41	-5.09
Open Land	-111.24	-16.13	18.07	0.99	-15	-0.82	-108.17	-5.96
Water bodies	-11.03	-0.60	-11	-0.61	5.09	0.28	-16.94	-0.93

The negative trends showing decrease in all categories by different years. This data shows the rate at which each land use is changing for the year intervals in between 1990-2000, 2000-2010 and 2010-2015. For each interval, every class is showing a positive or negative trend according to change in these years.

Change Detection of Built-up Land

Built up is showing a positive trend throughout all the year intervals. It has slightly increased by 1% in between 1990 and 2000. Study area has grown some parts in its southern direction which were not present earlier. This slight increase was due to less construction during these years. Only 5 new colonies were built during this time period.
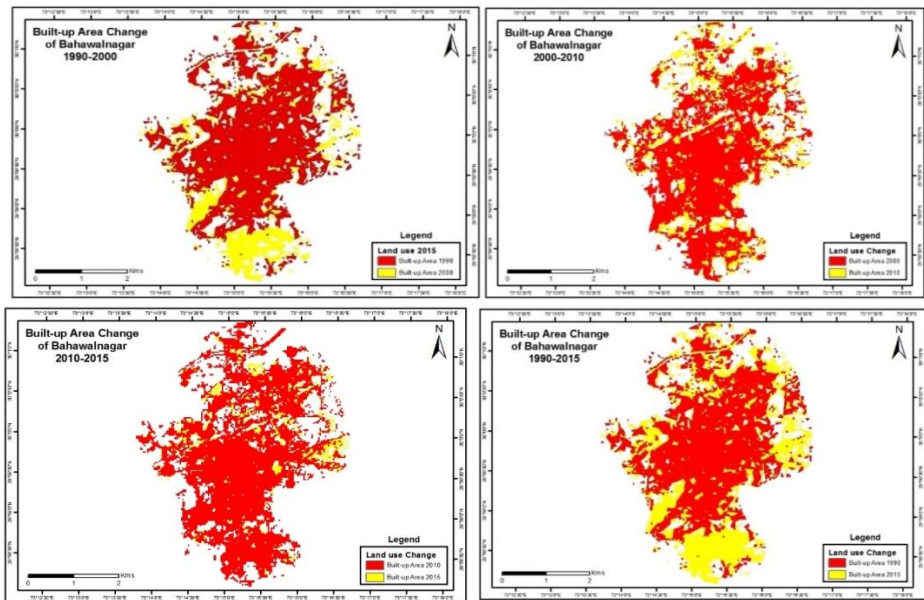

Figure 4: Change Detection of Built-up in Bahawalnagar (1990-2015)

Change Detection of Agricultural Land

Comparison between years 2000 and 2010 shows a negative trend in agricultural class. However, slightly increase could be observed in the south western parts and eastern parts. Beside this much land has occupied by the built up area due to construction of many new colonies in Bahawalnagar.
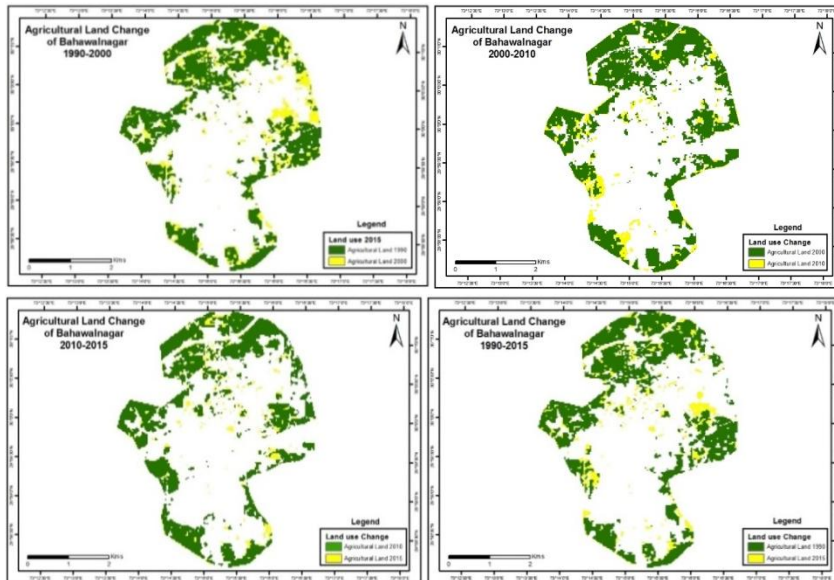
Figure 5: Change Detection of Agricultural Land (1990-2015)

CONCLUSION AND RECOMMENDATIONS

All classes of land use for the pattern identification were exclusively produced for the each research but most significance was given to densely populated land as it is due to cultural venture which build up this class and that's why, it is one land use which has important impact on the other categories. In order to cope we are already using numerous statistical patterns and the formulas. The result of study gives an idea about the rapid progression in densely populated use from 1990 and 2015 whereas same period observed a reduction in other classes specially the group under agricultural land use. It was more suggested that in coming years the future change is to go behind the same pattern just as in the past.

A few recommendations are given below about the land use design for the future use in Bahawalnagar.

- According to the current research it is suggested that the city will get larger in the coming years resulting the over crowdedness and explosive increase in addition with the main city roads ruling towards other nearby cities. This condition will have different but same time dangerous effects in the area because of the interrelated problems like lack of facilities, congestion, overcrowding, more crimes and traffic burden. That's why it is suggested that the citizens should be motivated to build towards the outer part of the town by the distribution of incentives that are obtainable at the city center.

- With research during 1990 to 2015 it is stated that with the passage of time the land use for agriculture is reducing evident by Satellite Remote Sensing data, whereas there has been a growth in the spatial enlargement of Bahawalnagar.
- Although, recently in study area there is a large number of industrial units. A number of those are already observed and disused during the research. That's why it is suggested, that the government of Punjab must be stimulate investors both foreign and locals which as a result may help them to grow up again.
- The most land use variations have been observed along all the roads which link Bahawalnagar with other small or big cities that's why it's suggested that the new areas for the people to live and allied venture may be constructed on the roads side i.e. along Lahore road, Sahiwal or Bahawalpur road.

References

A. Gaffar, 2015 "explore the spatio-temporal dynamics of land use changes and evaluate the spatial patterns of urban expansion in Lahore, Pakistan from the year 2000 & 2014"

A. Tomao, V. Quatrini, P. Corona, A. Ferrara, R. Lafortezza, L. Salvati, 2017 "Resilient landscapes in Mediterranean urban areas: Understanding factors influencing forest trends". Environmental Research 156 (2017) 1–9

A. Butt, R.Shabbir, S.Saeed, Ahmad and N.Aziz, 2015 "Land use change mapping and analysis using Remote Sensing and GIS: A case study of Simly watershed, Islamabad, Pakistan" The Egyptian Journal of Remote Sensing and Space Sciences (2015) 18, 251–259.

B. Majumder 2012, "land use and land cover change detection, Study at Sukinda valley using remote Sensing and GIS."

BHANDARI, S. 2010 *"Urban change monitoring using GIS and remote sensing tools in Kathmandu valley, Nepa"l.* Thesis, (M.Sc.).University of Munster, Germany.

D. Jovanović, M. Govedarica, F.Sabo, Ž.Bugarinović, O.Novović, T.Beker, M.Lauter, 2015 "Land Cover change detection by using Remote Sensing – A case study of Zlatibor (Serbia)" Faculty of Technical Sciences, University of Novi Sad, Vol. 19 (2015) 162-173.

E. Teferi, W. Bewket, S. Uhlenbrook and J. Wenninger, 2013 "Understanding recent land use and land cover dynamics in the source region of the Upper Blue Nile, Ethiopia: Spatially explicit

statistical modeling of systematic transitions". Agriculture, Ecosystems and Environment 165 (2013) 98–117.

FOODY, G. M. 2002 "Status of land covers classification accuracy assessment. *Remote Sensing of Environment"* 80, 185-201.

H. G. Coskun, U. Alganci and G. Usta, 2008 "Analysis of Land Use Change and Urbanization in the Kucukcekmece Water Basin (Istanbul, Turkey) with Temporal Satellite Data using Remote Sensing and GIS". Faculty of Civil Engineering, Istanbul Technical University (2008) 8, 7213-7223.

I.R.Hegazy, M.R.Kaloop, 2015 "Monitoring urban growth and land use change detection with GIS and remote sensing techniques in Daqahlia governorate Egypt"International Journal of Sustainable Built Environment (2015) 4, 117–124

J. B. Olaleye, 2009 "land use change detection between the time periods of 1964 to 2003 in Lekki Peninsula Area of Lagos, Nigeria"

J. O. Owoeye and O. A. Ibitoye, 2016 "Analysis of Akure urban land use change detection from remote imagery perspective" Department of Urban and Regional Planning, School of Environmental Technology, Vol. 2016, 9

J.S. Rawat, Manish Kumar, 2015 "Monitoring land use/cover change using remote sensing and GIS techniques" The Egyptian Journal of Remote Sensing and Space Sciences (2015) 18, 77–84

JENSEN, J. R. 2004 *Introductory image processing: A remote sensing perspective*. New Jersey:Prentice-Hall.

K.M. Kafi, H.Z.M. Shafri and A.B.M. Shariff, 2014 "An analysis of LULC change detection using remotely sensed data; A Case study of Bauchi City" Department of Civil Engineering, Faculty of Engineering, Earth and Environmental Science 20 (2014)

KAISER, M. 2008 Spectral enhancement of the spot imagery data to assess marine pollution near Port Said, Egypt. In PIERS Proceedings, Cambridge, USA, 746-753.

L. Salvati, A. Sateriano and S. Bajocco, 2013 "Land Cover Relationships in a Mediterranean City Region and implications for land use management". Cities 30 (2013) 113–121

LILESAND, T. AND KIEFER, R. 2002 *Remote sensing and image interpretation*. New York: John Wiley & Sons, Inc.

M. S. Khattak, S. Rehman, K. Shoukat and M. A. Khan, 2015 "Analysis of Land use Changes using Remote Sensing and GIS Techniques: A

Case Study of District Peshawar-Pakistan". International Journal of Engineering Research & Technology (IJERT) Vol. 4, 2015

Pandian.M., Rajagopal.N., Sakthivel. G., Amrutha. D.E., M.Tech, 2014 "Land use and land cover change detection using remote sensing and GIS in parts of coimbatore and tiruppur districts, TAMIL NADU, INDIA" International Journal of Remote Sensing & Geoscience Volume 3, Issue 1, Jan. (2014) 2319-3484.

RATANOPAD, S. AND KAINZ, W. 2006 Land cover classification and monitoring in northeast Thailand using Landsat 5 TM data. In ISPRS Technical Commission II Symposium, Vienna, 12-14 July 2006. 137-144. Available from: http://www.isprs.org/proceedings/XXXVI/part2/pdf/ratanopad.pdf [Accessed 12 May 2011]

S. M. Raza and S.A. Shirazi, 2014 "the temporal analysis of urban development from 1992 to 2010 of Sargodha, Pakistan using satellite imaginary"

S. Pathak, 2014 "New Change Detection Techniques to monitor land cover dynamics in mine environment". The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Vol. XL-8, 2014

SADIDY J., FIROUZABADI P.Z., AND ENTEZARI, A. 2009 "The Use of Radar sat and Landsat Image Fusion Algorithms and Different Supervised Classification Methods to use Map Accuracy – Case study: Sari Plain – Iran. Available from:

http://www.cirgeo.unipd.it/cirgeo/convegni/mmt2007/proceedings/papers/sadidy_javad.pdfImprove .

Y. Deyong, S. Hongbo, S. Peijun, Z. Wenquan and P. Yaozhong, 2009 "How does the conversion of land cover to urban use affect net primary productivity". Agricultural and Forest Meteorology 149 (2009) 2054–2060

Y. H. Araya, 2009 "Urban land use change analysis and modeling: a case study of Setúbal and Sesimbra, Portugal".

Y. Zhang and B. Guindon, 2006 "Using satellite remote sensing to survey transport-related urban sustainability". International Journal of Applied Earth Observation and Geo information 8 (2006) 149–164

Z. A. Opeyemi, 2006 " Land use changes from 1972 to 2001 using GIS and Remote sensing applications".