URBAN EXPANSION AND LAND USE CHANGE IN BAHAWALPUR CITY DURING 1998-2018

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ABSTRACT

Urban growth has a direct effect on urban land use. It is mainly pushed by unorganized expansion, rapidly increasing population and increased immigration. In this context, land use and land cover change are considered one of the central components in current strategies for managing natural resources and monitoring environmental changes. Some cities of Southern Punjab are heavily affording the burden of a real population and hence, the fertile land is rapidly converting into the built up area. Bahawalpur is one of the good examples, which is expanding rapidly with high growth rate and patterns. The current study is done with the some indices like NDVI, NDWI and NDBI are used which shows the scenario of change. The supervised classification and unsupervised classification gave the statistics of the land use land cover and also tell us about the changes which occurred in twenty years. According to the results of supervised classification three land covers increase built up area 7780 hectare, bare land 2452 hectare, and Fallow land 9304 hectare, and three land covers decreased agriculture area 16907 hectare, water 860 hectare and forest 1769 hectare respectively. On the basis of population census overall population depicts that the population was 806,580 and increased and reached on 1,256665 in 2017. The least squares regression analysis shows the relationship of population and built area which is strongly positive with the value of 0.997. This research is helpful for policy makers and decision makers for better planning of Bahawalpur City.

KEYWORDS: urbanization, unorganized expansion, geospatial technologies, change detection, decision makers, agriculture area

INTRODUCTION

Land use land cover change is a human modification on earth surface. However, humans have been converting the land to obtain or to fulfill the requirements of the population in the past as well as in the present. The current speed of land-use change is very high compare to the past.(Ellis and Pontius Jr, 2006) Land-use change has been observed the local issue but this not reality, it's actually the global issue now a day. Land-use change provide the cause of disturbance atmospheric components like increasing in carbon dioxide (CO_2) and ozone layer depletion etc.(Edwards, 2001). Land use land cover causes the severe changes in environment at local as well as global scale(Belay and Mengistu, 2019). The changes in landscape, shifting of cultivation and land transformation are the important parts of LULC changes; the application of Change detection is very significant in these kind of studies(Andualem et al., 2018). The human population is increased day by day; they convert from natural environment to artificial environment. In

the result the urban researcher and environmentalist active to sustain the environment. They know the consequences of LULC change and its results on humans(Carey et al., 2013). The Anthropogenic activities on the Earth surface provide a baseline to many spatial and temporal scales changes that were occurred in the last few decades. The remote sensing technique has the capability to measure temporal variability (KHAN, 2013).

Earlier, when remotely sensed data were not exited, LULC change was analyzed manually and on topographic sheets. But then this method was traditional and required a large amount of finance, maximum workforce and also time-consuming. When the remote sensing techniques prepared then this method is converted to digitization. The longitudinal studies were conducted on the bases of regular interval (Shamsi, 2005).Urban areas are considered the attractive places of planet earth. The millions of the people lived in cities and cities were provided socio cultural centers to the world. The groups of people lived in urban areas in the form of clusters. Currently Pakistan is facing the problems that are associated with cities. The major cities of Pakistan like Karachi, Lahore, Islamabad, Rawalpindi, as well as Faisalabad. Faisalabad is city that is growing very fast in few decades. The Bahawalpur is 11th largest city of Pakistan which is facing so many problems due to the land use land cover change and increasing population.

The changes in LULC in Pakistan are very important because of rapid population growth and unorganized of urban areas(Butt et al., 2015). According to(Sohl and Claggett, 2013) LULC changes analysis provide the meaningful help to decision makers to make the environment sustainable and to study the dynamics of changing environment. During the past 50 years, huge changes were occurred due to population growth, unorganized development and severe earthquakes. LULC is a significant tool to understand the relationship between man-made activities and environment; it is Mandatory to observe the changes to make a sustainable environment(Colomina and Molina, 2014). According to(Shirazi, 2012) the population of the world exceeds the figure of 7 billion and most of the people lived in urban areas. The people modified the structure of urban areas into their needs and completely changed the landscape of the earth surface. The urban development and the process of urbanization with technology have changed the LULC in the world. Pakistan is also faced this situation and the main cities of Pakistan are affected.

(Degife et al., 2018)said that the three main factors works behind the LULC change was resettlement programs, increasing agricultural area and also population growth.(Sharma and CHAND, 2014)stated that he forces that worked behind urban expansion like population growth, climate changes etc., were solved with the help of Geo spatial technologies. These techniques will provide help to present scenario as well as future predictions. The changes in land use and landscape over the time is more

accurately compare to traditional methods that were used in past for urban studies. Remote sensing gives multi temporal studies of urban areas and to study out the land use land cover of the area as well as the mapping and analyzing these change patterns. This is very applicable in those areas where the land use land cover changes worked rapidly(Dewan and Yamaguchi, 2009).

Remote sensing studies focused on sensors that are based on spectral reflectance of the images. The famous satellites LANDSAT and SPOT etc. have different spectral resolution. Different land cover has different reflectance according to their color(Bowker et al., 1985). The main objective of this research is to analysis LULC changes and urban expansion in Bahawalpur City by satellite datasets and to analyze the extent and nature of LULC change over the period of twenty years.

MATERIAL AND METHODS

Study Area

The Bahawalpur District has Six Tehsils namely (Bahawalpur City, Bahawalpur Saddar, Yazman, Ahmed Pur East, HasilPur and KhairpurTamewali). This study is conducted based on temporal data start from 1998. The Bahawalpur city and Bahawalpur Saddar Tehsils were combined and then this Tehsil Bahawalpur was divided into two Tehsils due to administrative purposes. So this study is conducted in Bahawalpur City and Saddar Tehsil with the name of Bahawalpur City. The area of the Bahawalpur city is 142708 hectares. The absolute location of the Bahawalpur city is latitudes 29°-22‟ N and longitude is 71°-37‟ E approximately. The elevation of the city from sea level is 152 meters. Bahawalpur is laid on the south side of the Sutlej River. Multan, exist in north, Bahawalnagar district and India in east, Rahim Yar Khan in west respectively.

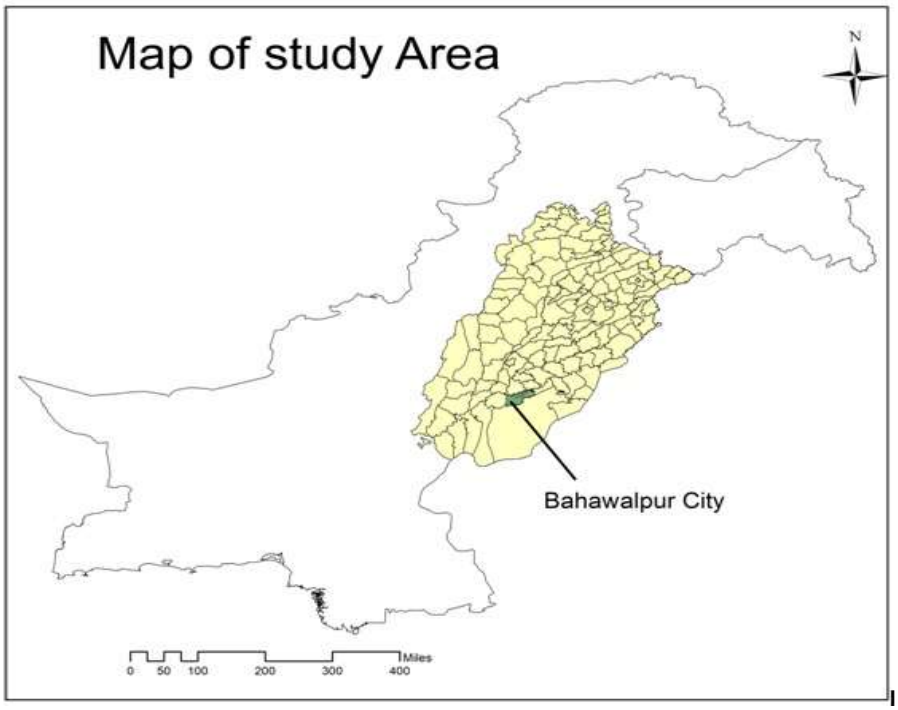


Fig. 1 Map of study Area

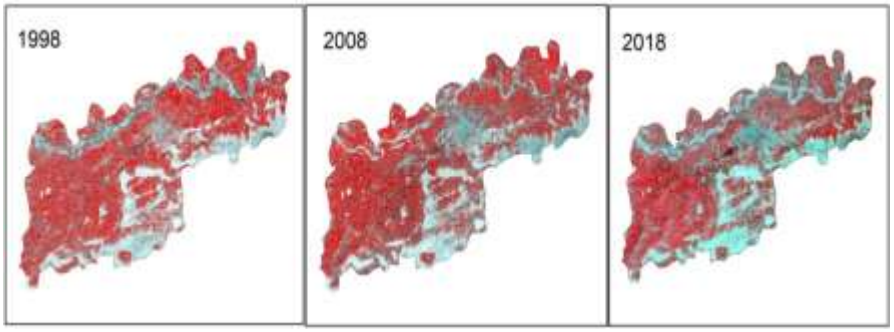
DATA AND METHODOLOGY

The actual focus in this research is based on satellite data. Several satellites are available for remote sensing studies, for instance SPOT satellite which is high resolution satellite, IKNOW, LADAR, RADAR etc which are very costly. But the problem of less developed countries like Pakistan, they have mostly financial issues which they faced. The researchers and the institutes cannot afford these satellite images. The second type of data which is used in this research is population census data which acquired from Pakistan bureau of statistics.

Table1: Reference of Landsat Data

Reference years	Sensor	Resolutions	Path/Row	Acquisition Date
1998	LANDSAT TM	30 M	150/40	03/29/98
2008	LANDSAT TM	30 M	150/40	10/02/08
2018	LANDSAT OLI	30 M	150/40	07/10/18

To acquire the timely LULCC of the Bahawalpur City including three temporal Landsat satellite images covering 20 years (1998, 2008, and 2018). These images included 30 m resolution Landsat TM image 1998 and 30m



resolution Landsat image from 2008 and Landsat OLI 2018 30 m resolution showed in Figure 2.

Fig. 2 Landsat images of 1998, 2008, and 2018

After downloading these images next process was layer stacking and subset etc are done in the software of Erdas imagine. Different indices, unsupervised and supervised classification are performed. The accuracy assessment is done with the help of GPS, Ground realties (Ground truthing) and also the very important source was online Google earth. The Map making and layouts of the Landsat images also performed in Arc GIS software.

Application of Indices

The remote sensing studies are incomplete without indices. The indices are the short term analysis techniques performed in remote sensing software's. Different indices are available in these software's. According to the nature of the study, the researchers choose the appropriate indices for the analysis. In this research the NDVI, NDWI and NDBI are the relevant indices which provide the clear picture of vegetation, water, and built up areas the three time periods. Indices are actually the combinations of different bands which are exist in Erdas imagine and other software's. The results of those indices are very helpful to perform the supervised classification. The indices are showed below in Figure 3.

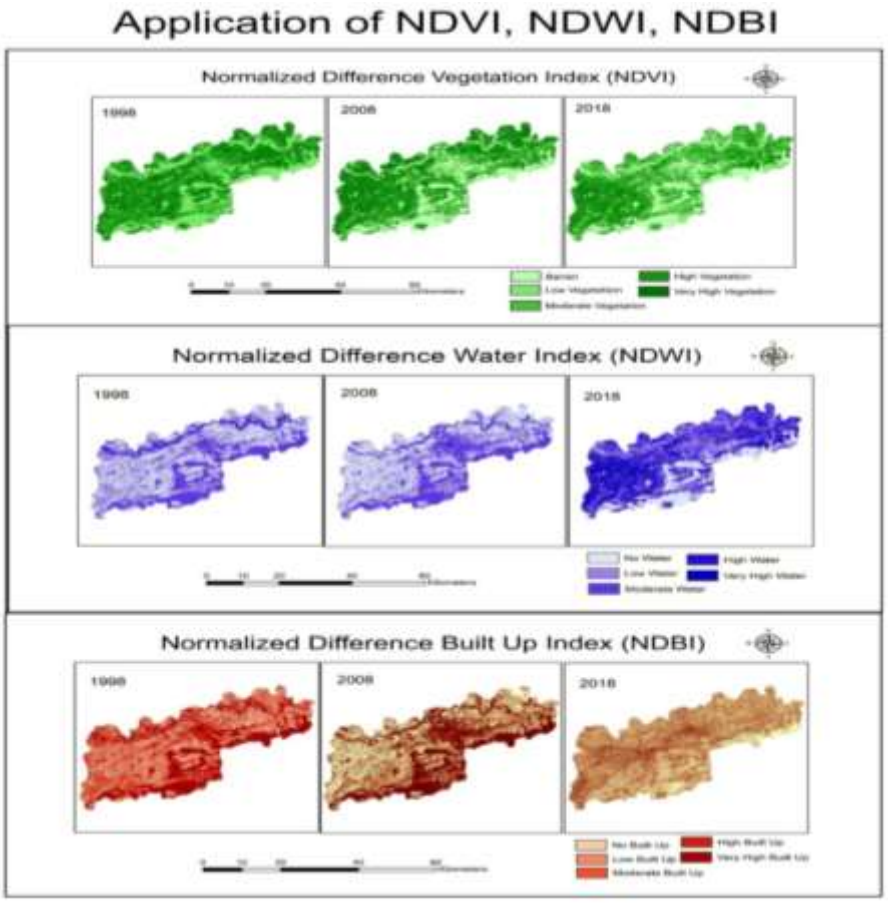


Fig. 3 Application of NDVI, NDWI, NDBI

The results of the NDVI are displayed with the help of GIS software. The year of the 1998, 2008 and 2018 shows the scenario of the vegetation and also the changes in images temporally. On the base of those images results we can clearly shows that the related land covers are changed or convert into other land covers. The results of normalized difference water are divided into five categories namely No water, low water, moderate water, high water and very water. The result of these three images clearly highlights the scenario of water in three different time periods 1998, 2008 and 2018. The results of normalized difference built up index of this research showed on the images of LANDSAT TM 1998, LANDSAT TM 2008 and LANDSAT OLI 2018 as well. Five classes are made namely Very high built up, high built up; moderate built up, low built up and no built up as well. With the help these indices the training of the signature will be easy to choose and define in an appropriate way and also it is showed the clear picture of changes.

Unsupervised Classification

The major contribution in this research is supervised classification but unsupervised classification also used in this research. The unsupervised classification doesn't need of expert to have the knowledge of the taking classes and the training of signatures, and importantly using some clustering algorithm classification an image data. This method can be used to decide the number and location of the homogeneous spectral classes. One of the most widely used methods of unsupervised classifications is the migrating means clustering classifier (MMC)(Liu and Gong, 2013). In unsupervised classification, as explained above, the classifier determines the unknown pixels and cluster of the pixels of different values into a different number of classes. ISODATA (Interactive Self Organization Data Analysis Technique) and the meaning of K are two similar techniques used for unsupervised classification. With the help of ISODATA, Landsat TM image of 1998, 2008 and LANDSAT 8 OLI images of the Bahawalpur City were separated into unknown classes, and after that on the basis of the local knowledge of the Bahawalpur City, ground truthing and pixel values, is done by the author. ISODATA or unsupervised classification needs three input demands:

- Number of classes
- Number of iterations
- The convergence threshold

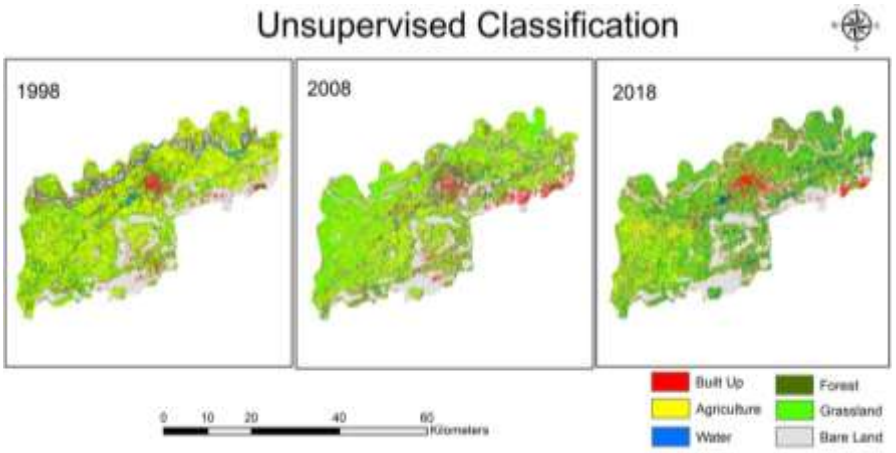


Fig. 4 Unsupervised Classification

The results of unsupervised classifications after the processing show that the land use is changed in previous twenty years very rapidly. The first land cover is a built up is changed in twenty years on broad levels. The Bahawalpur City Tehsil is increased and almost covers the large area of agricultural land and fallow land from 1998 to 2018. The land cover of waters also changed, the River Sutlej was flowing properly in 1998 but it is dry in 2018, the water bodies expect the river also convert or dry with the

passage of time. The agricultural land which most dominant in 1998 convert into built up of urban area as well as the rural areas settlements due to growing population and other factors. The agricultural land also covers also damaged by the grassland/fallow land as well as the bare land. The grassland or fallow land also affected by the passage of time, the changes in fallow land may be occurred seasonal and the grassland areas also converted into built up areas and the bare land areas due to the lack of irrigation water and shortage of rainwater in this deserted region of Cholistan. The forest area is also converted into urban area and also due to the deforestation in the forest area. The overall big changes are occurred in these twenty years are discussed above.

Supervised Classification

The training of samples is considered one of the significant factors in supervised classification which can affect the classified images accuracy. The land cover types that were choose for trainings were identified both on satellite image and ground. Training places for signature collections were taken from the 1998, 2008and 2018 images (for the six lands cover classes based on the sources which are given below, expect the local knowledge of the researcher about the Bahawalpur City the important sources was Online Google Earth, Topographic map of the study area, Map of Bahawalpur City, Unsupervised classification and indices.The next thing was after evaluation and analysis of the signatures, and selection of different bands, 4, 3, and 2 in 1998 and 2008 image and 5, 4, 3 in 2018 image, Maximum Likelihood classifier (MLC) in supervised classification was applied to all Landsat images of 1998, 2008and 2018. Finally the pixel is selected in the most suitable class for which it had the highest probability of lying.

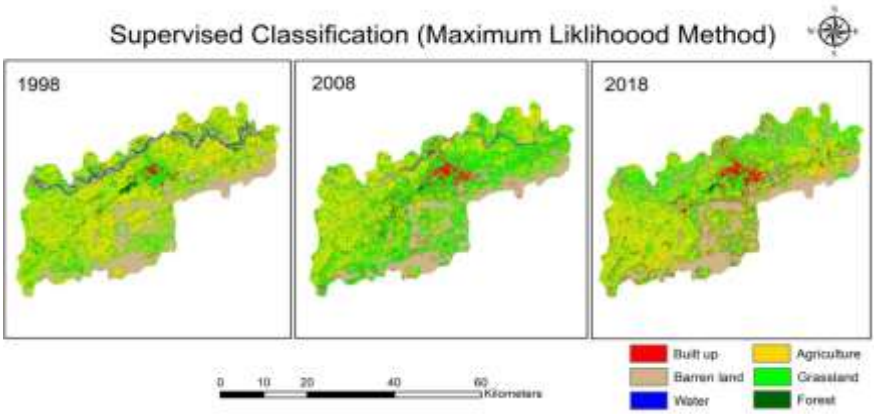


Fig. 5: Supervised Classification (Maximum Likelihood Method)

The comparison of the results on the basis of supervised classification is clearly detected the land use changes in the study area. The LANDSAT images results, layouts and the statistics defined the changes in the study

area. The six land covers which are taken for the supervised classification explain the changes very clearly.

Table 2: Statistics of the Land Covers from 1998 to 2018

Land use/ Land cover	**1998**		**2008**		**1998-2008**	**2018**		**2008-2018**	**1998-2018**
	Area(ha)	**%**	**Area(ha)**	**%**	**Changed(ha)**	**Area(ha)**	**%**	**Changed(ha**	
Built up	5451	3.81	8277	5.80	-2826	13231	9.28	-4954	-7780
Barren Land	28214	19.78	28823	20.19	-609	30666	21.49	-1843	-2452
Water	2656	1.87	822	0.58	1834	1796	1.25	-974	860
Agriculture	62489	43.79	42264	29.62	20225	45582	31.95	-3318	16907
Grassland	41748	29.25	56570	39.64	-14822	51052	35.77	5518	-9304
Forest	2150	1.50	5952	4.17	-3802	381	0.26	5571	1769
Total	142708	100	142708	100		142708	100		

The results showed the statistics of the land cover briefly. The built area which was 3.81 % in 1998 increased and reached 5.80% in 2008 and 9.28 % in 2018. The second land cover barren land was 19.78 % in 1998 and reached at 20.19 % 2008 and increased and reached 21.49 % in 2018. The water was detected in 1998 of Sutlej River so the area of water was 1.87 % in 1998 and decreased in 2008 and 2018 due to the lack of water in the river. The next land agriculture is fluctuating and shows that the 43.79 % was in 1998 and decreased in 2008 29.62 % and increased from 2008 to 2018 is 31.95. The grassland was 29.35 % in 1998 and 39.4 % in 2008 and 35.77 % in 2018. The next land cover is forest was 1.50 % in 1998 and increased 4.17 % in 2008 and decreased drastically and reached on 0.26 % in 2018 after the results of supervised classifications.

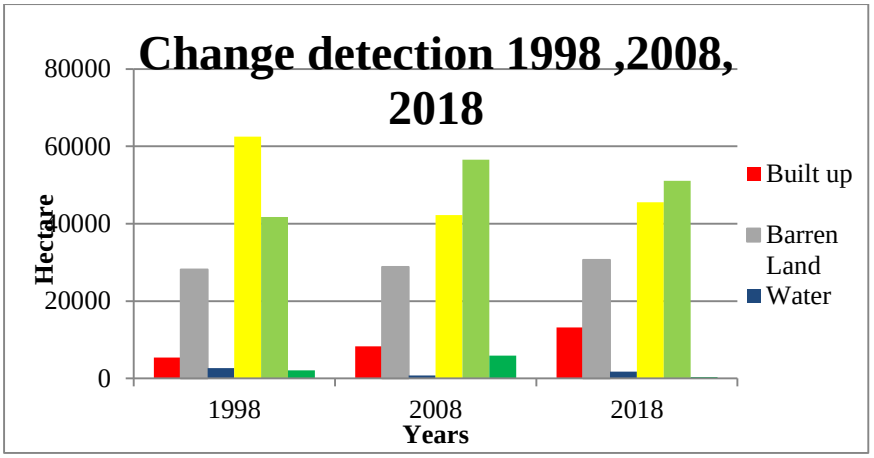


Fig. 6 Change detection 1998, 2008, and 2018

Accuracy Assessment of Landsat Images

Accuracy is defined in different contexts at different places. Accuracy assessment explains the quality of information accrued from remotely sensed data. Assessment can be qualitative or might possible it can be quantitative. In qualitative assessment, you explain if a map 'looks accurate' with the comparison what you see in the map or what you see on the ground with image(Anand, 2017). Accuracy assessment is the last step in the procedure of remote sensing data which provide assistance to verify how accurate our results are. In present research the accuracy assessment is done all three classified images of 1998, 2008 and 2018. Different sources visual interpretation, interviews of the local peoples, topographic map of Bahawalpur, online Google earth which compatible with the Erdas Imagine software 2014.

Table 3: Accuracy Assessment of 1998

Classified data	Class Image	Reference data						Column Total	User's Accuracy (%)	CE (%)
		Bup	Ag	W	BL	F	FL			
	Bup	34	0	0	2	0	4	40	82.35	17.65
	Ag	0	32	0	0	1	2	35	90.62	7.38
	W	0	3	55	0	2	0	60	90.90	9.10
	BL	8	0	0	60	0	2	70	83.33	16.67
	F	0	2	0	0	28	0	30	92.85	7.15
	FL	0	1	0	0	0	14	15	92.85	7.15
Column Total		42	38	55	62	31	22	250		
Producer Acc. (%)		80.95	84.21	100	96.77	90.32	72.72	Over all accuracy:		
Omission error		19.05	15.79	0	3.23	9.68	27.28	89.20		

Table 4: Accuracy Assessment 2008

Classified data	Class Image	Reference data						Column Total	User's Accuracy (%)	CE (%)
		Bup	Ag	W	BL	F	FL			
	Bup	70	2	0	6	0	2	80	85.71	14.29
	Ag	0	45	0	5	0	0	50	88.88	11.12
	W	0	3	37	0	0	0	40	91.89	8.11
	BL	7	0	0	52	0	1	60	84.61	15.39
	F	0	1	0	0	9	0	10	90.00	10.00
	FL	0	2	0	0	0	28	30	92.85	7.15
Column total		77	53	37	63	9	31	270		
Producer Acc. (%)		90.90	84.90	100	82.53	100	90.32	Over all accuracy: 89.25		
Omission error		9.10	15.10	0	17.47	0	9.68			

Table 5: Accuracy Assessment 2018

Classified data	Class Image	Reference data						Column Total	User's Accuracy (%)	CE (%)
		Bup	Ag	W	BL	F	FL			
	Bup	74	0	0	4	0	2	80	91.89	8.11
	Ag	0	45	0	0	5	0	50	88.88	11.12
	W	1	0	4	0	0	0	5	80.00	20.00
	BL	6	0	0	86	0	4	96	98.83	1.17
	F	0	5	0	0	35	0	40	85.71	14.29
	FL	0	0	0	1	0	8	9	87.05	12.95
Column total		81	50	4	91	40	14	280		
Producer Acc. (%)		91.35	90.00	100	94.50	87.50	57.14	Over all accuracy: 90.00		
Omission error		8.65	10.00	0	5.50	12.50	42.86			

The accuracy of the 1998 showed that the total 250 signatures are taken for the classification of this image. The built area is 40, agriculture 35, water 60, barren land 70, forest 30 and fallow land 15 signatures are collected. The wrong signatures are in built up are 8 which was actually a barren land, the 3 in water 2 in forest and 1 in fallow land from agriculture, the water is all right, 2 signatures of built up from bare land, 1 agriculture and 2 from forest is taken agriculture from forest and 4 built up 2 bare land and 2 agriculture from fallow land. The user and producer accuracy is given in the table. The overall accuracy of the image of 1998 is a 89.20 % which depicts that the results are reliable and trust worthy. The accuracy of the 2008 image showed that total 270 signatures are chosen for the classification including 80 of built up, agriculture 50; water 40, barren land 60, forest 10 and fallow land are 30. The user accuracy of built area 85.71 %, agriculture 88.88, water 91.89, barren land 84.61, forest 90.00 and fallow land are 92.85. The producer accuracy of built area 90.90 %, agriculture 84.90, water 100, barren land 82.53, forest 100 and fallow land are 90.32. The overall accuracy

of the 2008 image is an 89.25 %. The accuracy of the 2018 image showed that total 280 signatures are chosen for the classification including 80 of built up, agriculture 50; water 05, barren land 96, forest 40 and fallow land are 09. The user accuracy of built area 91.89%, agriculture 88.88, water 80.00, barren land 98.83, forest 85.71 and fallow land are 87.05. The producer accuracy of built area 91.35%, agriculture 90.00, water 100, barren land 94.50, forest 87.50 and fallow land are 57.14. The overall accuracy of the 2018 image is a 90.00 %.These are three images accuracies are obtained after the accuracy assessment which clearly shows the picture of accuracy assessment.

Change in Built up Area

The built up area is a very important land cover because all type of land covers are affected by this land cover. On the basis of the results of supervised classification the built up area is increased. The results of the classification of 1998, 2008 and 2018 depicts that the increased of the built up at the sequence of these years. The Figure 7 shows that the picture of built up area and also the area in hectare.

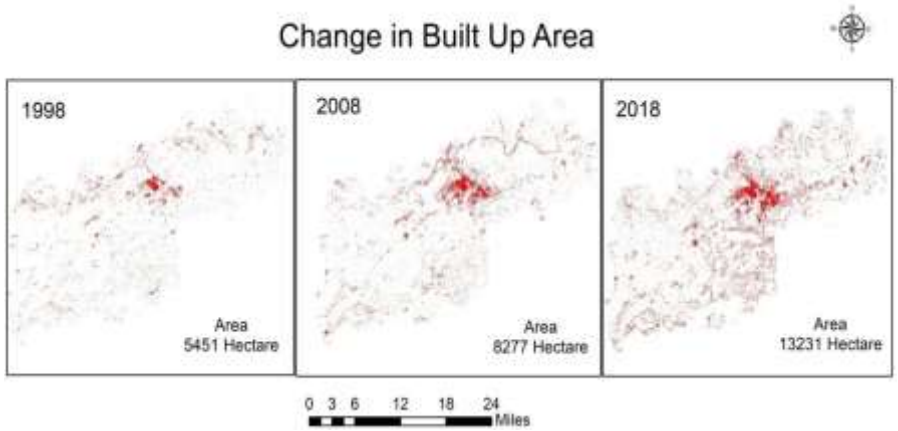


Fig. 7 Changes in Built Up Area

The Figure 7 shows that in 1998 the built up area in 1998 was 5451 hectare. Then in 2008 it's increased and reaches at 8277 hectare. The next display shows that the built up area reached 13231 hectare in 2018. The purpose to show the built up area in separately that highlight the change which is occurred in 20 years. The causes of the changes are discussed in next chapter in detail. The built up which increased is definitely occupy the other land cover like agriculture, forest, grassland or may be the bare land.

Population Growth in Bahawalpur City

Now we discuss the population of study area within the time of study which is determined. The study time is started from 1998 and end at 2018. In this

time two Censuses were conducted and the year of the 2008 which are given below are on the basis on estimated population. The table 6 shows the population of study area from 1998 to 2017.

Table 6: Population Growth in Bahawalpur City

Years	Population
1998	806580
2008	989984
2017	1256650

According to Table 6 the population of Bahawalpur City in 1998 was 806580. The next year of the estimated population is 2008 and the population at that time was 989984. The next census year is 2017 and the population at that time was 1256650. The graph of the population is given below in Figure 8.

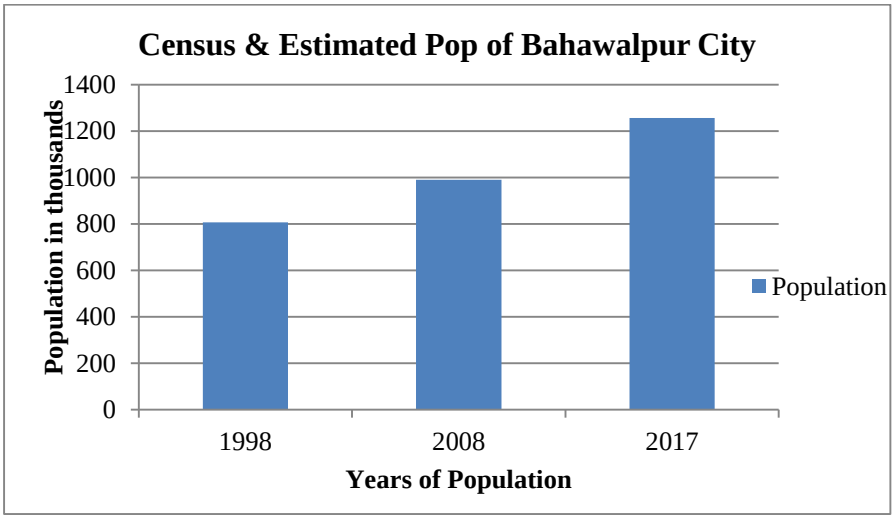


Fig. 8 Census and Estimated Population of Bahawalpur City

According to Figure 8 the population of Bahawalpur City in 1998 was 806580. The next year of the estimated population is 2008 and the population at that time was 989984. The next census year is 2017 and the population at that time was 1256650. The graph of the population is given below in Figure 8.

Relationship between population and Built up Land area

The relationship between population and built land is an essential part of change studies. To explain this relationship the statistical measure (least squares regression analysis) is used which shows the relationship of the built up area with the population. On the basis of classification results the built

up area in 1998 was 5451 hectare. The next was 2008 and in 2008 the built up area was 8277 hectare. The next year of result was 2018 and at that time the built area was 13231 hectare. On the other hand according to the census of 1998 the population of 1998 was 806580. The estimated population of 2008 was 989984 and in 2017 were 125665.

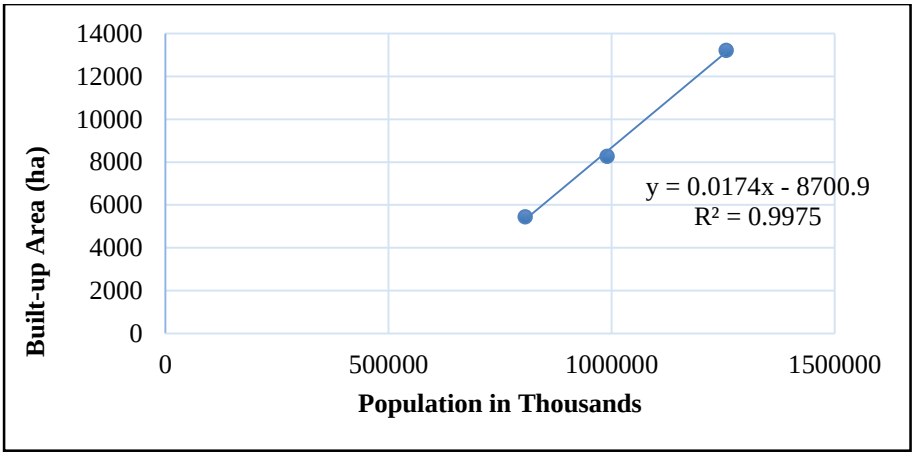


Fig. 9 Relationship between Population and Built up Land area

The value (least squares regression analysis) of the correlation is (R^2) 0.997.The Figure 9 shows the high positive correlation between these two variables. The population is increased as from 1998 to 2008 and then from 2008 to 2018. The built area results illustrate that the built up area is also increased in these period of time. These two variables shows that the positive correlation between them.

CONCLUSION AND SUGGESTIONS

The images of Landsat TM 1998, Landsat TM 2008 and Landsat OLI 2018 are used in this research. After downloading the next thing which is done in this research area some indices namely normalized difference vegetation index, normalized difference water index, normalized difference built up index are performed. These indices depicts the picture of vegetation, agriculture area, forest, built up area, and water etc in results which provide help to supervised classification.

The second and very important section is added in this research which is a spatial image data processing's. The unsupervised classification shows the changes which occurred in twenty years. Then the important thing is a supervised classification and the supervised classification results express that the built up increase 7780 hectare in these twenty years. The barren are increased 2452 hectare. The Grassland/Fallow increased 9304 hectare. The agriculture area decreased the agriculture is 16907 hectare from 1998 to 2018. The water is decreased 860 hectare and the forest is also decreased

1769 hectare. Then the comparison of these results shows with the help of tables and graphs. The accuracy of these image classifications was 89.20, 89.25, 90.00 in 1998, 2008 and in 2018 respectively.

The third section of the research is based on census data. The population of Bahawalpur Tehsil is discussed, census wise respectively. The least square regression analysis used to show the relationship between the populations and built up area results which are strongly positive with the value of 0.997.

The land use land cover change is not a negative phenomenon. The problem is that the land covers are increased now a day's which are not beneficial for the society and environment etc. For examples the urban area are increased rapidly and in the result the agricultural areas and natural environment is damaged, that is a negative thing. In this research also the built area is increased and the agriculture area is decreased. The other land also effect by these land covers. Some suggestions are given below which will provide help to the decision makers and concerned authorities.

- The built up area which is increased in twenty years is a huge area. Definitely this land cover occupies the other land covers like agricultural areas. In the urban area definitely the city is increased through new colonies and projects. These projects are approved by the government and respective departments. These projects and colonies are built on the agricultural area because the peripheral areas of the city are very fertile and useful for agriculture. The government should be responsible to make new colonies and projects on those areas which are barren or not used for the purpose of the people. The rehabilitation on agricultural areas should be strictly banned.
- The second is agricultural land which is decreased in twenty years. The first thing is to avoid the rehabilitation on agricultural areas and the other thing which is very important to highlight the importance of agriculture among the people. The rural areas people move to urban areas because the situation of agriculture is going to down day by day. The government provides faculties and better circumstances to the farmers like loan schemes, better fertilizers and pesticides. In the result the pressure on urban areas will decrease and the loss of agriculture should be stop.
- The forest area is also decreased, which is harmful for the city. The government should take action on it and stop the deforestation in forest area. If this was not break the Bahawalpur will be forest free in future which is a very negative thing.
- Another land cover is a barren land in this area. The positive thing is that the barren area is decreased. But the rate decreasing is very slow. The Cholistan development authority and other concerned department should prepare polices for the rehabilitation of the desert area as well as other barren lands.

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