IMPACT OF LAND USE CHANGE ON AGRICULTURE PRODUCTION OF MULTAN DISTRICT. (A CASE STUDY)

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ABSTRACT: *Examining and predicting changes in agricultural production are vital for the management and viable use of land, so on the earth's surface land use is rapidly changing due to urbanization, deforestation, and industrialization. The present research is mainly aimed at detecting and simulating land use / land cover change in association with agricultural production in the area under study. The main purpose of this research was to examine the factors which caused land-use changes in the study area and to examine the loss caused due to loss in the area of agriculture land use class because of land-use changes in the study area. For mapping and analysis, Arc GIS software was used. In order to assess change detection, the quantitative technique and post-classification contrast variation recognition were used for the fulfillment of the objectives of the study. Land-sat satellite images of the study area were acquired for the years 2000, 2008, and 2016 from the USGS website. Land-use classes incorporated in the study were dense vegetation/orchards, sparse vegetation/agriculture, built-up area, soil / barren land, and water. Change detection analysis was performed using the supervised classification method. Land-use change detection results revealed that agricultural production along dense vegetation/orchards land-use class was highest in the year 2000 which decreased in the year 2016 and water, built-up area and sparse vegetation had increased during 2000–2016, while soil/ barren land and dense vegetation/orchards have decreased in the area during these years. It is predicted that the study area will undergo a decreasing trend with respect to agricultural production of wheat crop and cotton followed by growth in a built-up area. These changes might be related to the conversion of barren and agricultural land use class to built-up land-use class.*

Keywords: Agricultural Production, GIS, Land Cover, Land Use, RS.

1. INTRODUCTION

The present century has witnessed land-use changes from agricultural land to urban land greatly. Land use can be referred to how the land with biophysical resources is being utilized for such as agriculture, logging, residential and industrial use [1]. Land use is the result of changes or the modification in the intensity of existing land use because of natural factors and human activities [2]. Multan's population according to the 2017 census is 1.871 million so it is the 7th largest city in Pakistan. Built-up areas and industrialization are the main causes of land-use change in Pakistan. The foremost intention for land-use change is the variation in social drives and superior desires for human needs. Human instinct has always played a crucial role in changing land-use and environmental degradation. The main cause of land use changes is a change in social aims and higher demands for human needs. Human nature has always played a crucial role in land-use change [3]. Satellite images signify that the built-up area of Pakistan has increased by almost 24% during the previous few periods [4]. Built-up areas are growing at alarming rates faster than the expansion of urban populations [5]. The most significant result of the built-up area is the decrease in agrarian production [6]. The land is basically the outer surface of our earth, it is filled with resources for many man-made activities. Land-use changes for the last six thousand years are related to the growth of the population of human settlements [7]. Data was gathered through a geographical information system (GIS) in the shapes of satellite images. The results revealed that the constant rise in the built-up area was due to exchange from barren land and agricultural land use class which is frequently decreasing due to expansion of the Multan city [8]. Land-use changes can greatly influence our earth's surface and environment [9]. At the global level, anthropogenic actions, for example, agriculture, industry, and transport combined with different socio-economic, political, and institutional indicators give rise to land-use changes [10]. Remote Sensing (RS), geographic information system (GIS) assesses the alteration of regional dynamics of land-use changes [11]. Land use and urbanization have been observed as a vital component of environmental change both at national and international levels (12). Rapid changes in land use are the result of the conversion of natural lands to built-up areas [13] If the urban populations continue to expand as estimated it will surpass by 60% by 2030 [14]. Such an increase in population will lead to changes in land use [15]. Results revealed that land use/land cover of dense vegetation/orchards, sparse vegetation/agriculture, and soil / barren land was highest in the year 2000 which decreased in 2016 while built-up area and water increased in 2016 which resulted in degradation in agricultural production of the study area. The main crops of the study area were cotton, rice, sugarcane, and wheat, which decreased from 2000 to 2016 while rice production increased and sugarcane production remained constant. This research also presents convenient measures to reduce the influence of land-use changes in the study area. The key objective of the study is to explore the reasons that are causing land-use changes in District Multan and to estimate the percentage of reduction in agricultural production because of changes in land use. This study is very helpful for all researchers and policymakers who are examining the land-use changes in the study area.

2. STUDY AREA

Multan lies in southern Punjab. The study area is situated to the north of Lodhran. River Chenab inflows in the west of Multan. Multan is the 7th largest city of Pakistan with a population of (1.871 million people) according to the 2017 census of Pakistan (Federal Bureau of Statistics). Multan Division lies between north latitude 29°22' and 30°45' and east longitude 71°4' and 72°4'55'' at about 215 meters above sea level. The southern part occupies the location of the study area situated in Punjab, Province of Pakistan, which is famous for its 5 major rivers. So, the area under study region is very popular for its furious storms due to extraordinary temperatures throughout the summer season. Relief features of the study area include fertile soils, old forts, mango gardens, and many shrines of famous saints. The physical features of the earth play a crucial role in maintaining the temperature, rainfall, and natural catastrophes. Multan has witnessed so many attacks, once it enjoyed the status of the national capital of the Punjab Province. It has many antique sites and also religious shrines. The center of this city was once a walled city, which exists till now, also surrounds by gradual suburban developments. The inner city is very congested which has narrow streets. The outer areas of the city are well developed and it has still land available for more expansion. A very little annual rainfall pours in Multan, approximately five times in a year. Even though this area possesses rich agricultural lands and access to an extensive canal system, harvests many crops, being most popular for mangoes. The geography of the city area is very unique from other cities, resembles a bowl-shaped geographic depression. The study area map has been shown in Figure.1

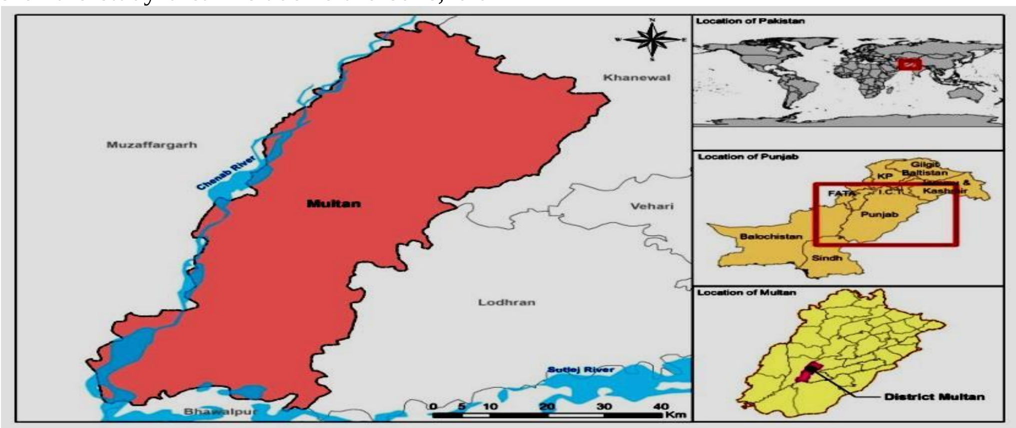

Figure 1. Study area map

3. MATERIAL AND METHODS

3.1 Data Collection

The present study employed the moderate resolution Landsat images which were downloaded from the United States Geological Surveys (USGS) and Earth Explorer websites (http://glovis.usgs.gov/) to examine land-use change for the past 16 years which influenced the agricultural production in the study area. Various techniques have their own advantages and disadvantages, which were used as a whole to complement each other. The techniques used in the present study are the Remote Sensing (RS) technique and Geographical Information System (GIS) to produce data on the spatial and temporal scale in land use or land cover changes. For this study, the images were acquired from the same season in the months between (July–September), so that the cloud cover may not exceed more than 10%. The images were acquired from diverse sensors with a similar spectral resolution, i.e. 30 m. A supervised classification is the kind of classification in which the user gathers samples of the land use classes and the image classification software determines each class to which it resembles best. Land use maps with practically high accuracy can yield a large number of the training samples with increased efficiency which permits a wide range of features representation [16]. Many Remote Sensing (RS) methods just like the object-based segmentation and classification have been included in Geographic Information System (GIS) [17]. The spatial-temporal patterns were used to evaluate urban expansion [18]. Data was collected in order to find out the change over stipulated periods of time, designated thematic satellite images of the chosen year's same season and similar time period images were acquired. A full list of all the images used in the study is shown in Table No.1. Post classification contrast variation recognition, the best method which is frequently utilized for the quantitative approach of change detection, this method was used to fulfill the objectives of the study area. Remotely sensed images were refined and cataloged individually, resulted in maps were then equated on a pixel by pixel basis to find out change detection source. So, the image processing methods which were incorporated in this study contain (i) Data collection (ii) Data preparation (iii) supervised categorization of images (iv) performing the analysis (v) and change detections maps preparations. All this process was completed by using (ERDAS) imagine and software (Arc Map).

Table No.1: Satellite Images Data

Sr. No.	Sensors	Spatial Resolution	Satellite Images
1	TM	30 M	May 2000
2	TM	30 M	May 2008
3	TM	30 M	May 2016

3.2 Pattern Recognition

It is the method and art for investigating extensive designs in data that can be easily segregated by cataloging system. So, this purpose was fulfilled by using Geographic Information System (GIS) software.

4. ANALYSIS AND RESULTS

The analysis was performed using land use and land cover images usually it incorporates the explanation of geographical or spatial data in the form of land-sat satellite images, graphs, tables, aerial photographs, earth measurements, and maps. Both quantitative and qualitative techniques were used to analyze the data. The results were plotted and were presented in percentiles, tables, and figures. The analysis was useful for determining and quantifying the driving factors for land-use changes in the study area. By understanding data from various periods of time, the time-based changes on the earth's surface may be estimated. All the maps were classified into five major land-use / land-cover classes by utilizing the re-classification tool in (ARC-Map) and then the area of study was calculated with the help of the raster-calculator option. Graphs were also made for all the land use/land-cover kinds for each year chosen for the study. Land use maps of the study area were acquired for the years 2000, 2008, and 2016 which are shown in Figure No. 2, Figure No. 4, and Figure No.6. The results derived for the year 2000 are shown in Figure No.2 & 3 and in Table No.2 respectively. Spatial analysis of these land-use maps shows that, in 2000, the built-up area covered 2.67% area in Multan, which increased by 5.07%% in 2008, extending to 6.63% by 2016. The dense vegetation land-use class was by area 20.11 % the same land-use class was decreased to 18.35% which further decreased in the year 2016 to 17.91. Sparse vegetation agriculture in the year 2000 was 65.89% which decreased in the year 2008 to 62.56 % but increased by 68.47% in the year 2016. Soil / barren land was 10.59% in the year 2000 which decreased by 5.25% in the year 2008 shown in Figures No.4 & 5 and in Table No.3 which further decreased to 3.85 in the year 2016. The water land-use class was 0.74% in the year 2000 which further decreased to 0.65% but increased to 0.77% in the year 2016 is shown in Figures No.6 & 7 and in Table No.4.The effect of the production of crops in the study area can be associated with land use or land cover change. Cotton production was 193 million bales in the year 2000 which decreased to 189 million bales in the year 2016. Wheat production was 203 million tons in the year 2000 which also decreased in the year 2016 to 184 million tons. Rice production increased from 11 million tons to 12 million tons between2000 to 2016r respectively. Sugarcane production remained 2 million tons equal year 2000 & 2016 but increased in the year 2008 to 3 million tons. The crop production in Multan District has been shown in Figure No.8 and in Table No. 5. The reduction in agricultural production is the result of the conversion of agricultural and barren land to the built-up area due to increasing population and man-made activities.

Previous studies in the same study area suggest that due to land-use changes there is an acute decrease in the agricultural land use class and agricultural production while an increase in the built-up area in Multan District. Human activities are the main drivers of the main land-use changes in the Multan District. In the recent past, urban advancement at the expense of agrarian lands has accelerated exponentially and it is expected to rise happening so. The condition is even very serious in the study area where it is the result of an increase in unplanned built-up area than planned urban expansion. Previous studies revealed that land-use changes in the study area can be credited to numerous indicators like increasing population burden, shifting from one profession to another. Such changes in land use resulted in a decrease in agricultural land, disappearing biodiversity, increased greenhouse gases release, urban heat islands impacts,

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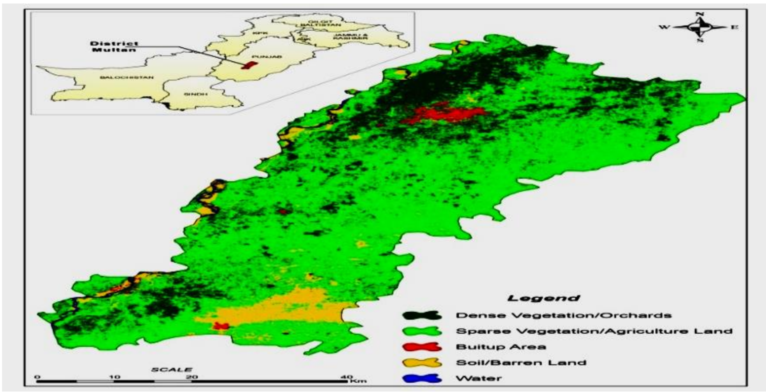

Figure 2. Land Use / Land Cover Change Detection Classified Map for the year 2000

Table No.2: Land covers change detection for the year 2000

Name of land use/land cover class	In percent
Dense Vegetation / Orchards	20.11
Sparse Vegetation / Agriculture	65.89
Built-up Area	2.67
Soil / Barren Land	10.59
Water	0.74

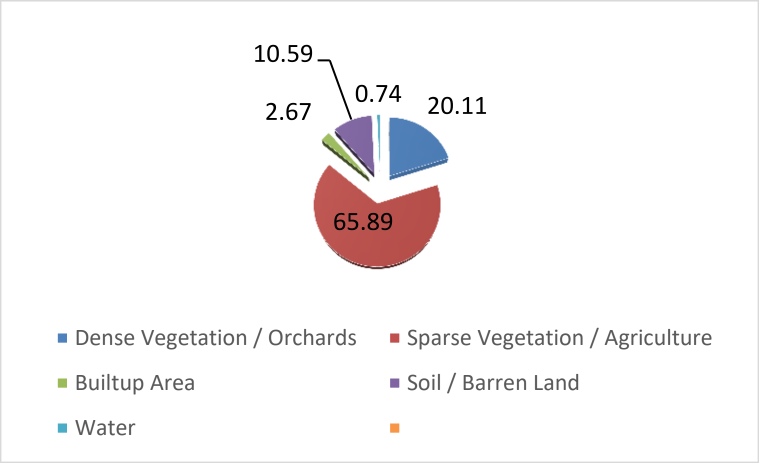

Figure. 3 Land cover change graphs for the year 2000

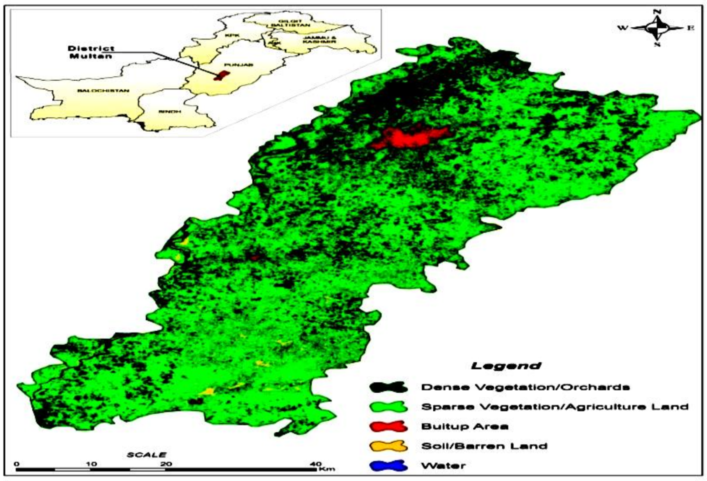

Figure.4 Classified Map 2008: Land cover change detection map.

Table No.3: Land use/land cover change detection for the year 2008

Name of land use/land cover class	In percent
Dense Vegetation / Orchards	18.35
Sparse Vegetation / Agriculture	62.56
Built-up Area	5.07
Soil / Barren Land	5.25
Water	0.65

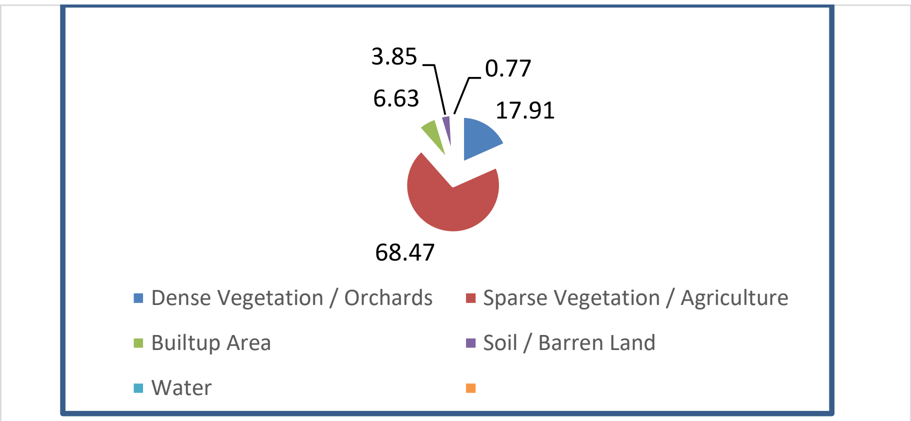

Figure No. 5: Land use/land cover change detection for the year 2008

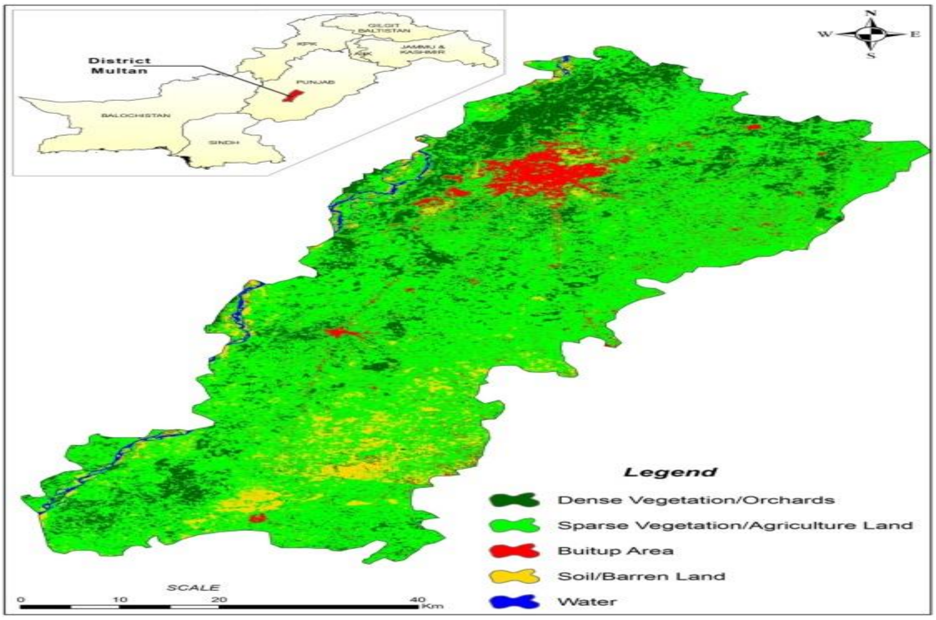

Figure.6: Land cover change detection classified map for the year 2016.

Table No.4. 2016: Land use/land cover change detection for the year 2016.

Name of land use/land cover class	In percent
Dense Vegetation / Orchards	17.91
Sparse Vegetation / Agriculture	68.47
Built-up Area	6.63
Soil / Barren Land	3.85
Water	0.77

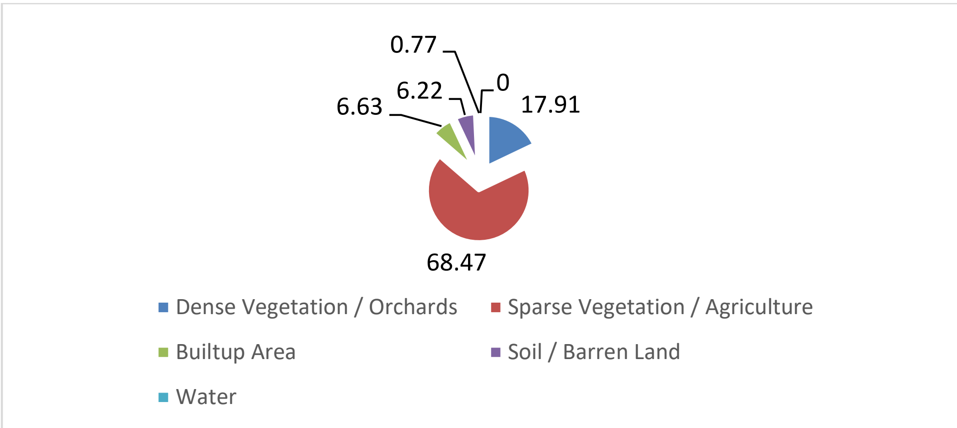

Figure No.7: Land use/land cover change detection for the year 2016.

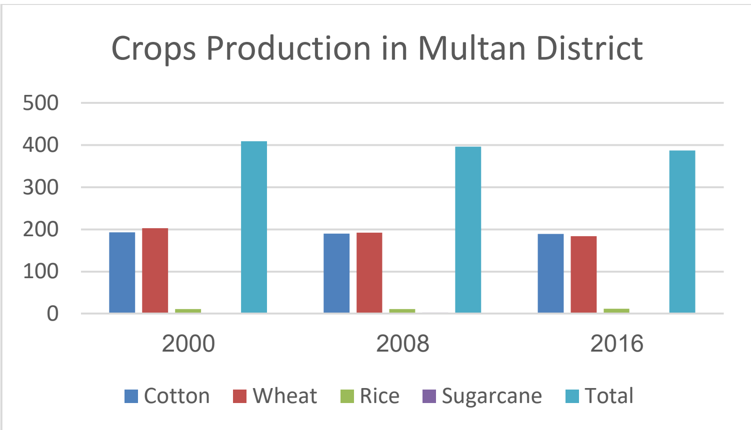

Figure.8 Graph for 2000,2008, 2016 for crop production in the study area.

Table No.5. Crops production in the study area for years 2000,2008, 2016

Crops Production in Multan District (in million tons)			
Crop Type	**(Year) 2000**	**(Year) 2008**	**(Year) 2016**
Cotton	193	190	189
Wheat	203	192	184
Rice	11	11	12
Sugarcane	2	3	2
Total	**409**	**396**	**387**

5. CONCLUSION

The aim of this research was to give an overview of land-use changes and their impact on agricultural production in the Multan district. Five major land use classes dense vegetation, sparse vegetation, built-up area, barren land, and water land use classes were included in the present study. So, the agriculture land-use class had witnessed the maximum change from the year 2000 to 2016 with a significant decrease in its area. Resultantly the built-up area land-use class increased at the expense of agricultural land and the bare land-use class and decrease in agricultural production of cotton, wheat, rice, and sugarcane from the year 2000 to 2016. Therefore, the pattern of land-use change is a cause for a decrease in agricultural production. The present study concluded that the study area has experienced Spatio-temporal changes in land use changes principally with the alteration of agrarian land into built-up land use at the cost of other land use classes. So, if effective actions are taken into consideration for judicious use of land, land-use changes effects can be mitigated and the production of agriculture of the area can be positively enhanced.

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