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ANALYTICAL STUDY OF LAND-USE CHANGE AND EXPANSION OF BUILT-UP AREA IN DISTRICT CHINIOT, PAKISTAN USING MULTI-TEMPORAL LANDSAT DATA

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ABSTRACT

Land is obviously one of the most vital natural resources and sustenance of all kinds of life. The objective of this study was to examine land use change in District Chiniot. Hence, the remotely Sensed (RS) data and Geographical Information System (GIS) procedures applied to analyze the Landsat remotely sensed imageries for the year 2000, 2010 and 2018. For all remotely Sensed data, classification and rectification were completed and Land-use/Land-cover (LU/LC) change maps were generated by adopting different matrix. The outcomes exhibited that built-up area of 97% meanwhile 1990-2015 was extended while there vegetation cover decrease was 27% during the same period. Urban expansion was seen generally towards north and southward direction along Grand Trunk (GT) Road furthermore toward west of the city center. By applying the post classification change detection method the study found that between 2000 to 2018, 5.82% vegetation class is changed into Built-up class and Bare soil likewise demonstrated a positive trend change detection and has also given increase in the value of the Built-up class within 18 years and this kind of significant change is witnessed around city zones but little changes are also come into observation in some other part of Study area. The class that is major influenced in this study area is vegetation cover and deep study about the field gives us that saltiness is increasing and influencing.

KEYWORDS: Land-use/Land-cover, Geographical Information System, Remote Sensing, Grand Trunk

INTRODUCTION

Land is undoubtedly one of the most vital natural resources upon which entirely the development events of life are carried on. In order to understand the global land status; LU is an important parameter, revealing the current as well as the past condition of the earth surface (Dimyati, Mizuno, Kobayashi, & Kitamura, 1996). Land use, generally, refers to human land-use, or instant actions altering or converting the Land use/Land cover. Land-use change is the immediate cause of Land-cover change. (Sherbinin, Kline & Raustiala, 2002). There could be different driving forces to this activity such as scientific, economic, demographic, and several others. Human forces generally in combination with biophysical forces form the landscape's spatial settings (Ales, Martin, Ortega, & Ales, 1992). In chronological scales, Human actions are the main cause in determining Land-use/Land-cover change. This change results from different management practices and built-up controlling political, economic and

social forces (Medley, Okey, Barrett, Lucas, & Renwick, 1995). Although, the landscape is to be dynamic by itself in terms of spatial patterns, structural and functional (Hobbs, 1997). Hence, the Social economic activities developing spatially and temporally affect the land-use greatly (Reid et al., 2000).

Mapping is unique of the utmost vital and essential application of remote sensed data specially when it is really concerned with land usage changes (Chrysoulakis, Abrams, Feidas, & Velianitis, 2004). Satellite data when obtained is in raw form for studying land usage modifications and human environment interactions (Codjoe, 2007). The production of maps of land usage by making use of satellite information, category associated with image is actually a robust way of information (Karteris, 1990). Using the innovation of Remote Sensing and Global information System technologies, the land use and land address modification mapping is quite useful and detailed by choice to raise the selection of areas created to agricultural, metropolitan and industrial aspects of a spot(Selçuk et al., 2003). Nowadays, the Remote sensing technology and Geographical Information System (GIS) are proved the most efficient techniques for analysis of various land use issues and problems (Parveen et al., 2019). It develops understanding of land use development and modeling. It can develop plans for many uses of normal resources and nature preservation by studying the land use development in the past. It manages the recent situation with latest GIS tools and modeling the long term future forecasting. The alteration in built-up land is usually dependent also on the force that is built within the system or on external driving forces (Bisht & Kothyari, 2001).

Many areas all around the world are presently facing quick, widespread changes in land-use (Mas, 1999; *Riaz et al.,* 2017). The earth's shape is constantly changing to some extent by the human activities. Existence of human beings on earth surface and their usage of land affected the natural environment and profound land use changes are also observed (Ayodeji Opeyemi, 2006; Anwar *et al.*, 2012). The data about the land use is of vital importance in order of planning. It also helps in application of land use because the total changes occur on land-use is usually result from some social, economic factors including anthropogenic activities in time and space. Therefore, such planning can fulfill basic human necessities. Such planning can also be useful in determining the changing aspects of land use resulting due to rapid growth of population and then can further assist in solving the issues regarding human necessities and welfare (Zubair, 2006).

The challenge is to make sure an alteration isn't resulted from short changes in the land use (Lambin, Geist, & Lepers, 2003; Lunetta, Knight, Ediriwickrema, Lyon, & Worthy, 2006). The true change occurs when the land is altered into built-up area or any other uses. In fact, land modification is more complex things and it will be classified into three numerous kinds a

systems, that are: 1. Systematic change, that will be reasoned by the interactions between yearly rainfall and temperature on vegetation life; 2. Gradual change, it really is driven by variability within the weather happened annually; and 3. Quick modification, which is due to some disturbances such as for instance floods, fires, deforestation and urbanization (Verbesselt, Hyndman, Newnham, & Culvenor, 2010). In an agricultural land use, land is coupled with a series of covers throughout a year; it could be vegetative, barren or inundated land. Meantime, deforestation throughout the globe remains absolutely on a large scale (Fao & Isric, 2010). A recent report revealed that the forest features have been diminished from 50 to 62 million sq. km in 1700 toward 43 to 53 million sq. km in 1990. This contraction in woodland location is a result of the growth this is certainly rapid land usage for vegetation and ranching. Numerous developing nations are the sufferer for this phenomena due to the growth of farming that could be the major reason behind the alarmingly diminution of forest cover (Goldewijk & Ramankutty, 2009). The fundamental aim of the study is to evaluate the changes took place in land use in Chiniot district over a Time period last eighteen years (2000-2018). Thus, the main objective of the study is to analyze the changing of land use in Chiniot district with the help of satellite imageries during 2000-2018.

MATERIALS AND METHODS

The Study Area

Chiniot is the 36th district of Punjab province of Pakistan. It is given the status of district in 2009 (Raza & Mehmood, 2014). Major part of the district consists upon the rural areas and their basic source of income is agriculture. The people of villages are un-educated and have lack of awareness. Chiniot comprises an agglomeration of several small villages and towns. Villages are commonly "Chak No" while Chiniot city comprises of redundant Municipal Committee (MC) Chiniot. Out of total 44 Union Councils (UC) in the Chiniot district, 8 Urban UC are comprised in Chiniot city. Chiniot city had a population of 251,671 souls in 1998, which increased up to 314,917 in 2017, the last national census of Pakistan and it is being expected that population of Chiniot will become 0.4 million in 2030 (PMSIP, 2009).

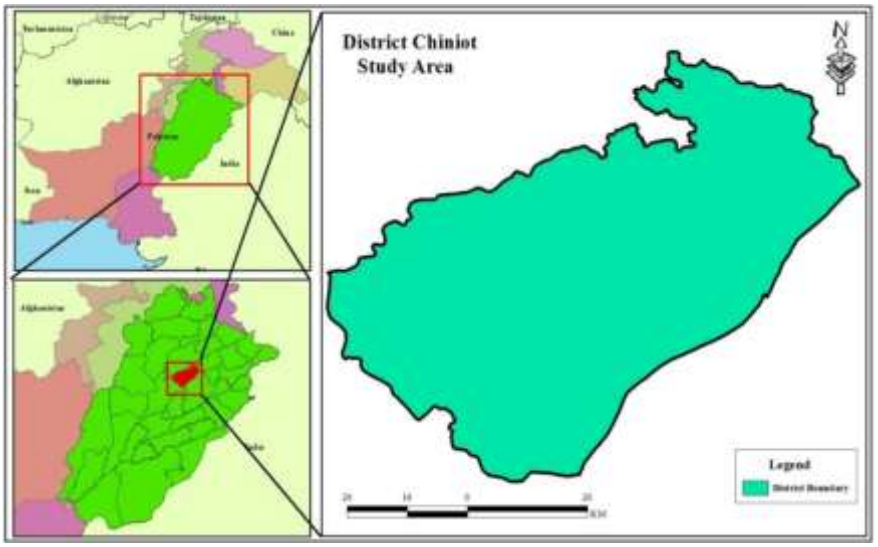

Figure 1: Map of Study Area
Source: Naeem (2018)

Chiniot is situated in the Northwest of river Chenab. It is linked with the main cities of Punjab, like Lahore, Faisalabad, Sargodha and Jhang via roads. It is 160 km away from Lahore to the east, about 30 km from Faisalabad to south-west, about 58 km from Sargodha to the west and 86 km from Jhang to south-west. Chiniot is located at latitude of 31°43' to 31°44' North latitude and 72°58' to 73°0' East longitude on the globe.

Data Acquisition Source

In order to monitor land use (LU) changes at district Chiniot, three remotely sensed imageries were obtained from Landsat data of different years i.e. 2000, 2010 and 2018 with a spatial resolution of 30 meters. These spatial imageries have been obtained from United States Geological Survey (USGS) that is a renowned site of earth observatory.

Table 1: Characteristics of Remotely-Sensed Data

Image No	Year	Satellite	Sensor	Spatial Resolution
1	2000	Landsat 5	TM	30.00m
2	2010	Landsat 5	TM	30.00m
3	2018	Landsat 8	OLI	30.00m

Data Analysis

In order to analyze and monitor the changing land use of Chiniot District, the Erdas Imagine (2014) tool was utilized for pre-processing and enhancement of all Satellite imageries. It was likewise the utilization for the accuracy assessment of each land classified map and for the use of

Normalized Difference Vegetation Index (NDVI. Band Stacking is the process of combing the spectral layers to get a multispectral image; truly it ties up the spectral layer to comprise an image. The method of band stacking is executed utilizing Erdas Image, Band Staking utility. Through Arc map 10.1 Lay outing and Map composition was also performed in this product, while Area figuring was additionally done by it. The Microsoft excel was utilized to bar graph from Statistical data.

Accuracy assessment of LU/LC classification:

The accuracy assessment essentially is a strategy to know precisely the classification was performed. Due to this reason, accuracy assessment tool in Erdas Imagine 2014 was utilized so as to get the accuracy for each land-use map that is ordered. Image Acquisition Date Accuracy Assessment was measured in percentage (%) and that was in 81.24% for 2000, 83.65% for 2010 and 90.89% for 2018.

Image classification procedure

Image classification is an important technique which is effective in all kind of satellite data for the assembling of information for specific purpose. From the analytical approach, the main theme that appears was evolving an effective and suitable classification method for LU change detection. Classification is a method of classifying an image to its constituents. Through Unsupervised or Supervised classification the remotely sensed images can be classified digitally. Supervised classification is more accurate for mapping information, mainly depends on the abilities and expertise of image analyst (Bhatta, 2010; Bhalli *et al*., 2012), whereas the computer perform unsupervised classification automatically. The initial phase during the time spent in administered grouping is to find the agent preparing destinations for each land-spread sort that can be recognized in the picture. The undertaking of supervised classification is performed using the classification utility of Arc Map 10.1 and satellite images are classified into four major land use classes viz. Build up, Vegetation, Bare Soil and Water respectively.

After classification of the remotely sensed images, these were and converted from Raster to polygon, digitized and each preparation site is drawn by polygons and each cover type is joined by exceptional identifier. ArcGIS 10.1 is utilized for changing over raster information into vector information. Each image is made by which is an easy procedure of conversion of raster data into vector form. By the nature of features, characteristics defined as built-up land, vegetation cover, river and soil type etc. and digitized as polygon. Finally land use Agriculture, Bare Soil and Water area calculated the yield document was in type of picture record having topical raster layer. In this record the information about class name, table, esteems, insights moreover histogram was naturally noted. RS and

GIS technologies were utilized to identify the mapping, morphological change, demonstration, examination furthermore display of spatial transient information. Information was brake down through ArcMap10.1 to figure out the land-use classes (Sun, Forsythe, & Waters, 2007). Charts were additionally arranged to demonstrate the wide range of changing land use in every year.

Change detection

The reason for change identification was to realize that which land use has changed and expanded or decreased over time. Change detection given a reasonable standard about the sum at which region is changing regarding land-use/land-cover. Structure the arrangement maps of Chiniot, it has been exposed that Chiniot has experienced a change as far as land use amid the most recent 18 years. To recognize the change in various land-use maps of a solitary class are looked at by overlaying maps of a particular class of 2 unique years. The obtained outcomes have shown an adjustment in term of land-use amid these regions. Developed areas witnesses a positive trends for every one the years. Vegetation shows a positive pattern and first year interim, in any case, it demonstrates a negative pattern for one year from now. Exposed soil initially demonstrates a negative pattern however pursues a positive pattern for some other time. Water, insignificantly pursues a positive, negative and afterward positive pattern.

RESULTS AND DISCUSSION

Land Use Classification in 2000

In 2000, the significant area of Chiniot was under vegetation activities which is about 64.69% out of total area (Table 2). This is generally on the grounds that Chiniot has a rich fertile land cover reasonable for the yield of cotton and wheat. The 2nd real zone is involved by the developed built-up land which has a share of 13.64%. In the year 2000 Chiniot appeared to have less developed area possesses just 354.82 sq. km. bare soil constituted about 21.23% land area of the district. The rise of Cotton Leaf Curl Virus (CLCuV) amid 90s represented a danger on cotton crop which consequently brought about the type of less development of cotton which is exceedingly developed yield in Chiniot. Along these lines numerous patches of land which had been developed before left empty because of the danger of CLCuV. Water bodies have a tiny share of 0.44% out of the total land area of 2,602.39 sq.km as it contains a stream Chenab and channel frameworks which are generally utilized for water system reason (Fig.4). As indicated by information gathered from Tehsil Municipal Administration (TMA) of Chiniot, showing the major classes of land-use in the year of 2000 (Fig.3).

Table 2: Land Use Classification of Chiniot in 2000, 2010 and 2018

Land Use Categories	2000		2010		2018	
	Area (sq.km)	**Area (%)**	**Area (sq.km)**	**Area (%)**	**Area (sq.km)**	**Area (%)**
Agriculture Land	1,683.71	64.69	1,618.4	62.19	1,532.15	58.87
Built-up Land	354.82	13.64	382.12	14.69	456.7	17.55
Bare Soil	552.5	21.23	588.36	22.6	599.43	23.04
Water Bodies	11.36	0.44	13.51	0.52	14.11	0.54
Total	**2,602.39**	**100**	**2,602.39**	**100**	**2,602.39**	**100**

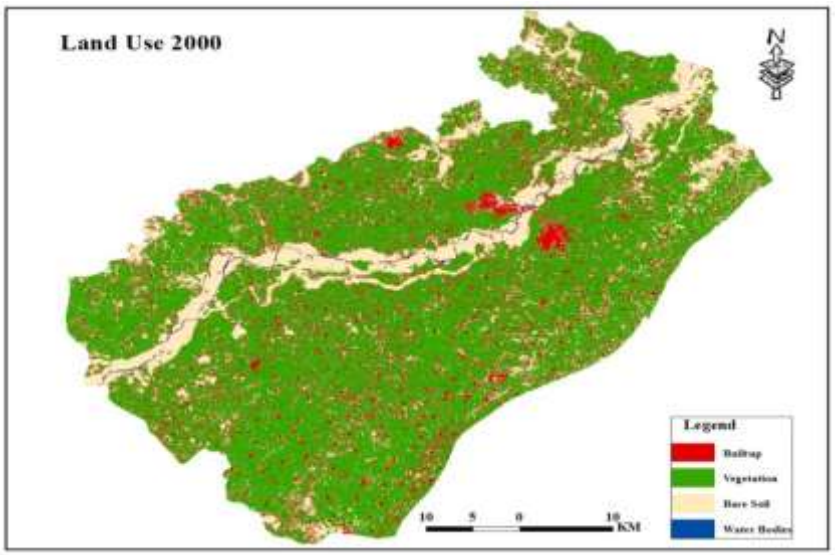

Figure 3: Land-Use classification of Chiniot in the year 2000
Source: Naeem (2018)

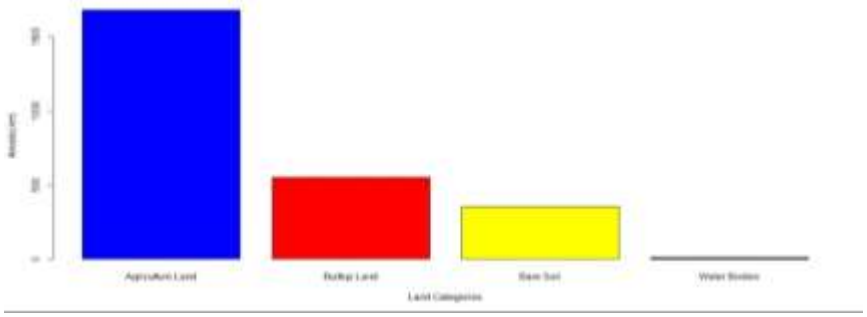

Figure 4: Land-Use classification for the year 2000

Land-Use Classification in 2010

In 2010, the vegetation area demonstrates a decline by 2.5% from mostly to last three years and makes a pile of 62.19% through and through the land use class. This reduction was expected to overcome of the CLCuV which urged the farmer to grow cotton crop once more. The developed built-up land has expanded by 1.04% till 2010 from 354.82 square kilometers to 382.12 square kilometers. A little development of settlements was observed as four new housing schemes were originated during 2000 to 2010 named as Maki Town, Gulshan Town, Satellite Town, and Model Town, (Fig.5).

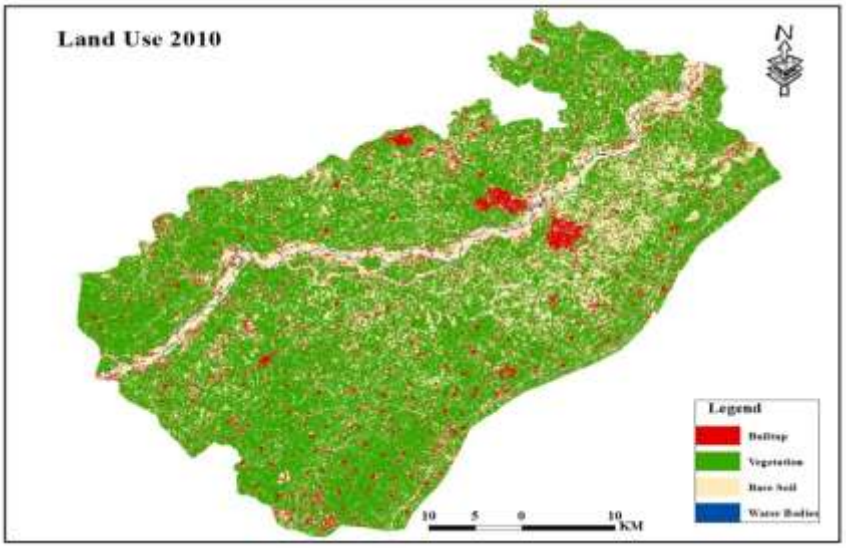

Figure 5: Land-Use classification for the year 2010
Source: Naeem (2018)

The Bare Soil has decreased its share from 22.6%-21.23% as a bare soil cover harvests once more. Additionally, the construction of the housing schemes has likewise secured some segment of bare soil. Water Bodies demonstrate a minor increment by 0.08% just going up from 0.44% in 2000 to 0.52% in 2010. This minor increment can be because of blustery season (Fig.6).

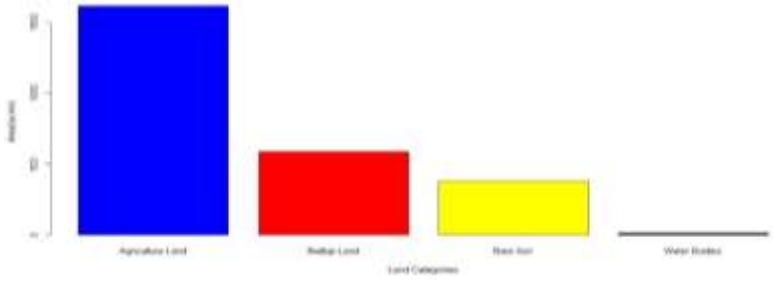

Figure 6: Land-Use classification for the year 2010

Land Use Classification in 2018

During 2018, vegetation area still occupies the major share of land but it has fallen by 3.31% in its stack, making it 58.87% in 2018 from 62.19% in 2010,

the main reason behind such a considerable decrease in vegetation land use was the re-emergence of CLCuV at the end of 2010 (Fig.7). The main reason is the increase in built-up area which also contributed in the reduction of vegetation land use.

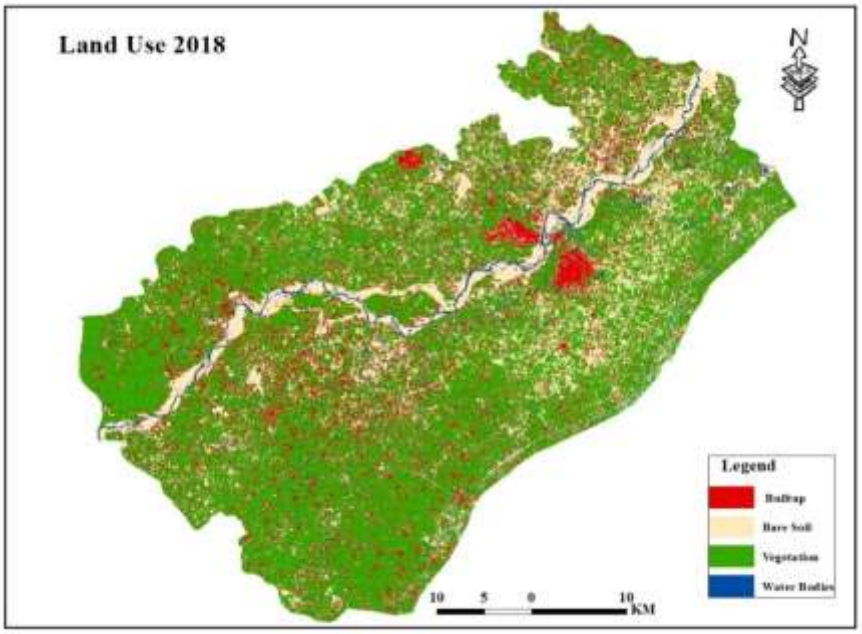

Figure 7: Land Use classification of Chiniot in the year 2018
Source: Naeem (2018)

During 2018, the city has started its voyage towards the outward expansion which outcome the form of growth of built-up area. The class of built-up is displayed a growth of 2.86% as it rises from 13.64% in 2010 to 14.69% in 2018. There are many new housing colonies were established during this time period.

Bare-soil increases its share again by 0.42% and occupies 23.04% area of all the land-use classes. This increase is generally because of reduction in vegetation land use due to the threat of CLCuV. Many vegetation patches left uncultivated which consequently increased the share of bare soil. Water still holds the least share among all the classes. However, it has slightly dropped by 0.02% going down from 0.54% to 0.52% which is quite a negligible amount. This minor change could be due to less rain (Fig.8).

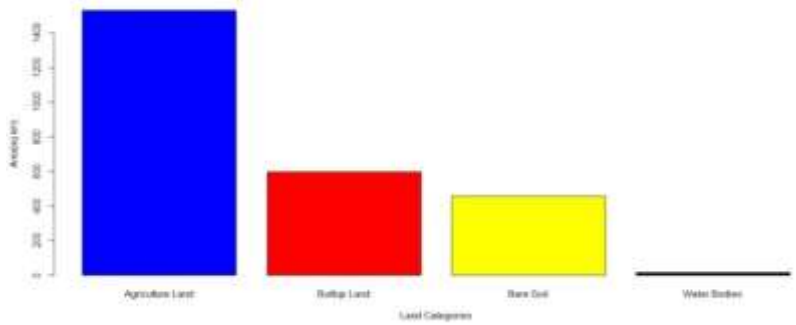

Figure 8: Land Use classification for the year 2018

CONCLUSION

Present investigation has endeavored to discover land use changes in Chiniot happened during 2000 to 2018 by using Landsat satellite remote sensing imageries and ground observation. To minimize the certain remote sensing data pitfalls, the ground truth overview was held in study area and helpful data was classified. The study area is generally comprised on towns and majority of the houses in towns are covered of mud soil, so satellite imageries accepting it as bare soil however it is the piece of developed zone. Same issues were come into perception in uncovered soil and water body class. It influences genuine percentage of each class. A blend of supervised and post supervised classification methods were utilized to make distinctive change identification maps of the study area. Subtracting the zone of 2000 from the territory of 2010, change consequence of vegetation class can be identified unmistakably in change detection maps. All the three change detection maps were taken by same system of developing two unique maps and it produces change detection maps of required class. Ground truth overview was performed to check these changes in study area. Barren land class is the second greatest class of the study area and it demonstrated an expanding pattern with 1.80% new increment in most recent 20 years. This expansion in barren land class is because of decrease in vegetation class. The major affected class is vegetation in this study zone and ground truth overview gives an essential reason of this change which is expanding saltiness issues in practically all skillet of study region. A few regions are exceptionally influenced by saltiness and water logging and consequences for the dirt are expanding as barren land. The water body class demonstrated a negative pattern in change detection maps and Almost 0.10% region is presently changed into bare soil class or built-up class (The conclusion section needs to re-consideration with focus on briefly stated the RS imageries analysis and description of major land use classification variations).

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