Change Detection in Land Use and Land Cover in the Ganga Valley Using Remote Sensing and GIS: A Case Study Area

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Abstract; During 1990-2020 in the Ganga river basin has been recognized as one of the most important drivers of environmental degradation, urbanisation in Land use and land cover pattern. The advanced ecosystem management and other natural resources have provided effective tools in Remote Sensing and Geographic Information systems. The maximum prominent deviations consist of losses in paddy field crops, miscellaneous crops, shrubs and healthy nature, and growths in built-up lands, rubber field areas, dense miscellaneous healthy forests, and the water bodies. The advanced floraand fauna have been finding out land use and land cover change in case of spread and health of the world's forest, parkland, and agricultural resources. The river valley has been considered by the topographical maps, LANDSAT satellite imagery included with the GIS techniques. The upper catchment of the Ganga river in the northern part has some Reserve forest, Sanctuary and deforestation activities. The built-up lands in human habitation have been developed for non-agricultural like building, road, transport, trade, communication, and services also in vacant lands of water bodies and vegetated lands. The composite band of the satellite imagery has been primarily used for the production of food, fibre, and other commercial and horticultural crops. Erosional soil, hardy rock, dunes, and dynamic depositional structures are involved in this area. Both natural and man-made water features in categories have been included rivers, streams, lakes, tanks, and reservoirs. Land conservation and water resources, then, the ecosystem management of the Ganga Basin has been formed as an important aspect of the study region.

Keywords: Remote sensing, GIS, Ganga flood plain features, Land use/Land cover, geomorphic features. Change detection, Satellite images, Landsat-8, Toposheet, course changes.

1. INTRODUCTION

Land use term in various human activities denotes the exploitation of property and resources while land that covers the earth's surface is the physical cover in the stream, flora and fauna, jungle, cultivated area and built-up area (Di Gregorio and Jansen 2005).[1]The speedy development due to ecological changes is renowned as one of the most important factors in land use and land cover (LULC).[2]The LULC maps with six major categories viz., Compact forest, exposed forest, agriculture land, metropolitan area, canal and stream, sand of the study region were generated througha supervised classification approach. The land use and land cover (LULC) information is a fundamental requirement for planning the application of the social resources and reasonable resources and also the inventory of other resources. So, it is expected to have collective implications in the sustainable and effective organization of ordinary resources and the atmosphere (Sheeja et al. 2011).[3]The extent of deforestation, change in LULC, expansion of agriculture area, population pressure, forest clearance for agriculture practices have been studied using remote-sensing coupled with field survey and the emphasis is given on the indicators of changes that have been derived using temporal analysis. The LULC changes in microclimate have been well-defined as the most important anthropogenic disturbance to the environment at the local level and causes (Meyer and Turner 1992; Roberts et al. 1998).[4] The LULC change during the twentieth century has been developed as a global phenomenon (Ramankutty et al. 2002).[5]As human and natural forces modify the landscape, resource agencies find it increasingly important to monitor and assess these alternations. In case of, variations in plants quality.

The speedy development due to the urbanisation, industrialisation, and rapidly changes agricultural activities in Land use and land cover pattern, where the most significant has been setting in the Ganga river basin. Indian peninsular over periods (1990 – 2020), land use and land cover has been changing over a period (1990 - 2020).[6] The maximum prominent deviations consist of losses in paddy field crops, miscellaneous crops, shrubs and healthy nature, and growthsin built-up lands, rubber field areas, dense miscellaneous healthy forests, and the water bodies. Supplementary, the bank caving and cut-offs at channel bends have been reached a menacing proportion leading to a large scale utilization of flood plain mud and river sand. The

Ganga river basin, it is consisting of land and water resources in nature conservation, a significant feature of ecosystem management.

Remote Sensing and Geographic Information systems have been providing effective outfits for progressive ecosystem organization and other natural resources. Wilkie and Finn, 1996 analysis of the Earth – system function, designing, pattern, regional and global data. Wilkie and Finn, 1996 has providedthe link between regional environmental data and rural, organization and internationalconservation and supervision of natural diversity.[7]The study region has been managed to present strategies for ecological resources and observing naturalchanges. Boffa, J. M. (1999) has consist of losses in paddy field crops, miscellaneous crops, shrubs and healthy nature, and growths in built-up lands, rubber field areas, dense miscellaneous healthy forests, and the water bodies. The advanced flora and fauna have been finding out land use and land cover change in case of spread and health of the world's forest, parkland, and agricultural resources.The advanced vegetation of mapping has been finding out digital data on land use land cover have been developed as significant.[8]

Remote sensing and geographic information system (GIS) have been endeavoured to explain the helpfulness of these technologies for studying LULC changes (Dhinwa et al. 1992; Ghosh et al. 1996; Kilic 2006; Raju and Kumar 2006).[9]For observing, exploring, and computing the LULC changes efficiently, large data has been considered needed. Remote sensing technologies have been providedwith the lead of rapid data acquisition to assemble LULC information often less than traditional ground survey methods. Then, an informed LULC data in remote sensing technologies have been provided to abstract and examine the past and present developments of LULC modification as well as to stimulate future trends efficiently.[10]Thus, LULC change in the spatially explicit model has been required to simulate the purpose to evaluate future LULC scenarios.

The mapping of computer applications is developed especially emerging trends of computer technologies and to use satellite information for fieldwork. The study region also engaged the same concept of the Ganga river valley which exploration of the study region in current land-use changes and that take place in land use and land cover pattern. The study region approaches were recycledto LULC changes and urban growth in the Mirzapur district of Uttar

Pradesh, India, which has experienced rapid population growth and urban sprawl over the last decades. The performance of this study area has been unmeasured previously. The recent study is to analyse and simulate LULC changes in the Mirzapur district of Uttar Pradesh from 1990 to 2020. The results of the LULC classes will change significantly. Specifically, this study of the LULC change has been concentrated on calculating the dynamics and responsible for the spatial and temporal trends. The analytical study in sustainable development can be used significantly.[11]

2. THE STUDY REGION

BhadohiandMirzapurdistricthasbeenchosenasthe studyareaasawholeregardingsitestudyfromRampurGhattoChunarGhat.thedistrictcomprisesabouts omething 55 km and is located within latitudes of 25^0 1' N to25^0 07'Nand longitudes of $82^0$25'E to $82^0$52' E. thisareais situated keepingfromRampur Ghatto ChunarGhat. The physical backgrounds of the study area are shown in (Fig. 1). The reason behind the selection of the study area is that it is an untouched area and till there is no work of that kind is carried out. The Ganga river flows from west to east (source to mouth), all stream and their canal of the basin take their sources over the Kaimur plateau and from the southern sides of the Vindhya range. The region having slopes gradually northward from the Kaimur range to the Rewa Scarps and plain countries.

Geologically the specially Mirzapur district is comprised of two major geological formations, Upper Vindhyan groups and Lower Vindhyan groups but in the Ganga river basin, only Upper Vindhyan groups have been covering the major portion of the study regions and the Achaeans involve granites and gneisses also recent alluvium. The study region has been conducted in the Ganga river basin of Peninsular India. The drainage system of the Ganga river basin exhibits a dendritic drainage pattern. The Ganga river in different types of lithologies and land surface has flowed through undulating terrain. The crystalline rocks are underlain in the upstream part, the middle reaches by alluvial and the downstream portions by the alluvium plain. Alluvial soil has been coveredin the major parts of the basin, while silt – alluvial has been covered by the large area in the northern part of the Ganga river basin. The land use pattern of the regions has been linked to the rapidly shifting drainage basin.

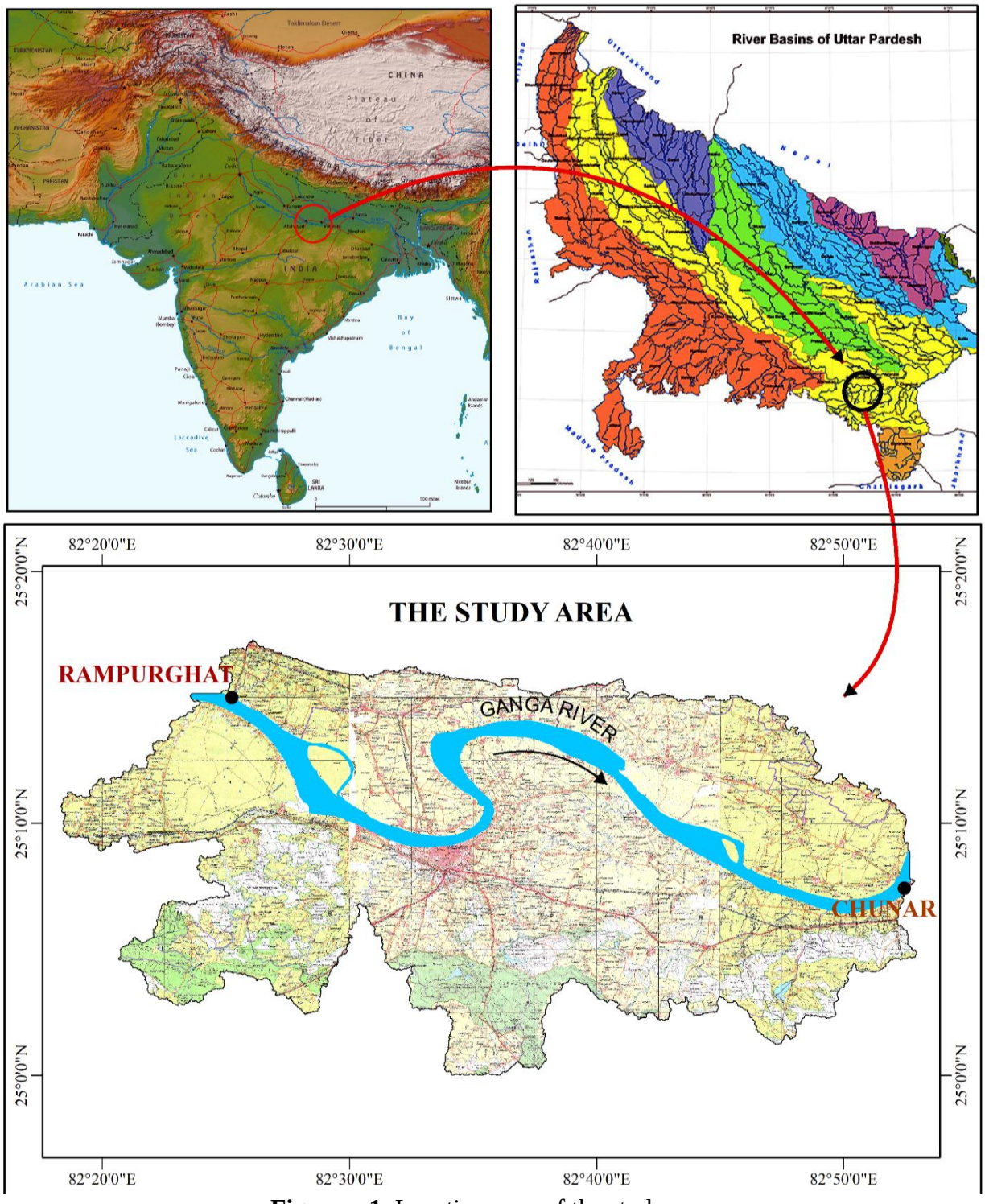


Figure – 1. Location map of the study area.

The river valley has been considered by the topographical maps, LANDSAT satellite imagery included with the GIS techniques. The areal parameter has shownthe extended shape of the Ganga valley and moderates to a steeper ground slope. This study can be applied for changing the river course in the river morphology, as well as disaster prevention from a similar type of Ganga basins.[12] The alluvial river has changed in the channel such as bank erosion, down cutting, and bank accretion isthe natural process for an alluvial river. The natural geomorphic have changed such as sand mining, infrastructure construction on the riverbanks, artificial/ natural cut-offs, bank revetment, reservoir construction and land use alterations in the regional development of the dynamics river.[13]

The study area has covered an area of 1154sq.km and is one of the Southernmostof the U.P and is characterized by Hard rocks particularly Vindhyan sediments alluvialformations consisting of Marginal alluvium and Quaternary alluvium. The study region has been divided into 04 tehsils namely Chunar, Marihan, Lalganj &Mirzapur Sadar and is further divided into 12 development blocks.[14]The upper catchment of the Ganga river in the northern part has some Reserve forest, Sanctuary and deforestation activities. the study area is reported leading to incidences of landslides. Land conservation and water resources, then,the ecosystem management of the Ganga Basin has been formed as an important aspect of the study region.

3.0 OBJECTIVES

1) To make a land use land cover changingmethod.
2) To define the movement, landscape, degree, site and extent of land use land cover change.
3) To make data on land use rate and land coverfactor since more highlighting on built-up land.
4) To calculate the socio-economic suggestions of predictablevariation.

3. DATABASE & RESEARCH METHODOLOGY

The boundary of the Ganga river has been outlined using Survey of India (SOI) topographical maps - No.63K/7, 63K/8, 63K/11, 63K/12, and 63K/16 at 1: 50,000 scale have been used. All the topographical maps and satellite images were mosaiced and georeferenced with the help of ArcGIS version 10.7. After georeferencing of the toposheets, they are rectified and resampled into a Universal Transverse Mercator (UTM) projection WGS 1984, Zone 44 North.

3.1. Image Acquisition

The study area in satellite imagery has been acquired during January with minimum cloud cover.

Table 1: Details of the image used in the study area.

Image	Path/Row	Acquisition Date	Spatial Resolution
Landsat 4-5	142/43	10/01/1990	30 meter
Landsat 08	142/43	13/01/2020	30 meter

3.2. Image Classification and Change Detection

Image classification (1990 & 2020) was implemented through supervised classification with maximum likelihood methods,which includes succeeding steps:

1) Selection of signature files (training sample sites) by the digitisation of the selection area on the image. The selection of signatures has been based on the knowledge and present literature and map.
2) On the basis signatures in the study area act as an input for digital image classification into four classes.
3) Based on results, the signature training samples were advanced awaiting a satisfactory result was achieved.
4) Classified images have been detailed to respective classes (i.e. Water Body, Built-up area, Barren Land, Vegetation, Sand Bar).

3.3. Image Pre-processing

1) Layer composite bands were performed on the GIS 10.7 software.
2) Compositing the image layer were mosaicked and then clipped with study area shapefile.
3) Classification image was done to correct using maximum likelihood methods to make LULC maps of 1990 and 2020.
4) Projection: The image downloaded in Universal Transverse Mercator (UTM) is reprojected to Geographical WGS 84, spheroid and datum Everest.
5) The boundary of the Ganga river has been outlined using Survey of India (SOI) topographical maps - No.63K/7, 63K/8,63K/11, 63K/12, and 63K/16 at 1: 50,000 scale have been used.

In this study, the several LULC modules in the Landsat series satellite was utilized digital remote sensing information and map. The images of Landsat series satellites areamong the extensively used satellite remote sensing data,and their spectral, spatial, and temporal resolutions made theirvaluable input for mapping and planning purposes (Sadidy etal. 2009)[15]. Remote sensing satellite data of Landsat 4-5 TM C2 L1 image acquired on 10 January 1990 and Landsat 4-5 Thematic Mapper (TM) image acquired on13 January 2020 were collected from the official website of US Geological Survey (USGS)(http://glovis.usgs.gov). In the study, the satellite data in detail have been used characterized. The other data sets used inthis study are the digital elevation model (DEM) and highway grids.

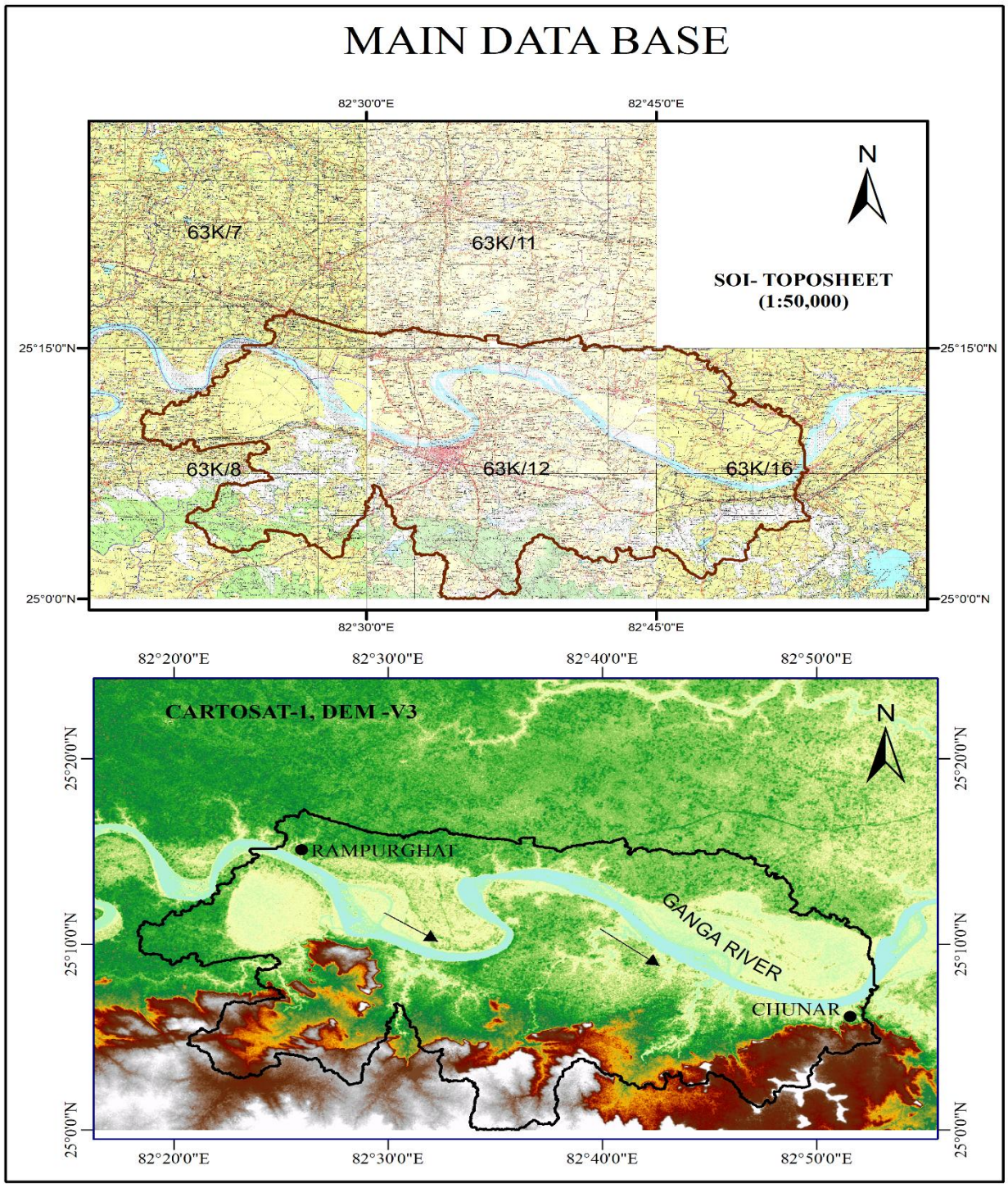


Figure -2. Topographical sheets and satellite data (imageries) of Ganga Valley (A) SOI topographical maps (63K/7, 63K/8, 63K/11, 63K/12, 63K/16) CARTOSAT-1, DEM V3.

4. RESULT &DISCUSSION

The study region is carried out to all analyses of the results. The objective of the result is presented enlighten of maps, charts and statistical tables and include the fixed, change and expected land use the land cover of each class. LULC classes in five major categories were delineated using Landsat satellite imagery data and field analysis viz., Vegetation, Barren Land, Built-up area, Water Body and Sand Bar. (fig. 3)In the year 1900, vegetation was covered accounted for about 29% (336.37 km²) that has been increased to 59% (675.99 km²) in 2020 respectively in the entire study area of 1154.36 km². therefore, the Built-up area has been covered accounted for 28% (325.01 km^2) and that has been increased to 4% (48.64 km^2). Again the Barren Land has been covered for 38% (435.95 km^2) and that has been decreased to 28% (320.17 km^2) and so on water body has been covered for 2% (27.74 km^2) and that has been increased 3% (33.50 km^2). (Table -2 and -3).

4.1. LAND USE AND LAND COVER DISTRIBUTION MAP & TABLE.

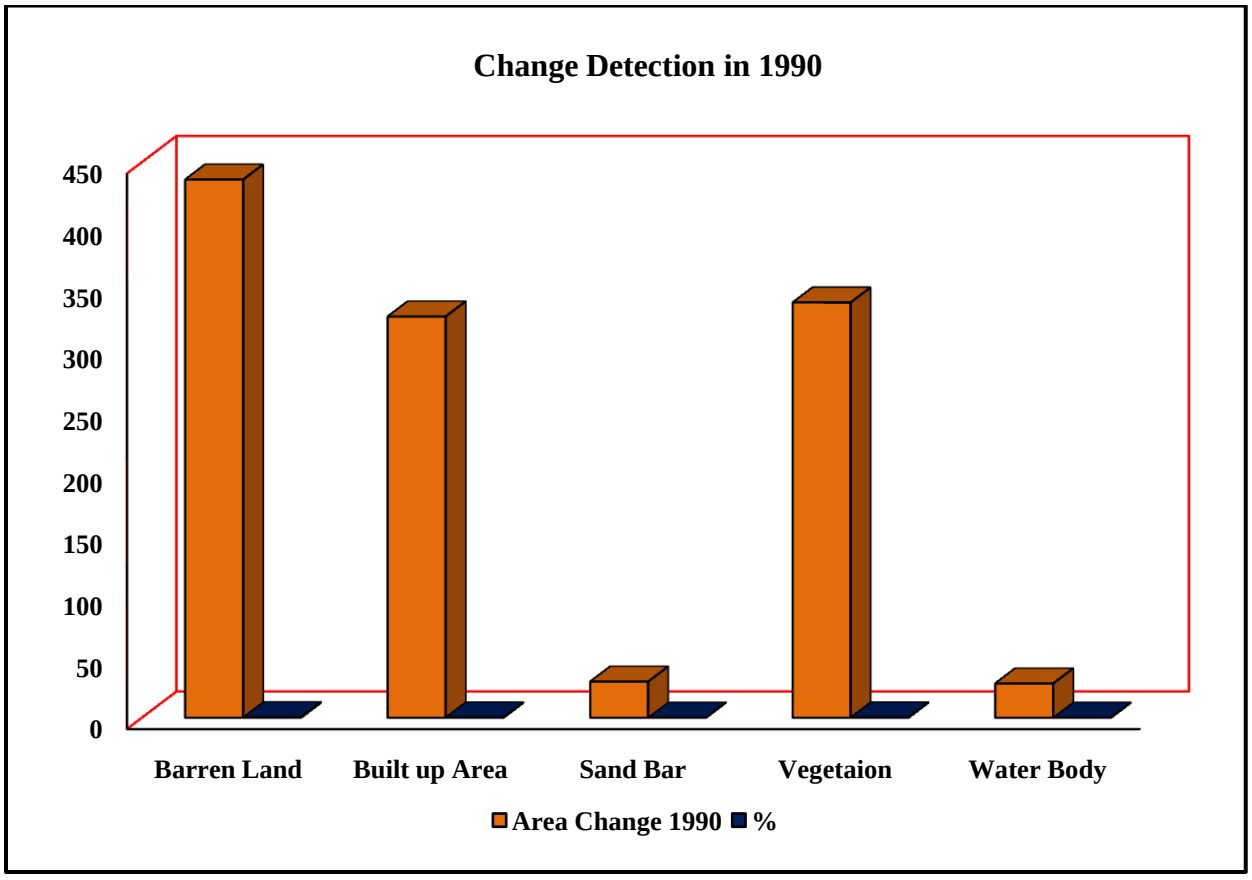
The LULC has been periods in the two periods 1990 and 2020 in the NRB are been existing in Table 2, and Table 3. A brief description of the major LULC has been covered classes by given below between the two periods. LULC distribution of NRB has been defined using the SOI toposheets and satellite images. Table no. 2 categories delineated include Barren Land, Built-up land, Vegetation, Water Body, and Sand Bar. Further, classification to Table no. 3.

4.2. BUILT-UP AREA

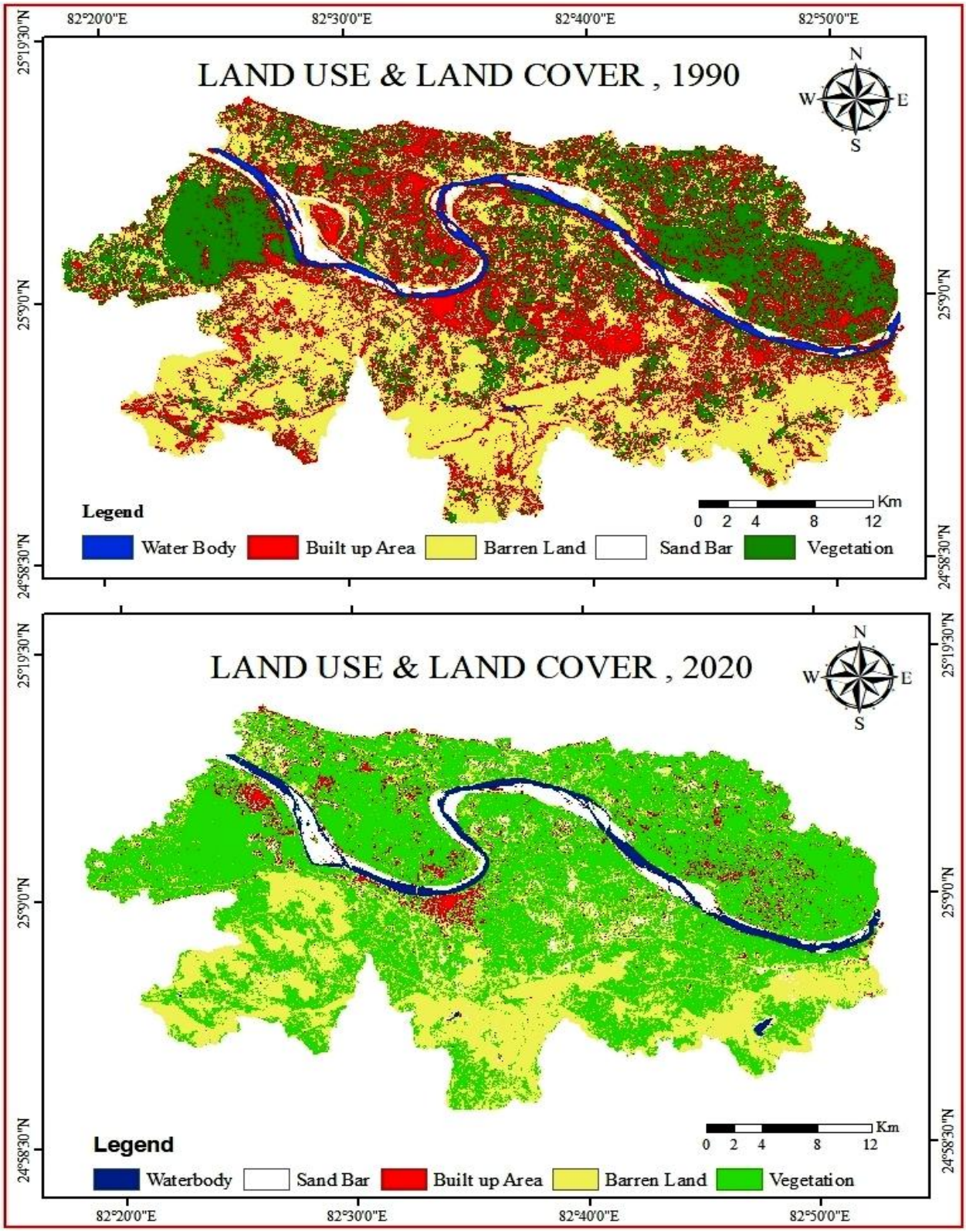
The built-up lands in human habitation have been developed for non-agricultural like building, road, transport, trade, communication, and services also in vacant lands of water bodies and vegetated lands. The composite band of the Satellite images can be recognized with dark red or reddish tones and their representative coarse and spotted texture. The study area has scattered the basin excluding the northern region, the maximum concentration of the Ganga river basin. The study region in table -2 is also rapid growth in built-up lands during 1990. Public transportation has not been exposed to agricultural land and fertile land. The conversion of wastelands has been remarkable development such as roads, National highways and Railways.[16]

Table 2. Land Use and Land Cover distribution of the study area in 1990.

Change	Area Change 1990 (km^2)	Change in %
Barren Land	435.95	38%
Built-up Area	325.01	28%
Sand Bar	29.26	3%
Vegetation	336.37	29%
Water Body	27.74	2%
Grand Total	**1154.36**	**100%**



Figure; 3 Land use and land cover in change detection (%) in 1990.



Figure; 4. Classified Change Detection in LULC maps of the study area during 1990 and 2020.

4.3. VEGETATION

The composite band of the satellite imagery has been primarily used for the production of food, fibre, and furthereconomical and gardening crops. The type of agricultural land in table no. 3 has identified various cultivated parks. Table no. 3 of the study region has been generallycategorized by agricultural lands and healthy forest to famous contrasts changing from bright yellow to green in the satellite images. The vegetation land in 1990 has been covered an area of 336.37 km^2 and agricultural land is consisting of 29% areain which involved wheat crops, paddy crops, potato vegetation and other vegetation crops has crops covers of miscellaneous selections including coconut, mango, jack, and other trees. Further, the agriculture area has been enlarged to 675.99 km^2 in 2020. It has been acknowledgedby changing green colour and yellowish colour, fabulous pattern and size of the cultivated land and vegetation crops, reference with the waterbodies, etc.

4.4. BARREN LAND

Barren land does not presentit or only holds the limited capacity to support vegetation and is referred to the desert soil. Erosional soil, hardy rock, dunes, and dynamic depositional structures are involved in this area. The chemical and physical properties of the soil may result in imposed in this location environment. In the study region, all the above categories could be easily recognizable on satellite imagery. The barren land in all categories of the study region was 435.95 km^2 in 1990 and then has been reduced to 320.17 km^2 in 2020. The main scrub and thorny bushes are exposed to degradation or erosional and acknowledged from their yellow colour and their proposition with altitudes and their unevencontours.

The barren lands are rocky contacts of changing lithology, often rocky surface and unfertile of soil area and vegetation. The uplands and plains have been occurred among highland forests as starts or dispersed as lonely introductions or movable fragments of boulders or ashard rocks. On the imagery, the barren lands have been appearing in brownish tones and rough shape. Significantly, apart from 38% of the total area in 1990 and 28% of the total area in 2020 has been decreasing in barren lands. The extensive growth of barren land has been showing in the built-up land.

Table no. 3. Land Use and Land Cover distribution of the study area in 2020.

Change	Area Change 2020 (km^2)	Change in %
Barren Land	320.17	28%
Built-up Area	48.64	4%
Sand Bar	76.04	7%
Vegetation	675.99	59%
Water Body	33.50	3%
Grand Total	**1154.36**	**100%**

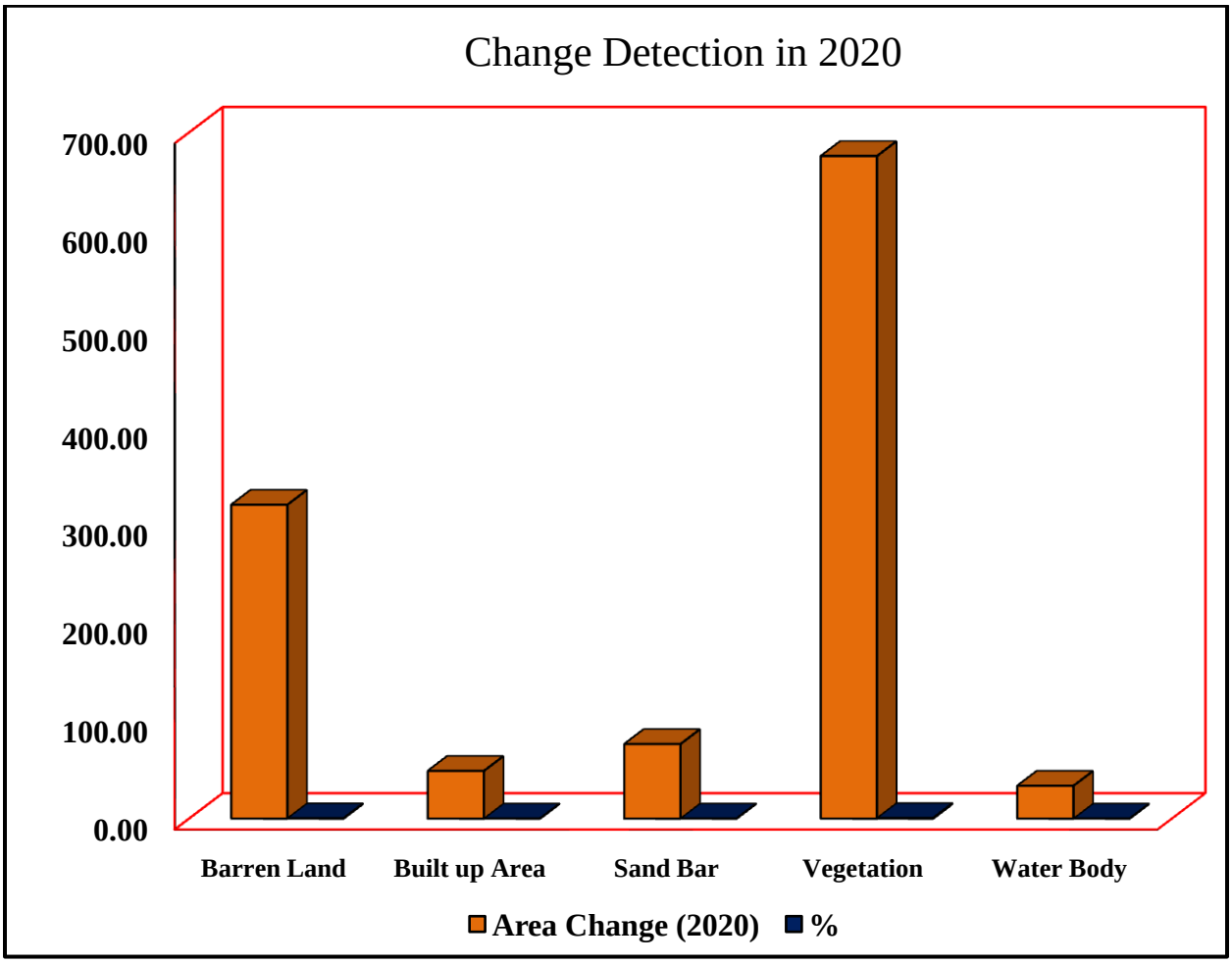
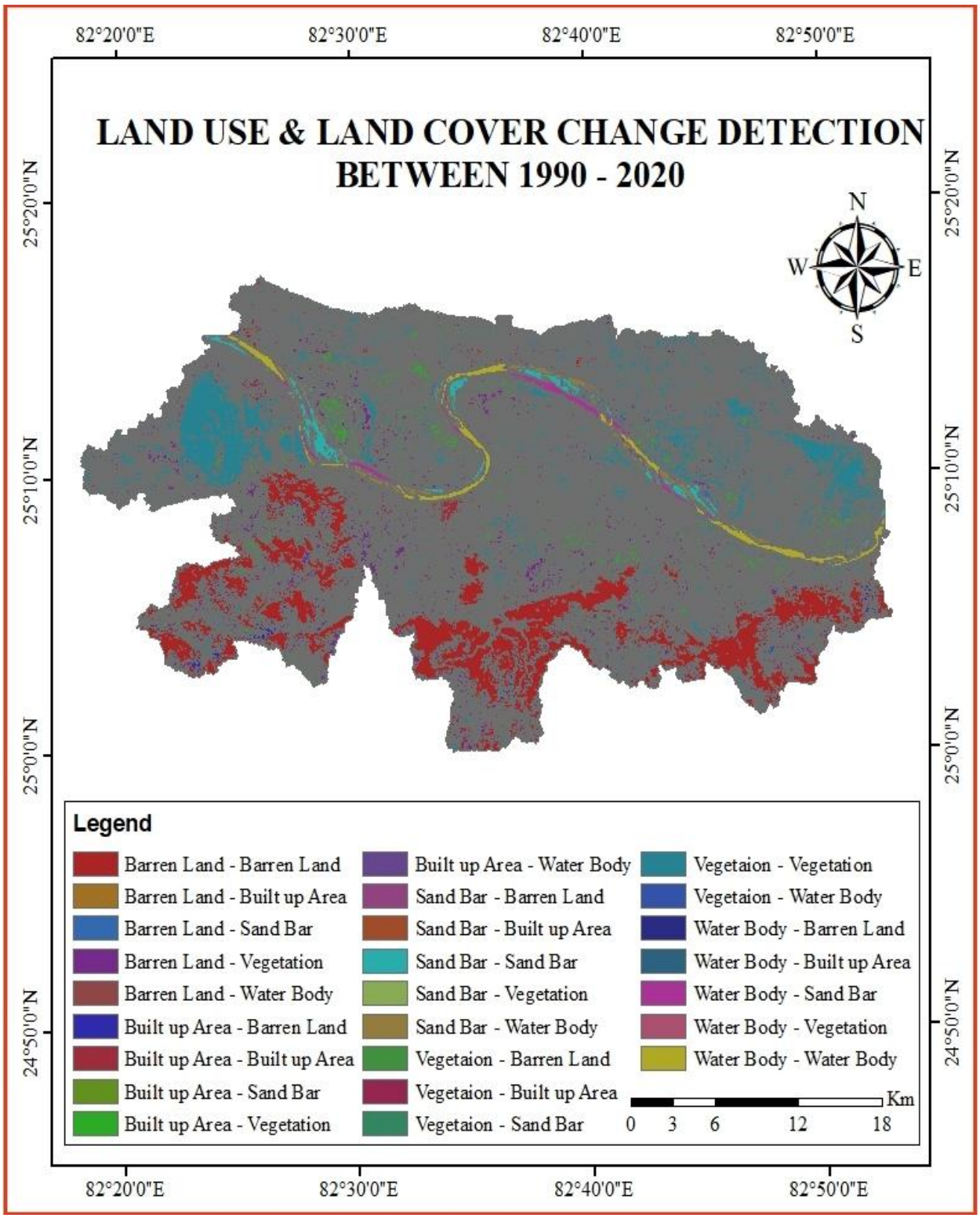


Figure: 5 Land use and land cover in change detection (%) during 2020.



Figure; 6. Combined Change Detection in LULC map of the study area in 1990 & 2020.

Change (1990 - 2020)	Area Change (km^2)	Change in %
Barren Land - Barren Land	229.31	20%
Barren Land - Built-up Area	8.48	1%
Barren Land - Sand Bar	20.94	2%
Barren Land - Vegetation	175.15	15%
Barren Land - Water Body	1.84	0%
Built-up Area - Barren Land	61.09	5%
Built-up Area - Built up Area	21.58	2%
Built-up Area - Sand Bar	19.01	2%
Built up Area - Vegetation	218.08	19%
Built-up Area - Water Body	5.06	0%
Sand Bar - Barren Land	0.60	0%
Sand Bar - Built up Area	1.00	0%
Sand Bar - Sand Bar	17.21	1%
Sand Bar - Vegetation	1.09	0%
Sand Bar - Water Body	9.35	1%
Vegetation - Barren Land	28.83	2%
Vegetation - Built up Area	17.16	1%
Vegetation - Sand Bar	9.42	1%
Vegetation - Vegetation	280.39	24%
Vegetation - Water Body	0.45	0%
Water Body - Barren Land	0.17	0%
Water Body - Built up Area	0.37	0%
Water Body - Sand Bar	9.43	1%
Water Body - Vegetation	0.96	0%
Water Body - Water Body	16.81	1%
Grand Total	**1153.79**	**100%**

Table no.4. Comparative LULC change of the study area during 1990 – 2020.

4.5. WATER BODIES

Both physical and man-made water features in categories have been included rivers, streams, lakes, lakes and basins. The stream has appeared in bluish natures in the digital imagery. The study region of the Ganga valley is located along a southeastern part of the ponds and tanks. The study region is being comprised of 27.74km^2 the waterbodies in 1990and increasing 33.50 km^2in 2020. Significantly, the waterbodies have been increasing from 2% to 3% area in 1990 – 2020.

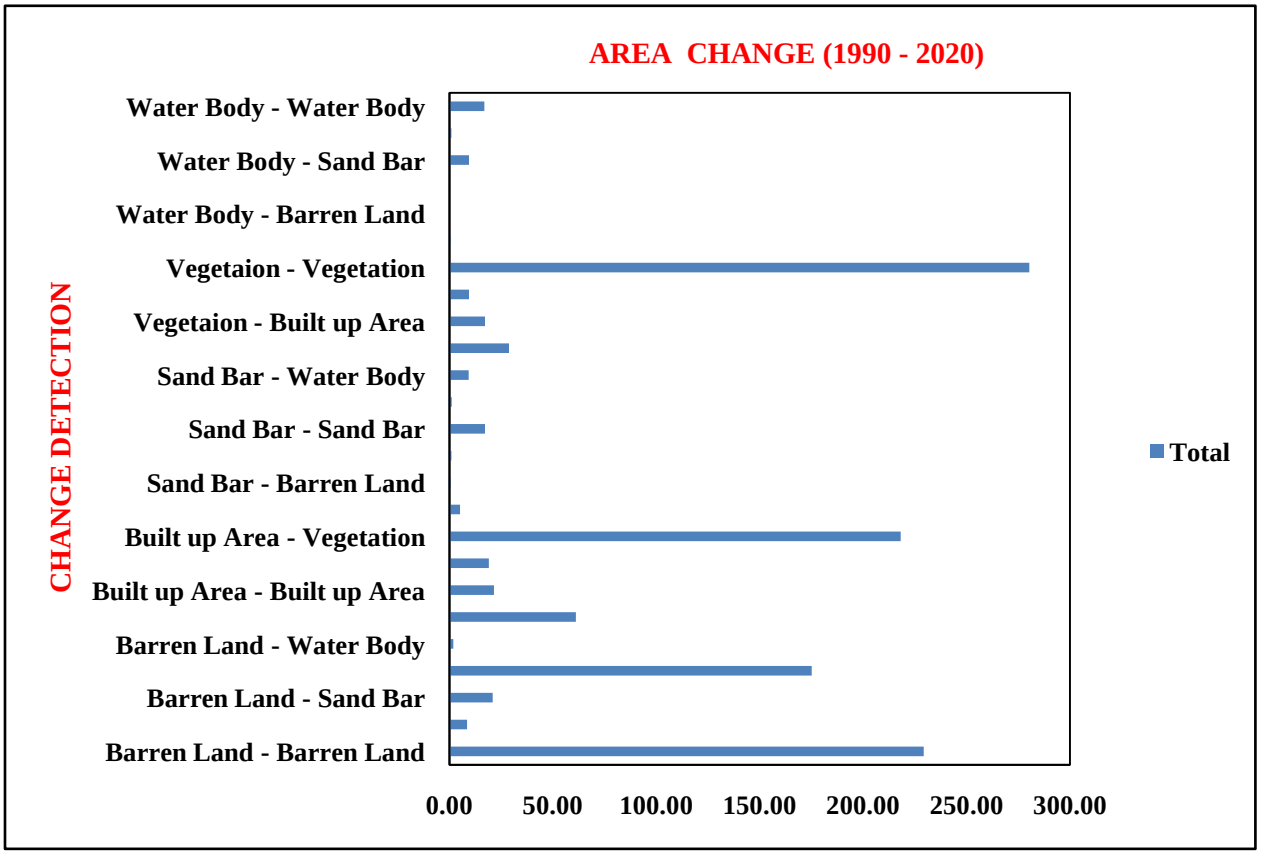


Figure -5. Changes in LULC (1990 to 2020) in different land use& land cover (1: Barren Land, 2: Built-up Area, 3: Vegetation, 4: Water Body, 5: SandBar).

5. CONCLUSION

The most remarkable changes have been included a tremendous change during 1990 -2020 in the comparative study of the land-use patterns. The LULC change in highlights study is to be based on the Landsat remote sensing images in spatial and temporal change using remote sensing and GIS techniques. During the area of 30 years, vegetation and agriculture are increased especially. Open forest and urban settlement have been spread still increased significantly. The study area has been fluctuating consist ofoutstandinggrowths in paddy field crops, miscellaneous crops, shrubs and healthy nature and speedilygrowths in the built-up area and water bodies. The LULC changes in agricultural lands have been covered especially in drastic changesthat took place in agricultural areas, built-up, and wastelands.

The cultivated lands and scrublands during 1990 - 2020 have taken place in paddy field crops to reduce andrise in the miscellaneouscrop area, but the miscellaneous crop areas have qualifiedduring 1990 – 2020, in changing pattern agriculture lands, mixed tree crops and built-up areas. All theperiod, the dense mixed forest andscrub forest area of the same level have been increased to enhance the environment deforestation. The geological sequence of the study area isa logical change inthe landuse pattern. The study region has found out in land use and land cover in the Ganga valley a large scale deforestation andheightening in eucalyptus and rubber plantation. During evergreen forest has been converted for settlement with mixed vegetation crops and built-up area. These processesin the built-up area will not make the water scarcity and then also enhance water pollution in the forest category.

The present trend of the land use pattern has been changed to paddy cultivation rapidly converted to vegetation areas.The study area has been touched to bank carving and cut-offs at channel beds in channel sand and largeexploitation of flood plain.Therefore, thepresent study in anthropogenic impact factors like excessive deforestation, encroachment, human settlement, grazing, valuable trees and overexploitation of natural assetsfaster the weakening of the current environment and future research work is required to ignore the loss of forests.

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