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DYNAMICS OF LAND USE LAND COVER (LULC) CHANGE DURING 2005-2018 USING REMOTE SENSING AND GIS: A STUDY ON CHUNDIA RIVER BASIN, WEST BENGAL

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Abstract:

Land Use Land Cover (LULC) change is very continuous process and dynamic in nature and its identification is important for sustainable development and future planning. The seasonal and temporal LULC change of the Chundia river basin from 2005 to 2018 is assessed using remote sensing and GIS tools. Landsat 5 for 2005 and 2010, and Landsat 8 for 2015 and 2018 are used to detect the LULC change through supervised classification in ERDAS 11 software. Google Earth is used for reclassification of the maps which are produced from satellite images. LULC features of the year 2005 to 2018 of dry and rainy season has been verified and reclassified based on Google Earth Quick Bird satellite imagery and LULC data and map has been generated using Arc-GIS 10.1 software. The result shows that temporally, in dry and rainy season, agricultural land has been decreased by 9.05 % (3357.42 ha) and 8.04 % (2985.34 ha) and fisheries enhanced by 9.01 % (3346.27 ha) and 8.02 % (2974.19 ha) respectively. In seasonally, agricultural land reduced by 1.38 % (511.63 ha) in 2005 and 0.38 % (139.54 ha) in 2018 that is totally occupied by fisheries. At present, seasonal conversion of the LULC is decreased due to development of the permanent fisheries. Annual rate of the alteration of LULC between agricultural land and fisheries is higher during the year 2015-2018 in both seasons.

Introduction:

Land is a fundamental resource to survive our life that provides the habitat, food and energy but at present, the land lost their qualitative and quantitative value due to growth of human population and their activities (Pillay et al. 2014). Transformation of the land from one purpose to another is a continuous (Dong et al. 2009) and natural process on the earth surface (Rahman et al. 2012). Most affected features on the earth surface are forest, water bodies and agricultural land throughout the past (Ji et al. 2018). The rate of conversion is varied from one decade to another decade and country to country because of different economic development process, demographic change and socio-economic policy (Munteanu et al. 2014). In a watershed area, conversion of the land from vegetation cover and water bodies to agricultural land and settlement area or urban area is very dynamic in nature. (Buttet al. 2015;Kumar et al. 1994; Ramachandran and Reddy 2015; Singh et al. 2018; Singh and Jeganathan2016). Nowadays, decreased of the agricultural land and increased of the built-up area is profoundly found in all LULC conversion scenarios (Benini et al. 2010). The process of LULC transformation from agricultural land, water bodies and dense forest area to built-up area, open forest land and plantation is very continuous and extensive at the surrounding area of an urban than rural area (Mallupattu and Reddy 2013). Higher rate of urbanization and rapid population growth acts as the triggering factor of the shifting the LULC of an area (Hassan et al. 2016). Enhancement rate of the built up area is very higher at fringe area of an urban land due to higher availability of open land with low price than city centre (Singh and Devi 2016).

LULC change is very progressive and complex in nature in all over the world due to different anthropogenic activities (Badreldin andGoossens 2013; Brahmabhatt et al. 2000; David et al. 2017). Identification of the causes of LULC transformation and its trend is important and impact of LULC change on human livelihood activities is very necessary for the management of natural resources, policy making and sustainable development of an area (Meshesha et al. 2016; Pasha et al. 2016). Detection of the LULC change play a significant role to knowing the spatial characteristics of the land use (Mas et al. 2004), temporal transformation of LULC feature (Stefanov et al. 2001) and dynamic of the landscape (Rawat and Kumar 2015). Digital change detection process from LULC map is used to identifying the changes and trends of the conversion with spatial and temporal basis for management of land degradation (Bai et al. 2017), environment, ecology and bio-diversity (Kilic et al. 2004). This detection process is also used for the measurement of urban sprawl (Coskun et al. 2008), extended urban area and making the policy and planning for the urban development (Erener et al. 2012).

The earlier LULC data and information of a particular area has been generated from the topographical map (Dewan and Yamagulchi2009; Shetty et al. 2005) and available cartographical map of previous time (Mas et al. 2004) which is used as a primary data source of a research work. But at present, the deficiency of historical land use data is a great problem for us which overcome by using various satellite images. At present time, satellite images become a necessary source of data for the mapping of the earth surface. Changing parameters of the land on the earth surface are easily identified and detected by using satellite images of the different point of time (Rawat and Kumar 2015). Day-to-day, application of the satellite images are gradually increased for the change detection analysis of LULC. Numerous research work on LULC has been done based on different remote sensing satellite imageries, such as Landsat MSS, Landsat 5 Thematic Mapper (TM) (Cohen and Goward2004) and Landsat 8 Operational Land Imager/Thermal Infrared Sensor (OLI/TIRS) (Meshesha et al. 2016;Bai et al. 2017), Landsat ETM+ (Dong et al. 2009; Sundarakumar et al. 2012; Kim 2016), SPOT-XS, SPOT-PAN (Tehrany et al. 2014), IRS 1- C/D and IRS LISS (Coskun et al.

2008; Rajesh et al. 2017), SAR (Waske and Braun 2009), IKONOS (Oyinloye and Kufoniyi2013), QuickBird (Lu et al. 2010), MODIS (Usman et al. 2015; Thenkabail et al. 2005) and IRS LISS-III (23.5 m) (Das and Choudhury 2015). Landsat Thematic Mapper (TM) data has been widely used for the study about agricultural cover and LULC change detection analysis also (Botkin et al. 1984; Wilkie and Finn 1996). Freely accessible Landasat 5 (TM) and Landsat 8 (OLI/TIRS) with 30 m spatial resolution images are extensively utilized to prepared the LULC map and data of various year and analysed the change of the features on earth surface with time (Stefanov et al. 2001; Kilic et al. 2004; Vittek et al. 2014).

Remote sensing (RS) and Geographical Information Systems (GIS) is an indispensible tools and well accessible technique for measuring, monitoring and assessment of the LULC change (Dong et al. 2009; Cakir and Ozdemir2014; Joshi and Gairola2004; Shamsudheen et al. 2005; Dhinwa et al. 1992; Mahajan and Panwar2005) because of correct geo-referencing and appropriate data processing and analysis technique (Rahman et al. 2012; Rawat and Kumar 2015; Chen et al. 2005; Nuñez et al. 2008). ERDAS Imagine and Arc-GIS software of RS and GIS is used as a primary and Fundamental tool which is broadly used for the classification of LULC and assessed the change detection (Butt et al. 2015; Mallupattu and Reddy 2013; Erener et al. 2012; Das and Choudhury 2015; Maddah et al. 2015). Geometric and atmospheric correction of the raw images is required to remove the error of images which occurred at the time of data collection. Image Geometric Correction module is an easy tool and very useful for reduction of the geometric error of image (Thakkar et al. 2016). Atmospheric distortion is corrected using linear regression model to get the actual data or image without using any ancillary and additional data (Tyagi and Bhosle2011). LULC map from satellite images has been prepared using supervised classification technique and change detection analysis by overlapping method and comparison the generated data (Badreldin and Goossens2013; Dewan and Yamagulchi2009; Kim 2016; Rajesh et al. 2012). Accuracy assessment for validation of land use map and data has been done by random sampling and field observation method (Mas et al. 2004), ancillary data and knowledge from previous study (Usman et al. 2015). Present accuracy assessment of most work is done from ground truth data of many selected random sample points on the Google Earth satellite imagery (Kim 2016; Tilahun and Teferie2015). The result of accuracy assessment is varying from 70% to 80% of the most cases and the highest overall accuracy level is found 85-90% (Dewan and Yamagulchi2009). Freely provided satellite images are very lower and medium spatial resolution type and higher spatial resolution images are not freely available and more expensive to purchase and sometimes not available for security issue (Malarvizhi et al. 2016). But Google earth is used as an alternative option which is openly accessible to us and provides very high resolution image with 15 cm to 15 m spatial resolution for micro level study (Tilahun and Islam 2015; Datta and Sarkar 2019) especially in heterogeneous region (Hu et al. 2013). So, the Google Earth Quick Bird satellite imagery is used to reclassify of the prepared LULC map from imageries for the accurate and details study. Group interview and discussion with local people is important to find out the causes of LULC change and identifying the driving forces behind the change (Coppin et al. 2004).

Study area:

The selected study area is Chundia river basin, located in PurbaMedinipur and PaschimMedinipur district of West Bengal, India (Figure 1). The basin spreads over 371.11 sq. km area of both district covering the parts of six blocks such as Moyna, Panskura-I, Pingla, Sabang, Debra and Kharagpur-II. Study area contains a total of 389 mouzas of six blocks and most of the study area falls under the Pingla (164.83 sq. km) and Moyna (83.55

sq. km) block. The principle river is Chundia, flows from north-west to south-east direction and joins the Kaliaghairiver in southern part of the Moyna Block. The elevation of the Moyna block is lower (5 m) than the surrounding area (10 m) which is situated at interfluves area of Kangsabati and Kaliaghairiver. The Kangsabati and the Kaliaghairiver is located along the eastern and southern side of the boundary of the study area. Extension of the study area is $22^0$10'00" N to $22^0$23'27" N and $87^0$26'03" E to $87^0$47'34" E.

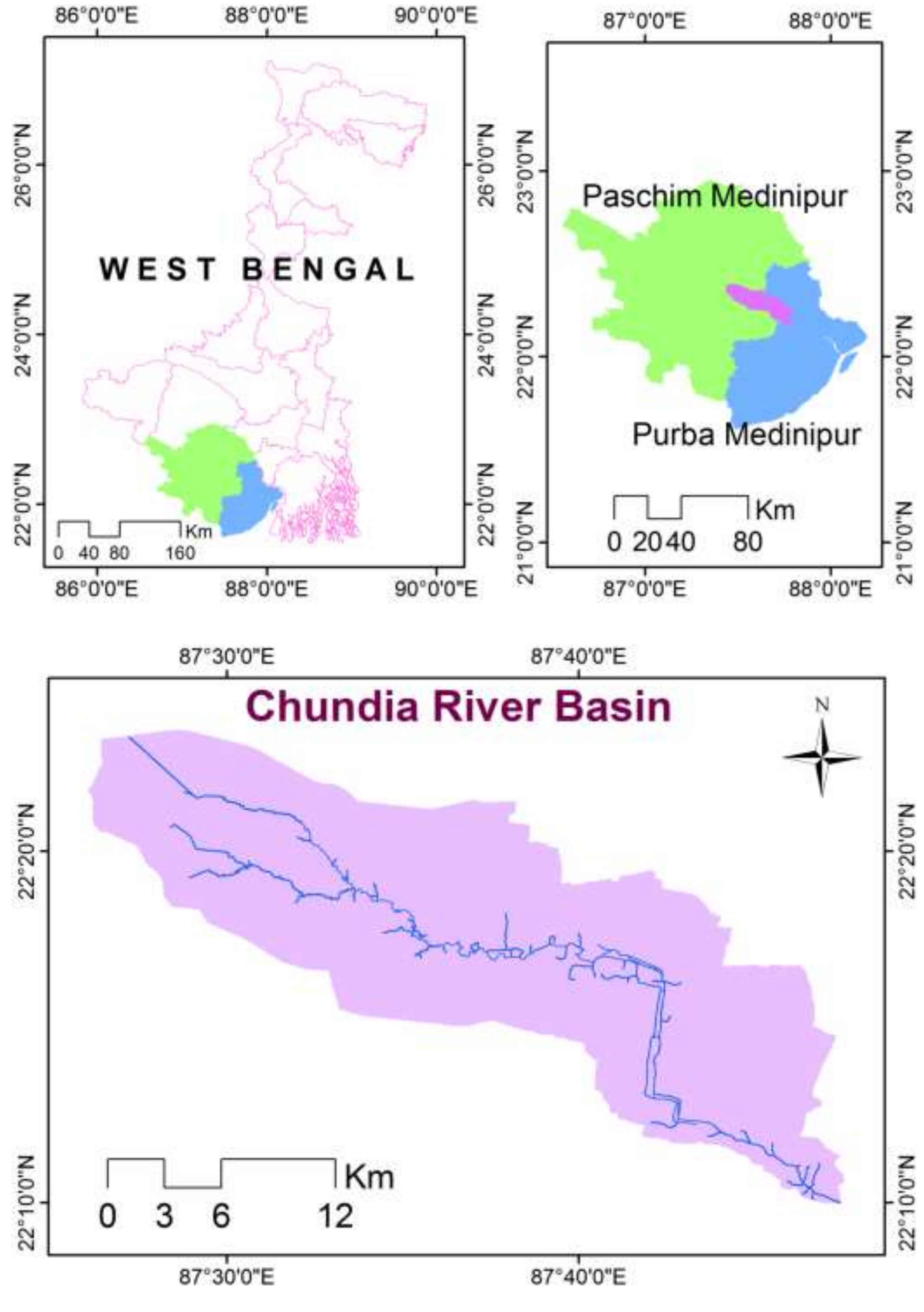

Figure 1: The study area

Lower portion of the study area mainly Moyna block experienced massive water logging problem in rainy season due to manger shape of the area, less percolation in clay loamy soil, high level of ground water, worst drainage condition and heavy rainfall. The economic activity of this region is based on agricultural production mainly paddy and jute cultivation throughout past. At present time, agricultural production (Aman crop) has been failed due to water logging that forced to change the LULC from agriculture to fisheries in seasonally. Now a day, the people of this region has been understood that the fishing cultivation is more suitable than the agricultural production. Then, they changed their economic activities from agriculture to fisheries permanently.

Materials and method:

Data collection:

Topographical sheets no 73N/7, 73N/11, 73N/12, 73N/15 and 73N/16 have been collected form survey of India, Kolkata to knowing about the previous status of the land use land cover and also used as a basic document of the study area. The multispectral Landsat satellite imageries with 30 m spatial resolution of the year 2005, 2010, 2015 and 2018 for the month of March (dry season) and September (rainy season) were obtained from United State Geological Survey (USGS) (https://earthexplorer.usgs.gov/). The details of the acquired satellite images for the analysis of LULC change are given in Table 1.

Table 1: Details of the obtained satellite images

Data	Year of acquisition	Bands/colour	Spatial resolution (m)	Spectral resolution/band (mm)	Source
Landsat 5 TM imagery	2005 and 2010	Multi-spectral	30	Band 2 (green) 0.52-0.60 Band 3 (red) 0.63-0.69 Band 4 (near IR) 0.76-0.90	USGS
Landsat 8 OLI & TIRS	2015 and 2018	Multi-spectral	30	Band 2 (green) 0.52-0.60 Band 3 (red) 0.63-0.69 Band 4 (near IR) 0.77-0.90	

High resolution imagery, various ancillary data included topographical map, aerial photography and ground truth data are used as additional data. Google Earth is used as high resolution satellite image for the reclassification and identification of the changing features. Ground truth data of 2015 and 2018 on March and September were collected by Global positioning system (GPS), used as a reference data for the accuracy assessment. Block-wise mouza map has been gathered from the land and land reforms department of West Bengal (banglarbhumi.gov.in). Geo-referencing of these maps has been completed in Arc-GIS 10.1 software and digitized the all mouzas of the six blocks which fall under the basin boundary. A social survey through interview of farmers and local people has been done on basis of some specific question about LULC change for the identifying of the driving forces of the LULC change.

Pre-processing and Classification of the imageries:

Pre-processing of the satellite imagery is very important for the analysis of LULC change detection. Geometric and atmospheric distortion has been occurred in remote sensed satellite imagery at the time of acquisition due to acquisition system, movement of the platform and condition of the atmospheric phenomenon. Geometric correction of the images has been done using ERDAS Imagine software (11) through the Image Geometric Correction module. Linear regression model (Regression Line Method) has been used to minimize the atmospheric effect on the obtained images. After the correction, images imported into Arc GIS 10.1 software and registered to a common projection system that is Universal Traverse Mercator projection (WGS 1984, UTM Zone, 45 N). Supervised classification method is used to classify the LULC feature into five classes based on specific digital number. The identified classes are Built-up area, Crop land, Vegetation, Water bodies and Fallow land or barren land. Distinctive colour has been assigned for each class to separate from each other. Raster data of the LULC converted to vector data as polygon in form of shape file (.shp) and further converted to Keyhole Markup Language (.kml) file format using conversion tools (To KML).

KML file of all LULC features import into Google Earth and complete the reclassification of the classified features through digitization process. Three classes are reclassified for the better output of the research. Built-up area is further classified into Road ways, brick field, settlement, rail way and platform. Crop land divided into two classess, agricultural land and betel vine. Water bodies are significant feature in this area that is divided into canal, river, deep water bodies and fisheries or shallow water bodies. After this, thirteen (13) LULC classes are identified namely river (RV), canal (CN), road ways (RoW), rail way (RaW), deep water (DW), fisheries or shallow water (FS), vegetation (VG), fallow land or barren land (FL), agricultural land (AL), betel vine (BV), brick field (BF), platform (PT) and settlement (ST) (Table 2). Reclassified and digitized features are saving as a KML file and imported in Arc-GIS 10.1 software using conversion tools (From KML) for conversion to shape file (.shp). The tool, ‘calculate geometry’ is used to extract the data from shape file and calculate the area in hectare of the polygon of the particular LULC type. Similarly, data of the various LULC type has been generated and export the all data as text file (.txt). Tabulation and calibration of the data has been completed using MS office Excel software.

Table 2: Classified LULC features from Satellite Image and Google Earth

Sr. No.	Class name	Reclassified name	Description
1	Built-up area	Road ways	all types of metal and un metal roads
		Settlement	Residential, commercial, industrial, institutional
		Brick field	Covering area of brick kiln
		Rail way	Total covering area of railway
		Platform	Total area of a platform or rail station
2	Crop land	Agricultural land	Crop field may be paddy, jute, vegetables etc.
		Betel vine	Only betel vine
3	Vegetation	Vegetation	Mixed forest land and social forest
4	Water bodies	Canal	All manmade major and minor canal
		River	Natural developed water channel (river and tributaries)
		Fisheries	Shallow water bodies with fishing cultivation

		Deep water	Lake, reservoirs, pond
5	Fallow or barren land	Fallow land	Land area without cultivation and influenced by human impact

Accuracy Assessment:

Estimation of accuracy is a crucial part for the LULC change detection analysis from satellite images. At first, produced maps of the year 2005, 2010, 2015 and 2018 for March and September month from satellite images imported into Google Earth (high resolution image) for correction and modification. Verified the all map based on Google Earth satellite image and reclassification process also done at the same time. Finally, accuracy of the map is calculated using ground control point taking by GPS for each LULC classification map of 2015 and 2018 of March and September month through random sampling method. Four map of the year 2005 and 2010 of both seasons are corrected using the Google Earth satellite image. Ground control point, 448 and 686 for 2015 and 724 and 751 for 2018 in dry and rainy season respectively are collected as a reference data by GPS for the accuracy assessment of both years. Comparison the data of image classification and reference point is done using Confusion matrixes for the statistical analysis of overall accuracy. The ultimate accuracy of the classified images is 97.32 % and 97.65 % on March and 97.23 % and 97.74 % on September of the year 2015 and 2018 respectively (Table 3 and Table 4).

Table 3: Cross tabulation matrix of classified data and reference data of the year 2015

Reference data

Classified data	AL	BV	RV	CN	DW	FS	VG	RoW	ST	RaW	PT	BF	FL	Total	User's accuracy (%)
2015 (March)															
AL	115	1	0	0	0	0	1	0	0	0	0	0	0	117	98.29
BV	0	51	0	0	0	0	1	0	0	0	0	0	1	53	96.23
RV	0	0	33	2	0	0	0	0	0	0	0	0	0	35	94.29
CN	0	0	1	29	0	0	0	0	0	0	0	0	0	30	96.67
DW	0	0	0	0	29	1	0	0	0	0	0	0	0	30	96.67
FS	0	0	0	0	1	46	0	0	0	0	0	0	0	47	97.87
VG	0	1	0	0	0	0	45	0	0	0	0	0	0	46	97.83
RoW	0	0	0	0	0	0	0	30	0	0	0	0	0	30	100.00
ST	0	0	0	0	0	0	0	0	37	0	0	1	0	38	97.37
RaW	0	0	0	0	0	0	0	0	0	6	0	0	0	6	100.00
PT	0	0	0	0	0	0	0	0	0	0	3	0	0	3	100.

														00
BF	0	0	0	0	0	0	0	0	0	0	0	5	0	5	100.00
FL	0	0	0	0	0	0	0	0	0	0	1	0	7	8	87.50
Total	115	53	34	31	30	47	47	30	37	6	4	6	8	448	
Producer's accuracy (%)	100.0	96.2	97.1	93.5	96.7	97.9	95.7	100.0	100.0	100.0	75.0	83.3	87.5	Over all accuracy	97.32 %
2015 (September)															
AL	201	2	0	1	0	1	1	0	0	0	0	0	0	206	97.57
BV	1	69	0	0	0	0	1	0	0	0	0	0	1	72	95.83
RV	0	0	37	1	0	0	0	0	0	0	0	0	0	38	97.37
CN	0	0	1	52	0	1	0	0	0	0	0	0	0	54	96.30
DW	0	0	0	0	53	2	0	0	0	0	0	0	0	55	96.36
FS	0	0	0	0	2	115	0	0	0	0	0	0	0	117	98.29
VG	1	0	0	0	0	0	33	0	0	0	0	0	0	34	97.06
RoW	0	0	0	0	0	0	0	45	0	0	0	0	0	45	100.00
ST	0	0	0	0	0	0	0	0	41	0	0	0	1	42	97.62
RaW	0	0	0	0	0	0	0	0	0	6	0	0	0	6	100.00
PT	0	0	0	0	0	0	0	0	0	0	3	0	0	3	100.00
BF	0	0	0	0	0	0	0	0	0	0	0	4	0	4	100.00
FL	0	0	0	0	0	1	0	0	0	0	1	0	8	10	80.00
Total	203	71	38	54	55	120	35	45	41	6	4	4	10	686	
Producer's accuracy	99.0	97.2	97.4	96.3	96.4	95.8	94.3	100.0	100.0	100.0	75.0	100.0	80.0	Over all accuracy	97.23 %

Table 4: Cross tabulation matrix of classified data and reference data of the year 2018

Reference data

Classified data	AL	BV	RV	CN	DW	FS	VG	RoW	ST	RaW	PT	BF	FL	Total	User's accuracy (%)
2018 (March)															
AL	232	2	0	0	0	1	1	0	0	0	0	0	1	237	97.89
BV	0	46	0	0	0	0	1	0	0	0	0	0	0	47	97.87
RV	0	0	37	1	0	1	0	0	0	0	0	0	0	39	94.87
CN	0	0	1	35	0	0	0	0	0	0	0	0	0	36	97.22
DW	0	0	0	1	38	1	0	0	0	0	0	0	0	40	95.00
FS	0	0	0	0	2	167	0	0	0	0	0	0	0	169	98.82
VG	0	1	0	0	0	0	41	0	0	0	0	0	0	42	97.62
RoW	0	0	0	0	0	0	0	52	1	0	0	0	0	53	98.11
ST	0	0	0	0	0	0	0	0	37	0	0	1	0	38	97.37
RaW	0	0	0	0	0	0	0	0	0	6	0	0	0	6	100.00
PT	0	0	0	0	0	0	0	0	0	0	3	0	0	3	100.00
BF	0	0	0	0	0	0	0	0	0	0	0	7	0	7	100.00
FL	0	0	0	0	0	0	0	0	0	0	1	0	6	7	85.71
Total	232	49	38	37	40	170	43	52	38	6	4	8	7	724	
Producer's accuracy	100.0	93.9	97.4	94.6	95.0	98.2	95.3	100.0	97.4	100.0	75.0	87.5	85.7	Overall accuracy	97.65 %
2018 (September)															
AL	215	1	0	0	0	0	2	0	0	0	0	0	0	218	98.62
BV	0	38	0	0	0	0	1	0	0	0	0	0	0	39	97.44
RV	0	0	34	2	0	0	0	0	0	0	0	0	0	36	94.44
CN	0	0	1	37	0	0	0	0	0	0	0	0	0	38	97.37
DW	0	0	0	0	29	1	0	0	0	0	0	0	0	30	96.67
FS	0	0	0	1	1	193	0	0	0	0	0	0	0	195	98.97
VG	1	1	0	0	0	0	54	0	0	0	0	0	0	56	96.43
RoW	0	0	0	0	0	0	0	47	2	0	0	0	0	49	95.92
ST	0	0	0	0	0	0	0	0	61	0	0	1	0	62	98.39
RaW	0	0	0	0	0	0	0	0	0	6	0	0	0	6	100.00
PT	0	0	0	0	0	0	0	0	0	0	3	0	0	3	100.0

															0
BF	0	0	0	0	0	0	0	0	1	0	0	9	0	10	90.00
FL	0	0	0	0	0	0	0	0	0	0	1	0	8	9	88.89
Total	216	40	35	40	30	194	57	47	64	6	4	10	8	751	
Producer's accuracy	99.5	95.0	97.1	92.5	96.7	99.5	94.7	100.0	95.3	100.0	75.0	90.0	100.0	Over all accuracy	97.74 %

LULC change detection:

Final LULC map of four point of time for month of March and September has been produces and change detection analysis is done in Arc-GIS 10.1 software. River, canal, road ways and rail way features of the LULC map are showing as a poly line but others parameters are present as a polygon in the LULC map for better visualization. Seasonal change of the LULC is recognized through comparison of the map and data between March (Dry season) and September (Rainy season) month of a particular year. In the same way, seasonal LULC change of 2005, 2010, 2015 and 2018 is detected. Detection analysis on temporal basis is done through comparison the map and data between two sequent years (dry and rainy season). An analysis table of the net gain and net loss from 2005 to 2018 is completed to detect the changing dominance of the LULC. A cross tabulation study of changing features is done to determine the amount of conversion from one particular category to another category. Most changeable LULC features are identified after the analysis of seasonal and temporal change and from cross table. Then, calculate the annual growth rate of selected features between two sequent years and overall annual growth rate from 2005 to 2015 of both seasons is calculated also. Mouza-wise area of most dynamic (positive change) feature (fisheries) is extracted in Arc-GIS software and find out the distribution result. Covering area of fisheries (percentage) per mouzais calculated to showing the changing area of the fisheries with the change of season and time period. Percentage of covering area of the fisheries has been calculated in respect to total area of the particular mouza and classified into five classes. These are 0.00-20.00 %, 20.01-40.00 %, 40.01-60.00 %, 60.01-80.00 % and 80.01-100.00 %.

Result and discussion:

In present study, thirteen (13) LULC classes are identified from satellite images and Google Earth. After the tabulation (Table 5) and analysis of the data, shows that total area of the basin is 37110.75 ha and the agricultural land is the dominant category of LULC. Agricultural land shares 71.87 % (26670.8 ha), 70.14 % (26030.75 ha), 69.04 % (25621.73 ha) and 62.82 % (23313.38 ha) in dry season and 70.49 % (26159.17 ha), 67.42 % (25021.79 ha), 65.95 % (24476.03 ha) and 62.45 % (23173.83 ha) in rainy season in 2005, 2010, 2015 and 2018 respectively. The second largest sharer is vegetation or forest, covering by 13.47 % (4999.49 ha) in 2005 and in 2018 that is 13.14 % (4875.65 ha). 5.76 % (2136.57 ha) of the total area covered by settlement in 2018 that was by 5.23 % (1939.54 ha) in 2005. Fisheries or shallow water bodies covered by 1.21 % (447.61 ha), 1.35 % (500.12 ha), 3.83 % (1419.54 ha) and 10.22 % (3793.88 ha) in dry season and 2.58 % (959.24 ha), 4.07 % (1509.08 ha), 6.91 % (2565.24 ha) and 10.60 % (3933.43 ha) in rainy season in 2005, 2010, 2015 and 2018 correspondingly. In this area, changing pattern of the land use land cover is mainly two types, first is seasonal and second is temporal. Figure 2 (A and B) illustrate the LULC change of the Chundia river basin of the year 2005, 2010, 2015 and 2018 of both seasons.

Table 5: Details information about LULC

LULC types			AL	BV	RV	CN	DW	FS	VG	RoW	ST	RaW	PT	BF	FL
2005	Dry season	Area (ha)	26670.8	86.88	276.44	685.11	1550.35	447.61	4999.49	325.94	1939.54	31.94	8.04	0.53	88.08
		Area (%)	71.87	0.23	0.74	1.85	4.18	1.21	13.47	0.88	5.23	0.09	0.03	0	0.24
	Rainy season	Area (ha)	26159.17	86.88	276.44	685.11	1550.35	959.24	4999.49	325.94	1939.54	31.94	8.04	0.53	88.08
		Area (%)	70.49	0.23	0.74	1.85	4.18	2.58	13.47	0.88	5.23	0.09	0.03	0	0.24
2010	Dry season	Area (ha)	26030.75	114.77	277.02	687.41	1518.71	500.12	5550.19	329.12	1972.34	31.94	8.04	8.42	81.92
		Area (%)	70.14	0.31	0.75	1.85	4.09	1.35	14.96	0.89	5.31	0.09	0.03	0.03	0.2
	Rainy season	Area (ha)	25021.79	114.77	277.02	687.41	1518.71	1509.08	5550.19	329.12	1972.34	31.94	8.04	8.42	81.92
		Area (%)	67.42	0.31	0.75	1.85	4.09	4.07	14.96	0.89	5.31	0.09	0.03	0.03	0.2
2015	Dry season	Area (ha)	25621.73	108.19	274.29	675.98	1452.87	1419.54	4993.89	338.8	2067.88	31.94	8.04	21.78	95.81
		Area (%)	69.04	0.29	0.74	1.82	3.91	3.83	13.46	0.91	5.57	0.09	0.03	0.06	0.26
	Rai	Ar	2447	108	274	675	145	256	499	338	206	31.	8.	21.	95.

	ny season	ea (ha)	6.03	.19	.29	.98	2.87	5.24	3.89	.8	7.88	94	04	78	81
		Area (%)	65.95	0.29	0.74	1.82	3.91	6.91	13.46	0.91	5.57	0.09	0.03	0.06	0.26
2018	Dry season	Area (ha)	23313.38	101.21	273.54	674.26	1436.87	3793.88	4875.65	352.41	2136.57	31.94	8.04	25.68	87.32
		Area (%)	62.82	0.27	0.74	1.82	3.87	10.22	13.14	0.95	5.76	0.09	0.02	0.07	0.24
	Rainy season	Area (ha)	23173.83	101.21	273.54	674.26	1436.87	3933.43	4875.65	352.41	2136.57	31.94	8.04	25.68	87.32
		Area (%)	62.45	0.27	0.74	1.82	3.87	10.60	13.14	0.95	5.76	0.09	0.02	0.07	0.24

Seasonal land use land covers change:

Seasonal change of the LULC is higher in the lower part of the basin area because of water logging due to heavy rainfall in monsoon period. According to table (Table 6) of seasonal LULC change, agricultural land is most affected category in a year with changing season. Agricultural land decreased gradually and converted to fisheries from dry to rainy season in a particular year. The amount of transformation is highest in 2015 that is 3.09 % (1145.70 ha) but in 2005 that was 1.38 % (511.63 ha). The lower amount of seasonal conversion is found in the year 2018 by 0.38 % (139.54 ha). In the other eleven (11) land use land cover classes have not found any seasonal conversion from the year 2005 to 2018. Seasonal change of the LULC is decreased with increasing time due to development of permanent fisheries.

Table 6: Seasonal LULC change from 2005 to 2018

LULC types	2005 (Dry-rainy)		2010 (Dry-rainy)		2015 (Dry-rainy)		2015 (Dry-rainy)	
	Changed (ha)	Changed (%)	Changed (ha)	Changed (%)	Changed (ha)	Changed (%)	Changed (ha)	Changed (%)
Agricultural land	-511.63	-1.38	-1008.96	-2.72	-1145.70	-3.09	-139.54	-0.38
Betel vine	0	0	0	0	0	0	0	0
River	0	0	0	0	0	0	0	0
Canal	0	0	0	0	0	0	0	0
Deep	0	0	0	0	0	0	0	0

water								
Fisheries	511.63	1.38	1008.96	2.72	1145.70	3.09	139.54	0.38
Vegetation	0	0	0	0	0	0	0	0
Road ways	0	0	0	0	0	0	0	0
Settlement	0	0	0	0	0	0	0	0
Rail way	0	0	0	0	0	0	0	0
Platform	0	0	0	0	0	0	0	0
Brick field	0	0	0	0	0	0	0	0
Fallow land	0	0	0	0	0	0	0	0

***- represents the negative change**

Temporal land use land covers change:

All LULC features changed their area from 2005 to 2018 that is illustrated in the Table 7. Maximum transformation has been found in fisheries or shallow water bodies as an increasing trend and Agricultural land as a decreasing trend. Agricultural land lost by 1.73 % (640.05 ha) of the total area from 2005 to 2010, 1.10 % (409.02 ha) from 2010 to 2015, and 6.22 % (2308.35 ha) from 2015 to 2018 in dry season and 3.07 % (1137.38 ha) from 2005 to 2010, 1.47 % (545.76 ha) from 2010 to 2015, 3.50 % (1302.20 ha) from 2015 to 2018 in rainy season. Overall lost of agricultural land from 2005 to 2018 is 9.05 % (3357.42 ha) in dry season and 8.04 % (2985.34 ha) in rainy season. Fisheries or shallow water bodies enhanced their area by 0.14 % (52.51 ha) (2005-2010), 2.48 % (919.42 ha) (2010-2015) and 6.39 % (2374.34 ha) (2015-2018) in dry season and 1.49 % (549.84 ha) (2005-2010), 2.84 % (1056.16 ha) (2010-2015) and 3.69 % (1368.19 ha) (2015-2018) in rainy season. Finally, total amount of the enhancement of Fisheries is 9.01 % (3346.27 ha) and 8.02 % (2974.19 ha) from the year 2005 to 2018 in dry and rainy season respectively. At present, the temporal transformation (Figure2 A and B) of the LULC is slightly higher in dry season than the rainy season due to improvement of the temporary fisheries as permanent fisheries. Average increasing trend from 2005 to 2018 has been found in betel vine, road ways, settlement and brick field and opposite tendency of transformation has been found in canal, deep water and vegetation. Rail way line and platform covered by 0.09 % (31.94 ha) and 0.03 % (8.04 ha) area of the total area and have not found any temporal change.

Table 7: Temporal LULC change of dry and rainy season

LULC types			AL	BV	RV	CN	DW	FS	VG	RoW	ST	RaW	PT	BF	FL
Dry season	2005 - 2010	Changed (ha)	-640.05	27.89	0.58	2.30	-31.64	52.51	550.70	3.18	32.80	0.00	0.00	7.89	-6.16
		Changed (%)	-1.73	0.08	0.01	0.00	-0.09	0.14	1.49	0.01	0.08	0.00	0.00	0.03	-0.04
	2010 -	Changed (ha)	-409.02	-6.58	-2.73	-11.43	-65.84	919.42	-556.30	9.68	95.54	0.00	0.00	13.36	13.89

	2015	Changed (%)	-1.10	-0.02	-0.01	-0.03	-0.18	2.48	-1.50	0.02	0.26	0.00	0.00	0.03	0.06
	2015-2018	Changed (ha)	-2308.35	-6.98	-0.75	-1.72	-16.00	2374.34	-118.24	13.61	68.69	0.00	0.00	3.90	-8.49
		Changed (%)	-6.22	-0.02	0.00	0.00	-0.04	6.39	-0.32	0.04	0.19	0.00	0.00	0.01	-0.02
	2005-2018	Changed (ha)	-3357.42	14.33	-2.90	-10.85	-113.48	3346.27	-123.84	26.47	197.03	0.00	0.00	25.15	-0.76
		Changed (%)	-9.05	0.04	0.00	-0.03	-0.31	9.01	-0.33	0.07	0.53	0.00	0.00	0.07	0.00
Rainy season	2005-2010	Changed (ha)	-1137.38	27.89	0.58	2.30	-31.64	549.84	550.70	3.18	32.80	0.00	0.00	7.89	-6.16
		Changed (%)	-3.07	0.08	0.01	0.00	-0.09	1.49	1.49	0.01	0.08	0.00	0.00	0.03	-0.04
	2010-2015	Changed (ha)	-545.76	-6.58	-2.73	-11.43	-65.84	1056.16	-556.30	9.68	95.54	0.00	0.00	13.36	13.89
		Changed (%)	-1.47	-0.02	-0.01	-0.03	-0.18	2.84	-1.50	0.02	0.26	0.00	0.00	0.03	0.06
	2015-2018	Changed (ha)	-1302.20	-6.98	-0.75	-1.72	-16.00	1368.19	-118.24	13.61	68.69	0.00	0.00	3.90	-8.49
		Changed (%)	-3.50	-0.02	0.00	0.00	-0.04	3.69	-0.32	0.04	0.19	0.00	0.00	0.01	-0.02
	2005-2018	Changed (ha)	-2985.34	14.33	-2.90	-10.85	-113.48	2974.19	-123.84	26.47	197.03	0.00	0.00	25.15	-0.76
		Changed (%)	-8.04	0.04	0.00	-0.03	-0.31	8.02	-0.33	0.07	0.53	0.00	0.00	0.07	0.00

***- represents the negative change**

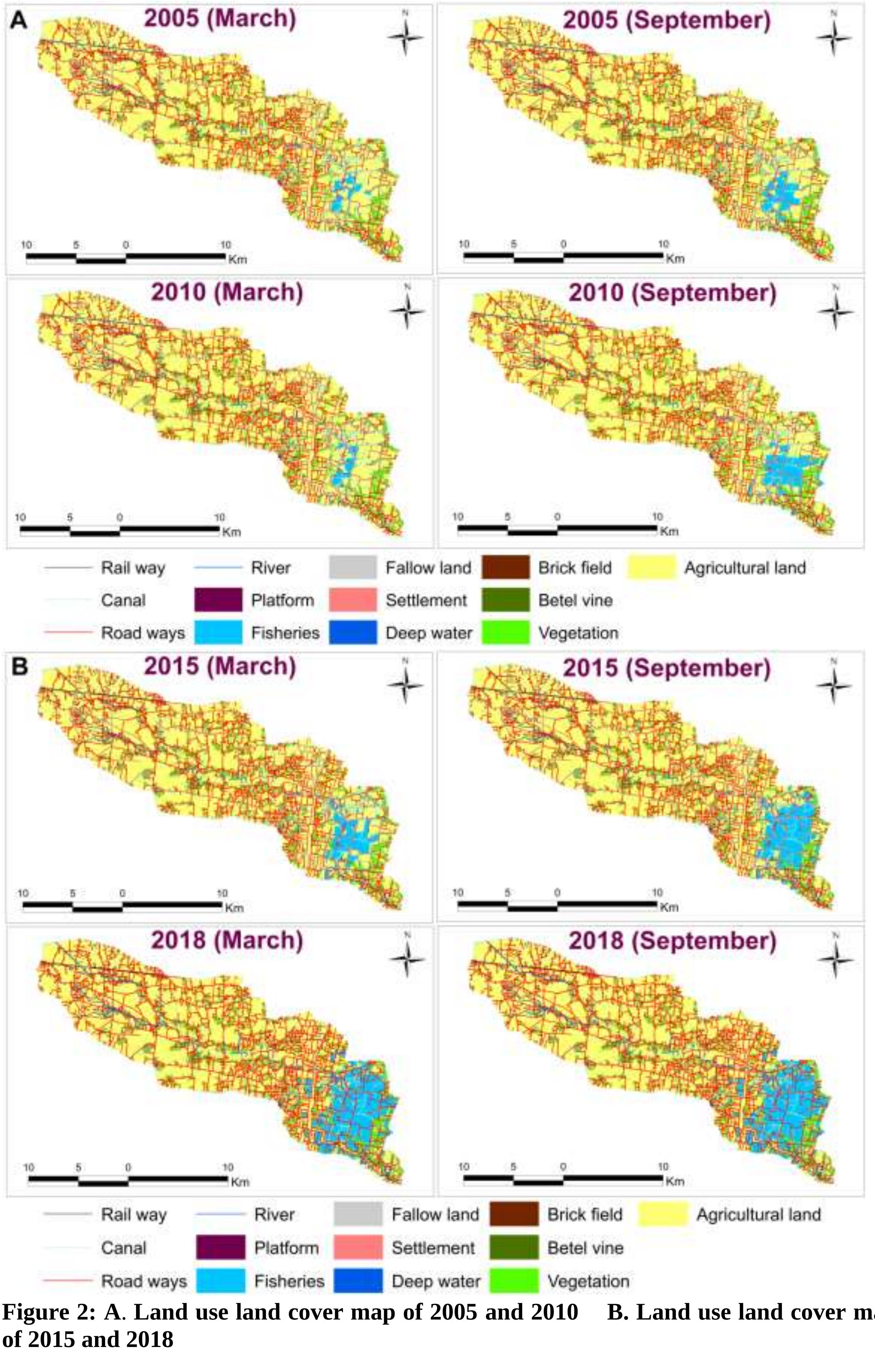

Figure 2: A. Land use land cover map of 2005 and 2010 B. Land use land cover map of 2015 and 2018

Annual growth rate:

Increasing rate fisheries or shallow water bodies and decreasing rate of agricultural land is varying year to year in both seasons which given in the Table 8. The average annual growth rate is slightly higher in dry season that is 0.70 % for agricultural land and 0.69 % for the fisheries or shallow water bodies. Where the average growth rate is 0.62 % for both land uses (agricultural land and fisheries) in rainy season. Annual decreasing rate of agricultural land is higher from 2015-2018 by 2.07 % in dry season and 1.17 % in rainy season. Fisheries or Shallow water bodies are increased annually by 2.13 % in dry season and 1.23 % in rainy season from 2015 to 2018 that is higher rate. The slower annual growth rate is found during 2005 to 2010 in both seasons. So, the growth rate of the fisheries has been increased gradually from the year 2005 to 2018.

Table 8: Annual growth rate of agricultural land and fisheries

Most dynamic LULC	Dry season (Annual growth rate in %)				Rainy season (Annual growth rate in %)			
	2005-2010	2010-2015	2015-2018	2005-2018	2005-2010	2010-2015	2015-2018	2005-2018
Agricultural land	-0.35	-0.22	-2.07	-0.70	-0.61	-0.29	-1.17	-0.62
Fisheries	0.03	0.50	2.13	0.69	0.30	0.57	1.23	0.62

***- represents the negative change**

Net gain and net loss:

Out of thirteen categories, fisheries or shallow water bodies is the highest positive dynamic feature of the study area gained by 3347.59 ha in dry season and 2975.51 ha in rainy season and lost by only 1.32 ha in both seasons since 2005 to present (Table 9). The agricultural land is lost their area by 3358.74 ha and 2986.66 ha in dry and rainy season correspondingly and gained only 1.32 ha in both season during the study period. Road ways, settlement and brick field have gained by 26.47 ha, 197.03 ha and 25.15 ha in both seasons respectively without any loss which indicates the positive development process in the study area. 2.90 ha, 10.85 ha and 0.76 ha area is lost without any gained in both seasons by river, canal and fallow land respectively which shows a negative effect on environment. Net area of the betel vine is increased by 14.33 ha, with loss of 11.54 ha and gain of 25.87 ha. Negative result is found in changed of the net area of deep water and vegetation cover with loss of 114.39 ha and 125.17 ha and gain of 0.91 ha and 1.33 ha in both seasons correspondingly. Any gained or lost have not found in the LULC category of rail way and platform.

Table 9: Net Gain and loss

LULC types	Dry season (2005-2018)			Rainy season (2005-2018)		
	Gain (ha)	Loss (ha)	Net gain or loss (ha)	Gain (ha)	Loss (ha)	Net gain or loss (ha)
Agricultural land	1.32	3358.74	-3357.42	1.32	2986.66	-2985.34
Betel vine	25.87	11.54	14.33	25.87	11.54	14.33
River	0.00	2.90	-2.90	0.00	2.90	-2.90
Canal	0.00	10.85	-10.85	0.00	10.85	-10.85
Deep water	0.91	114.39	-113.48	0.91	114.39	-113.48
Shallow water	3347.5	1.32	3346.27	2975.5	1.32	2974.19

	9			1		
Vegetation	1.33	125.17	-123.84	1.33	125.17	-123.84
Road ways	26.47	0.00	26.47	26.47	0.00	26.47
Settlement	197.03	0.00	197.03	197.03	0.00	197.03
Railway	0.00	0.00	0.00	0.00	0.00	0.00
Platform	0.00	0.00	0.00	0.00	0.00	0.00
Brick field	25.15	0.00	25.15	25.15	0.00	25.15
Fallow land	0.00	0.76	-0.76	0.00	0.76	-0.76

***- represents the loss**

Conversion of the land from a particular category to another category is illustrates in Table 10. Most of the agricultural land is converted to fisheries by 3343.63 ha in dry season and 2971.55 ha in rainy season from 2005 to 2018. A small part of the agricultural land is occupied by betel vine (8.77 ha), deep water (0.91 ha), road ways (2.72 ha), settlement (1.36 ha) and brick field (1.35) in both seasons. Simultaneously, vegetation cover lost their area for settlement (66.78 ha), bête vine (17.10), road ways (20.36 ha) and brick field (20.93 ha). Canal decreased the area due to settlement (4.29 ha), fisheries (3.54 ha) and road ways (3.02 ha). Deep water and shallow water bodies converted in a fixed direction to settlement (114.39) and agricultural land (1.32 ha) respectively. Some part of the river (2.53 ha) and fallow land (0.34 ha) is occupied by the brick field in both seasons during this period. Three sources of the land for fisheries are identified; these are agricultural land, canal and fallow land (0.42 ha). Vegetation (1.33 ha) and settlement (10.21 ha) are occupying the area of betel vine, similarly, betel vine occupied the area of agricultural land and vegetation.

Table 10: Major LULC conversion from 2005-2018

From class	To class	Dry season, 2005-2018 (Area in ha)	Rainy season, 2005-2018 (Area in ha)
Agricultural land	Betel vine	8.77	8.77
	Deep water	0.91	0.91
	Fisheries	3343.63	2971.55
	Road ways	2.72	2.72
	Settlement	1.36	1.36
	Brick field	1.35	1.35
Betel vine	Vegetation	1.33	1.33
	Settlement	10.21	10.21
River	Brick field	2.53	2.53
	Road ways	0.37	0.37
Canal	Settlement	4.29	4.29
	Fisheries	3.54	3.54
	Road ways	3.02	3.02
Deep water	Settlement	114.39	114.39
Shallow water	Agricultural land	1.32	1.32
Vegetation	Settlement	66.78	66.78
	Betel vine	17.10	17.10
	Road ways	20.36	20.36

	Brick field	20.93	20.93
Fallow land	Brick field	0.34	0.34
	Fisheries	0.42	0.42

Mouza-wise distribution of the fisheries:

After the analysis of LULC change, found that fisheries or shallow water bodies are the most enlargement feature out of thirteen element of LULC that mainly replaces the agricultural land. Presently, fisheries or Shallow water bodies are largely concentrating in the lower portion of the basin spreads over Moyna, Sabang and Pingla block. Location of the mouza map with their JL no of the selected block is represents in Figure 3. In the figure, JL no with blue colour are the mouza of Moyna, Red is Sabang and Black is Pingla block. The area of the fisheries is varying between the year 2005, 2010, 2015 and 2018 in both season. Mouza-wise distribution of area of fisheries is presented in Figure 4 and Figure 5 and shows that lowest covering area of the fisheries is 447.61 hectare in dry season of 2005 where the Moyna block shares 436.93 hectare (97.61 % of the total fishing area).

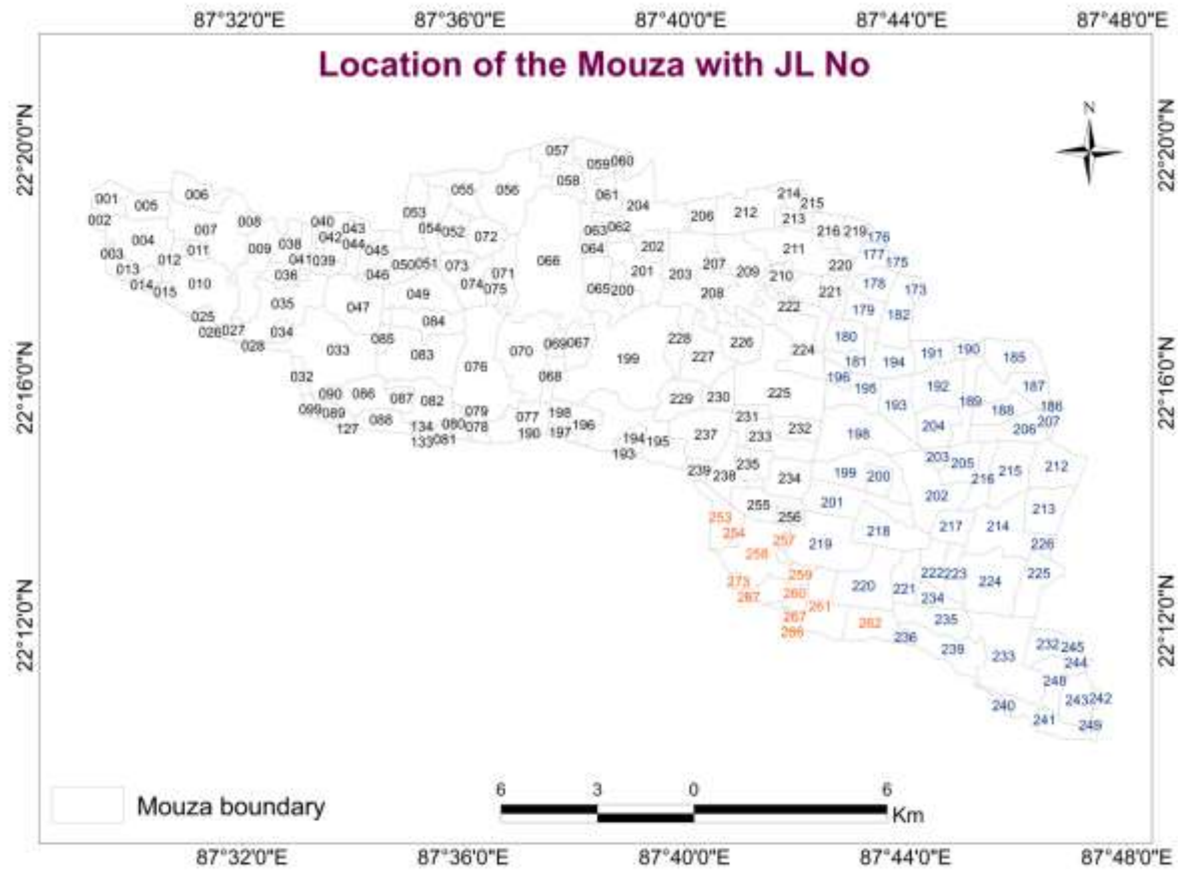

Figure 3: Location and distribution of Mouza with JL no.

Dakshin Changrachakmouza (JL No. 202) have highest coverage of fisheries in four points of time periods of both seasons due to water logging because of low elevation. Maximum coverage is 247.63 hectare in dry season and 249.46 hectare rainy season in 2018 that was 148.65 hectare in dry season and 194.93 hectare in rainy season in 2005. HarkuliBhandarchak (215) mouza is most growing area of fisheries, covering with 182.18 hectare and 183.94

hectare in dry and rainy season respectively in 2018 but in 2005, this mouza covers only 5.14 hectare and 8.93 hectare in dry and rainy season. Ramchak (218) Baitalchak (217), Kalagechhia (214), Raychak (220) etc. mouzas have always well covered with fisheries due to less agricultural production. At present, surrounding mouzas of the water logging area are converted to fishery from agricultural land. These mouzas are Anandapur (212), DakshinHarkuli (213), Gojina (225), Tilkhoja (185), Janaberiya (190), Hajarichak (191), Harduyachak (192), Raghunathchak (189), Radhaballavchak (182) etc. Nowadays, the fisheries are gradually spreads over some adjoining mouzas of Sabang and Pingla block and occupying the productive agricultural land.

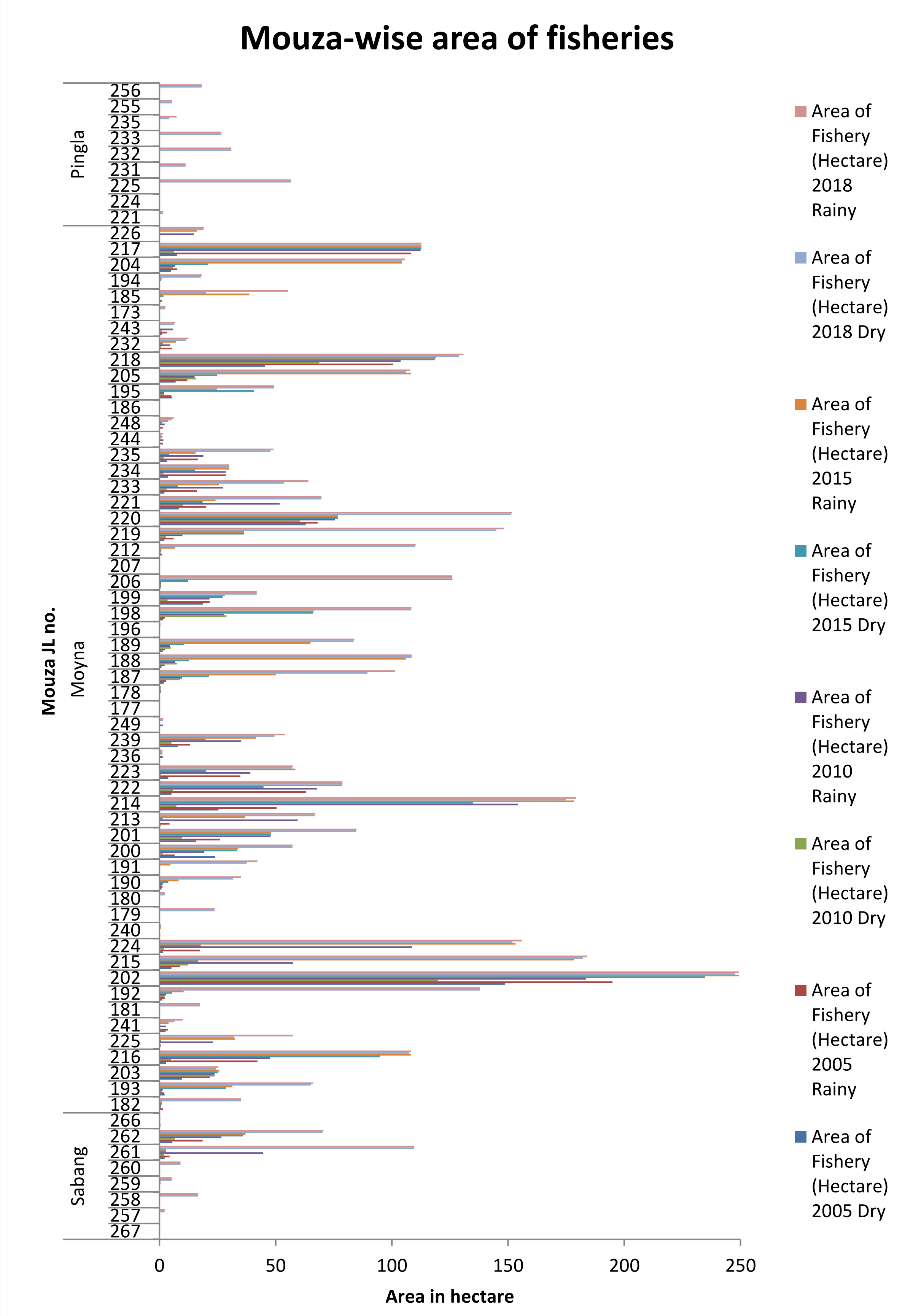

Figure 4: Mouza-wise area of fisheries

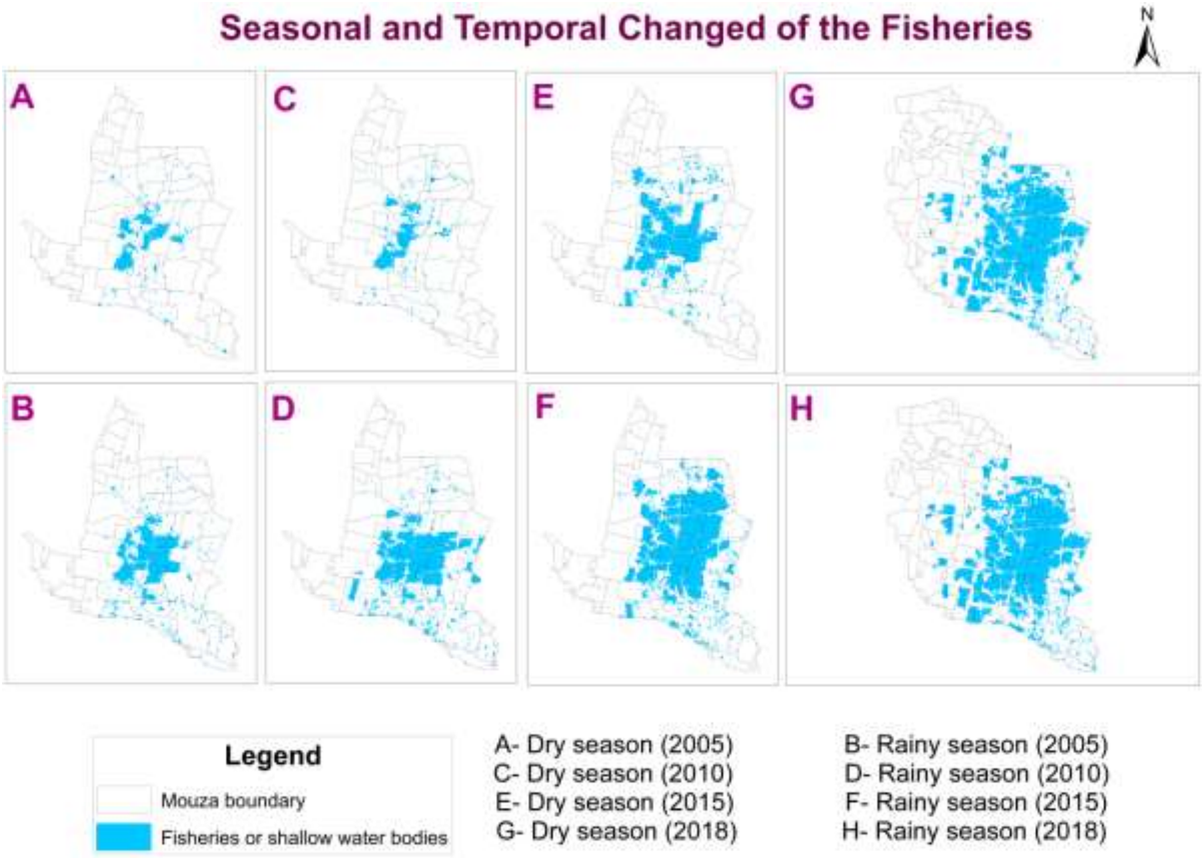

Figure 5: Mouza-wise seasonal and temporal change of the area of fisheries

Mouza-wise covering area of fisheries:

The maps of mouza-wise covering area maps of fisheries of both seasons during this period are represented in Figure 6 and Table 11 and show that dominancy of the fisheries are high in the central portion of the Moyna block that is gradually spreads towards the surrounding area. Highest coverage is found in DakshinChangrachakmouza (JL No. 202), covering by 49.54 % of the total area in dry season of 2005, but in rainy season, Baitalchak (217) occupied the top position covering by 91.84 %. The percentages of the covering area are gradually increased from the year 2005 to 2018 from dry to rainy season.Most of the mouzas fall under the class of below 20.00% in 2005 but number of the mouzas of this particular class gradually declined with changing time. The upper two classes (60.01%-80.00% and above 80.00%) are not found in dry season of the year 2005 and 2010. The number of mouzas of the upper two classes is increased in rainy season of 2015 than dry season. But in 2018, have not found significant changed of the covering percentage between two seasons due to development of permanent fisheries. Fifteen (15) mouzas in dry season and Sixteen (16) mouza in rainy season of 2018 are covered by fisheries by above 60.00 %. In 2018, Baitalchak (217) covered by 95.60 % in dry season and Gopalchak (216) covered by 95.97 % rainy season of fisheries that are the highest coverage in this year. Total number of affected mouzas is increased with time. In 2005, number of influenced mouza are 44 but in 2018, it reached in 73.

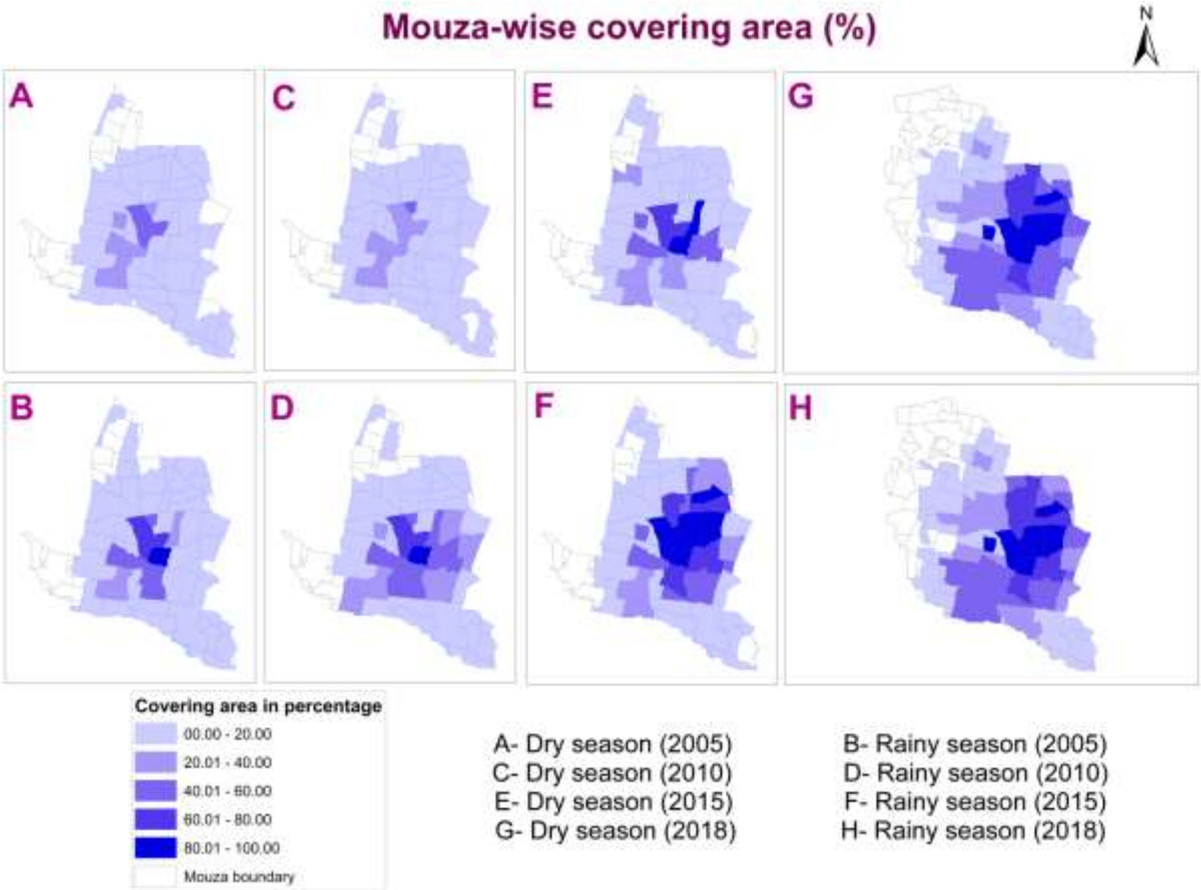

Figure 6: Mouza-wise covering area of the fisheries in percentage

Table 11: Mouza-wise distribution of covering area of fisheries

Block	Covering area (%)	2005		2010		2015		2018		Total
		Dry	Rainy	Dry	Rainy	Dry	Rainy	Dry	Rainy	
Moyna	0.00-20.00	36	36	37	30	32	25	22	20	238
	20.01-40.00	4	2	3	6	5	4	9	10	43
	40.01-60.00	1	5	1	8	3	6	10	10	44
	60.01-80.00	0	1	0	1	2	6	8	9	27
	80.01-100.00	0	1	0	1	2	6	7	7	24
Sabang	0.00-20.00	3	3	3	1	3	3	6	6	28
	20.01-40.00	0	0	0	1	1	1	0	0	3
	40.01-60.00	0	0	0	0	0	0	2	2	4
	60.01-80.00	0	0	0	0	0	0	0	0	0
	80.01-100.00	0	0	0	0	0	0	0	0	0
Pingla	0.00-20.00	0	0	0	0	0	0	0	7	7
	20.01-40.00	0	0	0	0	0	0	0	1	1
	40.01-60.00	0	0	0	0	0	0	0	1	1
	60.01-80.00	0	0	0	0	0	0	0	0	0
	80.01-100.00	0	0	0	0	0	0	0	0	0
Total		44	48	44	48	48	51	64	73	420

Conclusions:

The present study has been done to detect the LULC change of four point of time such as 2005, 2010, 2015 and 2018 for the month of the March (dry season) and September (rainy season). Thirteen category of the LULC has been classified using Landsat satellite images and Google Earth with the help of ERDAS Imagine (11) and Arc-GIS (10.1) software. Seasonal and temporal conversion of the LULC has been identified and measured for better analysis. Annual growth rate of the Agricultural land and fisheries is calculated and a cross table is developed to detect the net gain and net loss from one category to another. As a result, most LULC conversion is found between agricultural land and fisheries. In seasonal change, agricultural lands are replaced by fisheries in total study time due to water logging in rainy season. Fisheries are occupied large amount of agricultural land, 3343.63 ha in dry and 2971.55 ha in rainy season from 2005 to 2018. Very less participation are found from other categories of LULC classes. Rail way and platform have not any contribution in the conversion process.

Conversion of LULC is rigorously found in lower part of the basin, also central region of the Moyna block that is gradually spreads towards the surrounding area. The seasonal transformation amount of the LULC is decreased gradually from 2005 to 2018 but temporal conversion is increased steadily due to development of permanent fisheries. 150 interviews and a group discussion have been conducted to find out the causes the land transformation of the particular area. The output shows that 91.52 % of total farmers interested in fishing cultivation due to more profit than agriculture and have not any risk in fisheries. They give their land to the fishers for money and engaged in other economic activity. Local farmers and peoples are argue that area of the fisheries is enhanced towards the encompassed area and occupy the available agricultural land in future

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Conflict of interest On behalf of all authors, the corresponding author states that there is no conflict of interest.

References:

Badreldin, N. andR.Goossens,Monitoring land use/ land cover change using multi-temporal Landsat images in an arid environment: A case study of EL-Arish, Egypt. Arabian Journal of Geosciences, 2013, 7(5): p. 1671-1681.

Bai, X., Sharma, R.C.,Tateishi, R.,Kondoh, A.,Wuliangha, B. andG. Tana,A detailed and high resolution land use and land cover change analysis over the past 16 years in the Horqin sandy land, Inner Mongolia. Mathematical Problems in Engineering, 2017. P. 1-13.

Benini, L.,Bandini, V.,Marazza, D. andA. Contin, Assessment of land use changes through an indicator-based approach: A case study from the Lamone river basin in Northern Italy. Ecological Indicators, 2010.**10**(1): p. 4-14.

Botkin, D.B., Estes, J.E. andR.B. MacDonald,Studying the earth’s vegetation from space.BioScience, 1984.**34**: p. 508–514.

Brahmabhatt, V.S., Dalwadi, G.B., Chhabra, S.B., Ray, S.S. and V.K. Dadhwal,Land use/ land cover change mapping in Mahi canal command area, Gujarat, using Multi-temporal satellite data. Journal of the Indian Society of Remote Sensing, 2000.**28**(4): p. 221-232.

Butt, A., Shabbir, R., Ahmad, S.S., N. Aziz,Land use change mapping and analysis using remote sensing and GIS: A case study of Simly watershed, Islamabad, Pakistan. The Egyptian Journal of Remote Sensing and Space Sciences, 2015.**18**(2): p. 251-259.

Cakir, G. andM. Ozdemir,Determination to results of forest management planning applications with land use changes from 1971 to 2008 in Yalova-Turkey. Journal of the Indian Society of Remote Sensing, 2014.**43**(1): p. 189-197.

Chen, X., Vierling, L. andD. Deering,A simple and effective radiometric correction method to improve landscape change detection across sensors and across time. Remote Sensing of Environment, 2005.**98**(1): p. 63–79.

Cohen, W.B. andS.N. Goward,Landsat's role in ecological applications of remote sensing. Bio-Science, 2004.**54**(6): p. 535–545.

Coppin, P., Jonckheere, I., Nackaerts, K. andB. Muys,Digital change detection methods in ecosystem monitoring: a review. International Journal of Remote Sensing, 2004.**25**(9): p. 1565–1596.

Coskun, H.G., Alganci, U. and G.Usta,Analysis of land use change and urbanization in the Kucukcekece water basin (Istanbul, Turkey) with temporal satellite data using remote sensing and GIS. Sensors, 2008.**13:8**(11): p. 7213-7223.

Das, S. andM.R. Choudhury,Earth Observation and management of land use and land cover dynamics- a case study of Guwahati city, Assam, India. International Journal of Environmental Sciences, 2015.**5**(6): p. 1061-1077.

Datta, K. and S. Sarkar,Calculation of area, mapping and vulnerability assessment of a geomorphosite from GPS survey and high resolution Google Earth satellite image: a study in Mama BhagnePahar, Dubrajpur C.D. block, Birbhum district, West Bengal. Spatial Information Research, 2019.https://doi.org/10.1007/s41324-019-00249-1

David, T.I., Mukesh, M.V., Kumaravel, S., Ramesh, G. and R. Premkumar,Exploring 16 years changing dynamics for land use/land cover in Pearl City (Thoothukudi) with spatial technology. Spatial Information Research, 2017.**25**(4): p. 547-554.

Dewan, A.M. and Y.Yamagulchi,Using remote sensing and GIS to detect and monitor land use and land cover change in Dhaka metropolitan in Bangladesh 1960-2005. Environmental Monitoring and Assessment, 2009.**150**(1-4): p. 237-249.

Dhinwa, P.S., Pathan, S.K., Sastry, S.V.C., Rao, M., Majumder, K.L., M.L. Chotani,et. al., Land use change analysis of Bharatpur district using GIS. Journal of the Indian Society of Remote Sensing, 1992.**20**(4): p. 237-250.

Dong, Q., Wang, W., Ma, M., Kong, J. andF. Veroustraetei,The change of land cover and land use and its impact factors in upriver key regions of the Yellow river. International Journal of Remote Sensing, 2009.**30**(5): p. 1251-1265.

Erener, A., Duzgun, S. andA.C. Yalciner, Evaluating land use/ land cover change with temporal satellite data and information system. Procedia Technology, 2012.**1**(2012): p. 385-389.

Hassan, Z., Shabbir, R., Ahmed, S.S., Malik, A.H,, Aziz, N., A. Butt, et. al.,Dynamics of land use and land cover change (LULCC) using geospatial techniques: A case study of Islamabad, Pakistan. Springer Plus, 2016.**5**(1): p. 1-11.

Hu Q, Wu W, Xia T, Yu Q, Yang P, Li G et al (2013). Exploring the use of Google Earth imagery and object-based methods in land use/ cover mapping. Remote Sensing 5(11):6026-6042

Ji, L., You, L., See, L., Fritz, S., Li, C., S. Zhang, et. al.,Spatial and temporal changes of vegetable production in China. Journal of Land Use Science, 2018. https://doi.org/10.1080/1747423X.2018.1459908

Joshi, P.K. and S.Gairola,Land cover dynamics in Garhwal Himalayas- A case study of Balkhila sub-watershed. Journal of the Indian Society of Remote Sensing, 2004.**32**(2): p. 199-208.

Kilic, S., Evrendilek, F., Berberoglu, S. andA.C. Demirkesen,Environmental monitoring of land use land cover changes in Amik plain, Turkey. Commission VII WG, 2004.**VII/3**: p. 1-6.

C. Kim,Land use classification and land use change analysis using satellite images in Lombok Island, Indonesia. Forest Science and Technology, 2016.**12**(4): p. 183-191.

Kumar, K.V., Palit, A., Chakraborti, A.K., Bhan, S.K., Chowdhury, B. and T. Sanyal,Change detection study of islands of Hooghly estuary using multidate satellite images. Journal of the Indian Society of Remote Sensing, 1994.**22**(1): p. 1-8.

Lu, D., Hetrick, S. and E. Moran,Land cover classification in a complex urban-rural landscape with QuickBird imagery. Photogrammetric Engineering & Remote Sensing, 2010.**76**(10): p. 1159–1168.

Maddah, S., Karimi, S., Rezai, H. andJ. Khaledi,Detecting land use changes affected by human activities using remote sensing (case study: Karkheh river basin). Current World Environment, 2015.**10**(2): p. 473-481.

Mahajan, S. andP. Panwar,Land use changes in AshwaniKhad watershed using GIS techniques. Journal of the Indian Society of Remote Sensing, 2005.**33**(2): p. 227-232.

Malarvizhi, K., Kumar, V.S. andP. Porchelvan, Use of high resolution Google Earth satellite imagery in land use map preparation for urban related applications. Procedia Technology, 2016.**24**: p. 1835-1842.

Mallupattu, P.K. and J.R.S. Reddy,Analysis of land use / land cover changes using remote sensing data and GIS at an urban area, Tirupati, India. The Scientific World Journal, 2013. P. 1-6.

Mas, J.F., Velazquez, A., Gallegos, J.R.D., Saucedo, R.M., Alcantara, C., G. Bocco,et. al.,Assessing land use/ land cover changes: a nationwide multidate spatial database for Mexico. International Journal of Applied Earth Observation and Geoinformation, 2004.**5**(4): p. 249-261.

Meshesha, T.W., Tripathi, S.K. andD. Khare,Analysis of land use and land cover change dynamics using GIS and remote sensing during 1984 and 2015 in the Beressa watershed northern central highland of Ethiopia. Modeling Earth Systems and Environment, 2016. **2**: p. 1-12.

Munteanu, C., Kuemmerle, T., Boltiziar, M., Butsic, V., Gimmi, U., L. Halada,et. al.,Forest and agricultural land change in the Carpathian region- a meta-analysis of long-term patterns and drivers of change. Land use Policy, 2014.**38**: p. 685-697.

Nuñez, M.N., Ciapessoni, H.H., Rolla, A., Kalnay, E. andM. Cai,Impact of land use and precipitation changes on surface temperature trends in Argentina. Journal of Geophysical Research, 2008. http://doi:10.1029/2007JD008638

Oyinloye, M.A.A. andO. Kufoniyi,Application of IKONOS satellite images in monitoring of urban landuse change in Ikeja, GRA, Lagos, Nigeria. International Journal of Engineering Science Invention, 2013. 2(5): p. 1–10.

Pasha, S.V., Reddy, C.S., Jha, C.S., Rao, P.V.V.P. andV.K. Dadhwal,Assessment of land cover change hotspots in Gulf of Kachchh, India using multi-temporal remote sensing data and GIS. Journal of the Indian Society of Remote Sensing, 2016.**44**(6): p. 905-913.

Pillay, K., Agjee, N.H. andS. Pillay,Modelling changes in land cover patterns in Mtunzini, South Africa using satellite imagery. Journal of the Indian Society of Remote Sensing, 2014.**42**(1): p. 51-60.

Rahman, A., Kumar, S., Fazal, S. and M.A. Siddiqui,Assessment of land use/land cover change in the North-West district of Delhi using remote sensing and GIS techniques. Journal of the Indian Society of Remote Sensing, 2012.**40**(4): p. 689-697.

Rajesh, S., Arivazhagan, S., Moses, K.P. andR. Abisekaraj,Land cover/land use mapping using different wavelet packet transforms for LISS IV Madurai imagery. Journal of the Indian Society of Remote Sensing, 2012.**40**(2): p. 313-324.

Rajesh, S.V.J.S.S., Rao, B.P. andK. Niranjan,Pennar (Somasila) to Cauvery (Grand Anicut) inter basin water transfer impact assessment on land use/land cover environment. Journal of Water Resource and Protection, 2017.**9**(04): p. 393-409.

Ramachandran, R.M. and C.S. Reddy, Monitoring of deforestation and land use changes (1925-2012) in Idukki district, Kerala, India using remote sensing and GIS. Journal of the Indian Society of Remote Sensing, 2015.**45**(1): p. 163-170.

Rawat, J.S. andM. Kumar,Monitoring land use/ cover change using remote sensing and GIS techniques: a case study of Hawalbagh block, district Almora, Uttarakhand, India. The Egyptian Journal of Remote Sensing and Space Science, 2015.**18**(1): p. 77-84.

Shamsudheen, M., Dasog, G.S. andN.B. Tejaswini,Land use / land cover mapping in the coastal area of North Karnataka using remote sensing data. Journal of the Indian Society of Remote Sensing, 2005.**33**(2): p. 253-257.

Shetty, A., Nandagiri, L., Thokchom, S. andM.V.S. Rajesh,Land use- land cover mapping using satellite data for a forested watershed, Udupi district, Karnataka state, India. Journal of the Indian Society of Remote Sensing, 2005.**33**(2): p. 233-238.

Singh, A.M. and K.R. Devi, Land use and land cover change detection of fringe areas of Imphal city, Manipur, India. Journal of Humanities and Social Science, 2016.**21**(2): p. 9-16.

Singh, B. andC. Jeganathan,Spatial-temporal forest change assessment using time series satellite data in Palamu district of Jharkhand, India. Journal of the Indian Society of Remote Sensing, 2016.**44**(4): p. 573-581.

Singh, G., Sarkar, M.S., Pandey, A., Lingwal, S., Rai, I.D., B.S. Adhikari,et. al.,Quantifying four decades of changes in land use and land cover in India's Kailash sacred landscape: suggested option for priority based patch level future forest conservation. Journal of the Indian Society of Remote Sensing, 2018.**46**(10): p. 1625-1635.

Stefanov, W.L., Ramsey, M.S. andP.R. Christesen,Monitoring urban land cover change: an expert system approach to land cover classification of semiarid to arid urban centers. Remote Sensing of Environment, 2001.**77**(2): p. 173-185.

Sundarakumar, K., Harika, M., Begum, S.A., Yamini, S and K.Balakrishna, Land use and land cover change detection and urban sprawl analysis of Vijayawada city using multi temporal satellite data. International Journal of Engineering Science and Technology, 2012.**4**(1): p. 170-178.

Tehrany, M.S., Pradhan, B. and M.N.Jebuv,A comparative assessment between object and pixel-based classification approaches for land use/land cover mapping using SPOT 5 imagery. Geocarto International, 2014.**29**(4): p. 351–369.

Thakkar, D.B., Patel, A.V. andM. Patel,Geometric distortion and correction methods for finding key points: a survey. International Journal for Scientific Research & Development, 2016.**4**(2): p. 311-314.

Thenkabail, P.S., Schull, M. and H. Turral, (2005) Ganges and Indus river basin land use/land cover (LULC) and irrigated area mapping using continuous streams of MODIS data. Remote Sensing of Environment, 2005.**95**(3): p. 317–341.

Tilahun, A. andZ. Islam, Google Earth for land use land cover change detection in the case of Gish AbbaySekela, West Gojjam, Amhara state, Ethiopia. International Journal of Advancement in Remote Sensing, GIS and Geography, 2015.**3**(2): p. 80-87.

Tilahun, A. andB. Teferie,Accuracy assessment of land use land cover classification using Google Earth. American Journal of Environmental Protection, 2015.**4**(4): p. 193-198.

Tyagi, P. andU. Bhosle, Atmospheric correction of remotely sensed images in spatial and transform domain. International Journal of Image Processing, 2011.**5**(5): p. 564-579.

Usman, M., Liedl, R., Shahid, M.A. andA. Abbas,Land use/ land cover classification and its change detection using multi-temporal MODIS NDVI data. Journal of Geographical Sciences, 2015.**25**(12): p. 1479-1506.

Vittek, M., Brink, A., Donnay, F., Simonetti, D. andB. Desclee,Land cover change monitoring using Landsat MSS/TM satellite image data over West Africa between 1975 and 1990. Remote Sensing, 2014.**6**(1): p. 658-676.

Waske, B. andM. Braun, Classifier ensembles for land cover mapping using multi temporal SAR imagery. ISPRS Journal of Photogrammetry and Remote Sensing, 2009. **64**(5): p. 450–457.

Wilkie, D.S. andJ.T. Finn, Remote sensing imagery for natural resources monitoring: a guide for first-time users. Columbia University Press, New York, 1996.