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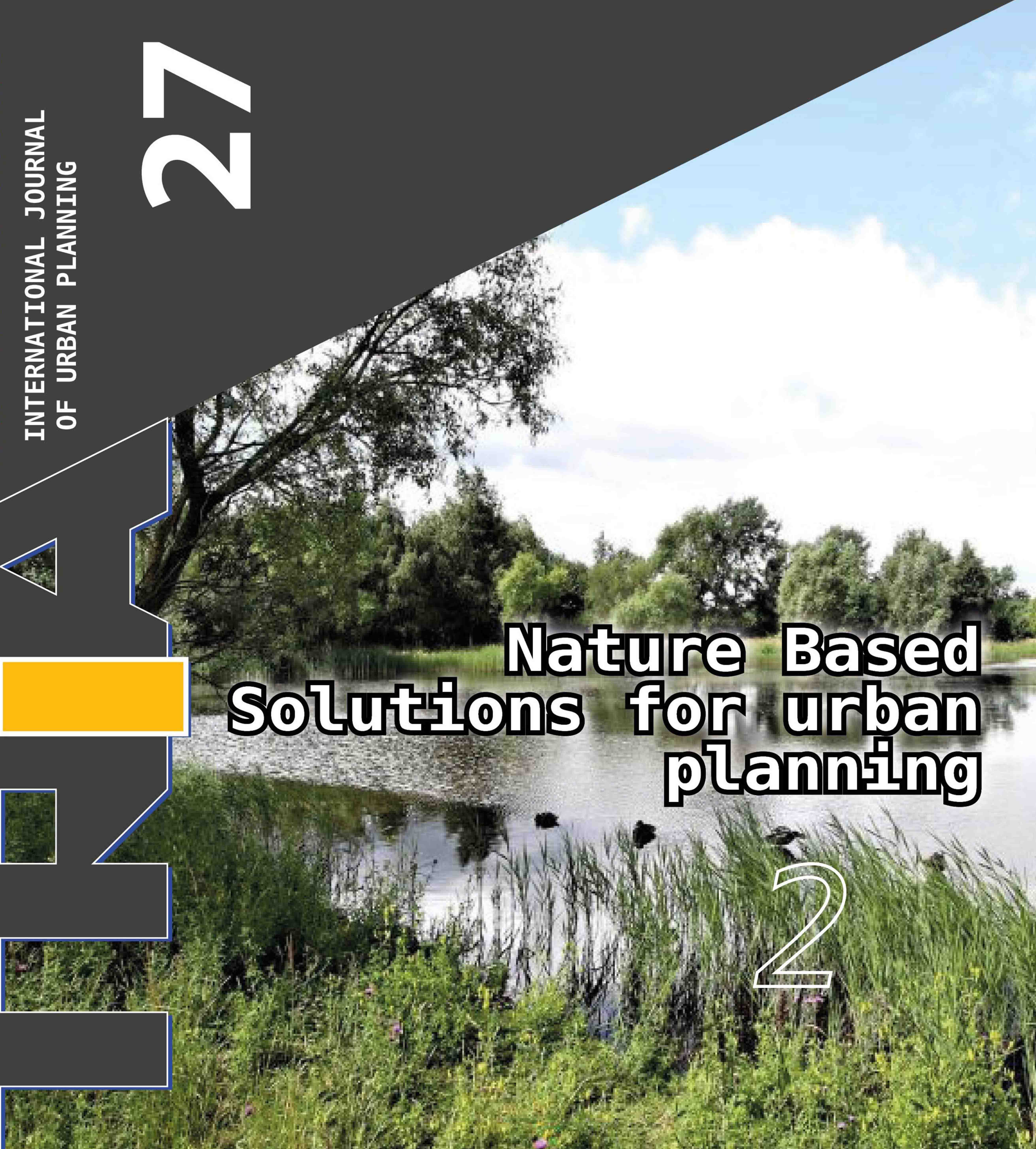

Nature Based Solutions for urban planning

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sommario

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abstract

Spatio-temporal change – An analytical geospatial study using satellite data – Farakka block, Murshidabad district, West Bengal (India)

Subham Kumar Roy, Abdus Sattar Shaikh

Abstract

The present study is mainly based on Remote Sensing and G.I.S analysis of the land use and land cover changes of Farakka community development block at Murshidabad district of West Bengal on spatio – temporal basis from Landsat Image 1990 to 2020. The main objectives are to detect the changes in land use and land cover and to examine the main factors and their impact on landscape dynamics. The Landsat images of the study area are classified into six categories with the help of GIS software and Google verified and validated by the process of accuracy assessment. The change detection analyses Earth Pro software. An image has been classified digitally with the help of the Supervised Image Classification method under Maximum Likelihood Classification techniques which also helps to identify the transformation of land from vegetation cover

to agricultural land and built-up area.

Keywords:
Accuracy assessment, Change detection, Maximum likelihood classification, Landscape dynamics, Land use and Land cover

Cambiamento spazio-temporale – Uno studio geospaziale analitico utilizzando dati satellitari – Quartiere di Farakka, distretto di Murshidabad, West Bengal (India)

Le infrastrutture ambientali giocano oggi un ruolo prioritario e strutturante nelle pratiche di rigenerazione urbana per il futuro della città contemporanea.

A partire dalla rilettura delle politiche internazionali ed europee, dei piani di ultima generazione e delle radici del tema e del disegno, sono state rintracciate nuove categorie interpretative delle infrastrutture verdi e blu (Ivb) al fine di costruire una toolbox, cassetta degli attrezzi delle azioni virtuose di cui la città deve dotarsi per affrontare le questioni in gioco.

Attraverso l'analisi degli strumenti e delle dinamiche in atto nella città di Milano, come esperienza paradigmatica per ripensare traiettorie possibili per il futuro della città contemporanea, è stato ricostruito un quadro sinottico e kit metodologico di quali sono gli strumenti per progettarle, gestirle e programmarle, dalla scala metropolitana a quella di prossimità.

Parole Chiave:
infrastruttura verde, infrastruttura blu, città contemporanea, rigenerazione urbana, toolbox

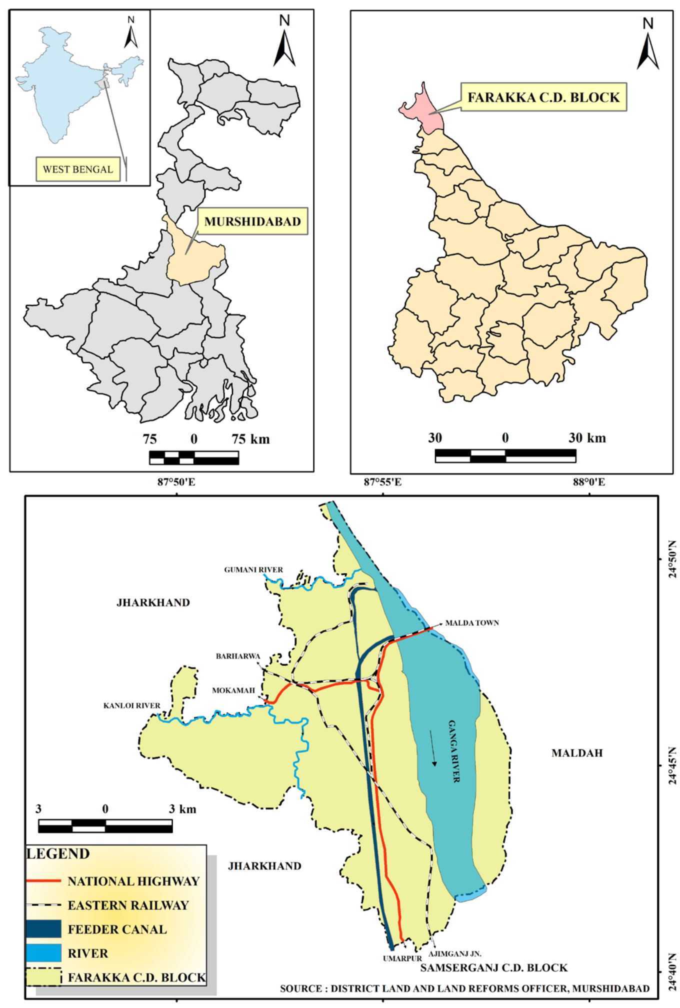
Spatio-temporal change – An analytical geospatial study using satellite data – Farakka block, Murshidabad district, West Bengal (India)

Subham Kumar Roy, Abdus Sattar Shaikh

1. Introduction

The land is a product of nature and it is an example of three-dimensional dynamic complex bodies. A part of land developed through the interaction of lithology, structure, drainage, climate, vegetation, and the geomorphological processes operating through time. As a result, different types of landforms have evolved in different parts of the earth. The potentialities and capabilities of these diverse landscapes, therefore, vary in time and space. Thus the nature and character of landforms reflect different environmental conditions and accordingly the types and patterns of land use change (De & Jana, 1997). The term Land cover mainly referred to the physical setup of the land surface but has broadened subsequently to include human structures, such as buildings or pavement, and other aspects of the physical environment, such as soils, biodiversity, surfaces, and groundwater (Moser, 1996). Broadly speaking, Land use means the actual use of land. The term may be defined as the putting up of a parcel of land for any purpose (De & Jana, 1997). Land utilization is the conversion of land from one major use to another general use (Nanavati, 1957). Land use is the application of human controls systematically to the key elements of any ecosystem to derive benefit from it, man being an essential part of the ecosystem tries to manipulate it (De & Jana, 1997). Land use concerns the function or purpose for which the land is used by the local human population and can be defined as the human activities, which are directly related to land, making use of its resources or having an impact on them(FAO, 1995). Land use (both deliberately and unintentionally) alters land cover changes in three ways: converting the land cover (qualitatively); modifying (quantitatively changing) its condition without full conversion; and maintaining it in its condition against natural agents of change" (Meyer and Turner 1996). The land use change may involve either (a) conversion from one type of use to another or (b) modification of a certain type of land use (Briassoulis, 2002). Landscape dynamics mainly identify the landscape, such as stability, persistence, resistance, resilience, and recovery that operate along with a broad range of temporal and spatial scales, such as shifting mosaic steady-state, and equilibrium spatial properties (Oxford Bibliographies 2017). A landscape is a natural arrangement on interrelated tracts of land which is very complicated in nature, the study of landscape dynamics ii is very much relevant for land use land cover planning management (De & Jana, 1997). Change detection has a significant process for managing and monitoring natural resources and urban development mainly due to the provision of quantitative analysis of the spatial distribution based on a temporal scale. There are a lot of available techniques that serve the purpose of detecting and recording differences and might also be attributable to change (Singh, 1989). The accurate and timely land use and land cover maps derived from remotely sensed images are the keys for monitoring and quantifying various aspects of global and local climate changes, hydrology, biodiversity conservation, and air pollution (Bonan 2008). Land use information forms an important part of the decision making at international, national, and state levels. At the national level, land use information is an important element forming policies regarding economic, demographic, and environmental issues. International requirements for land use data also focus on many of today's major concerns considered at their broadest level. The remote sensing technique has emerged as a powerful tool to study land use and land cover changes. It not only provides reliable and accurate baseline information for land use mapping but also generalized delineation of land use classification for large areas and spatial distribution of land use categories is easily possible through satellite imageries (Campbell, 2003; Jenson, 2004). The relative advantage of remote sensing over conventional methods is that not only is the synoptic view of the area under the study available but also change detections are easily deciphered (Verma,2013). So, overall knowledge of the land, soil, and water is indispensable for understanding the past and present land use as well as for the future prediction (De & Sarkar, 1992).

Fig. 1 – Location Map of Study Area.



2. Objectives

The main objectives of the study are as follows -

a. To detect the changes of land use and land cover.

b. To examine the main factors and its impact on landscape dynamics.

c. To identify major land use and land cover problems and provide some probable solutions.

3. Study area

The study area of the Farakka community development block is the northernmost block of Murshidabad district under the Jangipur subdivision. Farakka CD Block is bounded by in the northern part Kaliachak III CD Block, in the western part Barhawarwa CD Block in Jharkhand, in the southern part Pakur CD Block at Jharkhand and in the eastern part Samserganj CD Block. It is lies between 24°40'29'' N to 23°51'17'' N and 87°55'48'' E to 87°53'27'' E. Farakka CD Block has an area of nearly 133.63 km2. According to Census 2011 total population of the Farakka CD Block was 274,111, under of which 167,826 were rural and 106,285 were urban. It has 1 panchayat samity , 9-gram panchayats, 147-

Tab. 1 – Types of the Data for Study.
Source: Prepared by Authors, 2021.

	SPATIAL DATA	DATA	DATA SOURCE	DATA OF ACQUISITION
SECONDARY DATA	SATELLITE IMAGE	LANDSAT 5 TM	USGS PATH 139 ROW 043	2/6/1990
		LANDSAT 8 OLI/TIRS		12/3/2020
	ADMINISTRATIVE MAP	BLOCK BOUNDARY	DLLRO, SADAR OFFICE	15/12/2020
	NONSPATIAL DATA	DISTRICT CENSUS HAND BOOK,2011 DISTRICT STATISTICAL HANDBOOK , 2010,2011,2013,2014 DISTRICT DISASTER MANAGEMENT PLAN 2020 - 21		

gram sansads (village councils), 73 mouzas and 56 inhabited villages and 8 census towns area available(Census,2011). Farakka police station serves this block. The headquarters of this CD Block is at Farakka. This area was mainly developed by their functionality – Farakka barrage construction started in 1961 and the project was worked in force for Nation in May 1975 and Farakka Super Thermal Power Plant is coal based power plant of National Thermal Power Corporation 1986. Farakka Port is a minor river port under National waterway 1 that handles mainly coal imported for Farakka Super Thermal Power Station.

4. Database & methodology

4.1. Database

The present study is mainly based on secondary data source satellite images Landsat 5 TM and Landsat 8 OLI/TIS images (path 139 and row 043) have been used. The Landsat TM (Date 2nd June 1990) and Landsat 8 OLI/TIS satellite images (Date 12th March 2020) were downloaded from the United States Geological Survey (USGS) Earth Explorer website. The spatial resolution of both Landsat satellite images is 30 meters all visible bands are included in the analysis part. In this study, ArcGis 10.2 and QGIS 2.14 software are used for the purpose of image processing. Both satellite images are geo-referenced to the Universal Transverse Mercator (UTM) coordinate system and WGS-84 datum.

4.2. Supervised Image Classification

A genuine procedure for identifying spectrally similar areas on satellite image by the assign of training sites of known targets and then extracting those spectral signatures to other areas of unknown targets are called supervised image classification. These classifications are a three-stage process performed by the analyst consisting of training, classification, and output. During the training stage, training sites are selected by the analyst to represent areas with known cover types. The analyst establishes the relationships between the various land cover types and the spectral data of multiple wavelength bands at the very first stage or training stage. The classification stage is the second stage of supervised classification: to differentiate numerous spectral bands

LANDUSE AND LAND COVER CLASS	DESCRIPTION
WATERBODY	Rivers, Canals, Ponds
SAND	Riverian Sands
VEGETATION AREA	Deciduous Forest Lands, Gardens, Mixed Forest Lands, Roadside or Riverside vegetation areas etc.
BARREN LAND	Permanently fallow area with stony or rocky body and other residual landforms
AGRICULTURAL LAND	Presently Cultivated Lands or Plantation areas
BUILTUP AREA	Residential, Commercial and Services lands

Tab. 2 – Land use and Land cover classes of study area. Prepared by Authors, 2021.

into accurate land use and land cover categories, several classifications, and pattern recognition algorithms have been developed for supervised classification. The most widely used classification algorithms are a maximum likelihood. The final stage is known as the output stage. Output products are used for presentation, visualization, and interpretation of the results. In the end, the classified data is compressed into a desired group of classes as determined by the analyst and presented in digital graphical and tabular form. The output product is accompanied by the statistical parameters, accuracy assessment table, and other supporting information (S. Khorram et. al.2013). In this work, a supervised image classification method has been used to show the change detection within a 30 years time span. In the supervised image classification, groups of training pixels are adopted to represent six land uses and land cover units of the study area. Each and every image is independently classified in a supervised classification method with the help of a maximum likelihood algorithm using Arc GIS (10.2) software.

4.2.1. Maximum Likelihood Classification Algorithm

The most powerful supervised parametric classifier in common use is that of maximum likelihood based on statistics (mean, variance/covariance). This method applies the probability theory to the classification task. This probability depends upon the distance from the cell to the class center and the size and shape of the class in spectral space. The maximum Likelihood Classification method computes all of the class probabilities for each raster cell and assigns the cell to the cell to the class with the highest probability value. The 'minimum distance to means' method when classes vary significantly in size and shape of spectral space when more accurate class assignments are on it. However, it should be borne in mind that several classes are not normal components of the actual ground scene (Bhatta, 2015).

4.3. Accuracy Assessment

Accuracy assessment has been a key component and the focus of a significant number of remote sensing studies. However, the accuracy assessment of change detection procedures is not in the operational stage yet and involves issues such as not yet widely accepted sampling techniques, image registration, boundary problems, and reference data. The error sources involved in the accuracy assessment include registration differences between reference data and remotely sensed data, delineation errors in digitizing, data entry errors, errors in image classification, delineation, errors involved in sampling or collection of reference data. The most commonly used procedure for accuracy assessment is error matrix analysis (S. Khorram et al.2013). The total number of correct samples in a given category is divided by the total number of samples based on classified data, and then this indicates the commission error. This measure is called "user's accuracy" or reliability because the user is interested in the probability that a classified sample represents the actual category on the ground surface (Story and Congalton 1986). Multivariate statistical measures have also been used for accuracy assessment. The most commonly used is a discrete multivariate technique, is called KAPPA.

Fig. 2 – Kappa Statistics. Source: Lillesand et. al.2015.

$$\hat{k} = \frac{N\sum_{i=1}^{r} x_{ii} - \sum_{i=1}^{r}(x_{i+} \cdot x_{+i})}{N^2 - \sum_{i=1}^{r}(x_{i+} \cdot x_{+i})}$$

where

r = number of rows in the error matrix
x_{ii} = number of observations in row i and column i (on the major diagonal)
x_{i+} = total of observations in row i (shown as marginal total to right of the matrix)
x_{+i} = total of observations in column i (shown as marginal total at bottom of the matrix)
N = total number of observations included in matrix

Tab. 3 – Kappa Statistics (Rwanga, 2017). Source: Das & Sahu, 2020.

Sl. No.	Value of K	Strength of agreement
1	<0.00	Poor
2	0.00 – 0.20	Slight
3	0.21 – 0.40	Fair
4	0.41 – 0.60	Moderate
5	0.61 – 0.80	Good
6	0.81 – 1.00	Very good

Fig. 3 – Correlation coefficient. Source: https://www.investopedia.com

$$r = \frac{\sum (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum (x_i - \bar{x})^2 \sum (y_i - \bar{y})^2}}$$

r = correlation coefficient
x_i = values of the x-variable in a sample
$\bar{x}$ = mean of the values of the x-variable
y_i = values of the y-variable in a sample
$\bar{y}$ = mean of the values of the y-variable

In the present study, for each class of land use and land cover unit with random training samples are taken to establish the relationship between satellite image and actual image. MS EXCEL 07 (Add Ins) is also used for analysis Pearson's product-moment correlation to understand the inter relationship among the classes and identify the actual changes within the group or outside the group of classes and provide accurate significance between satellite image interpretation and statistical measures.

5. Result and discussion

5.1. Land use and Land Cover Classification 1990

Land use land cover classification was done in the study area under the supervised classification method using maximum likelihood algorithm. On the basis of the number of pixels, the area of each class was calculated (Das & Sahu, 2020). Based on the land use land cover map of 1990 the area and percentage of areas as classified are water bodies 12.24 % (16.68 Sq.Km.), sand 4.08 %(5.14 Sq.Km.), vegetation area 23.80 % (31.5 Sq.Km.), barren land 16.05 % (12.24 Sq.Km.), agricultural field 27.21 %(36.37 Sq.km.) and built up area 20.40% (27.56 Sq.Km.). The dominated land use class was agricultural field and main land cover type was vegetation cover.

5.2. Land use and Land Cover Classification 2020

In other hand based on the land use land cover map of 2020 the area and percentage of areas as classified are water bodies 11.64 % (15.51 Sq.Km.), sand 6.16 %(5.14 Sq.Km.), vegetation area 12.32 % (16.19 Sq.Km.), barren land 6.84 % (9.08 Sq.Km.), agricultural field 34.93 %(46.91 Sq.km.) and built up area 28.08% (37.05 Sq.Km.). The dominated land use class was agricultural field and main land cover type was vegetation cover. In case of spatio temporal change it is very indicated that most part of the vegetation cover transforms into agricultural land or built up area.

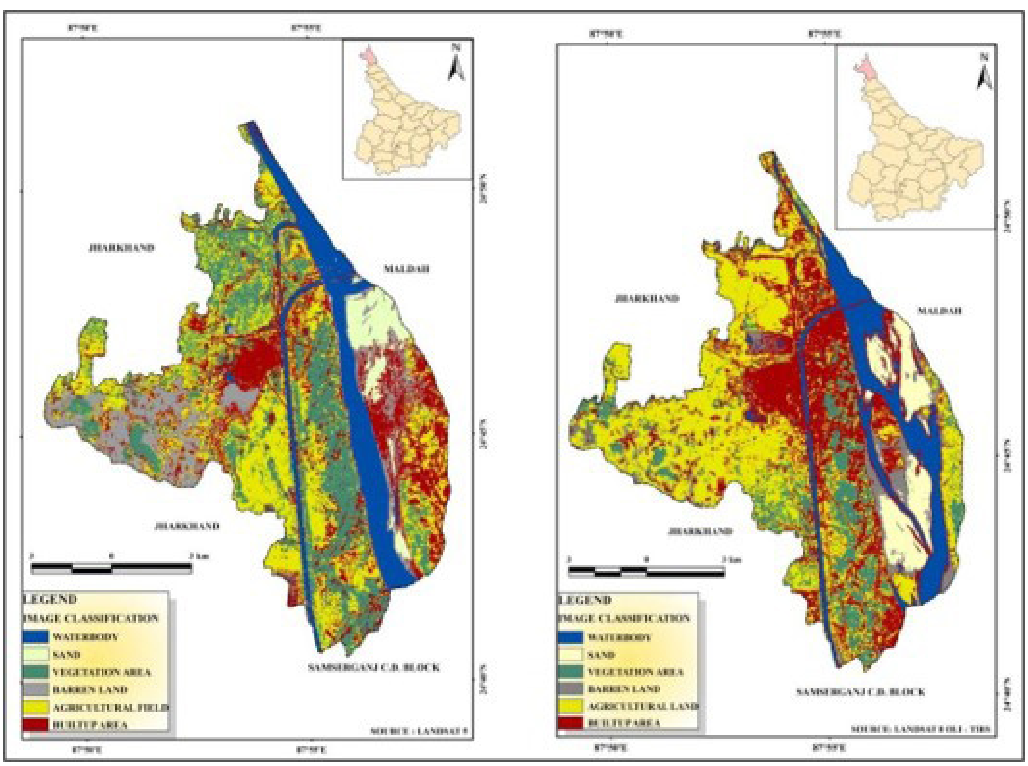


Fig. 4 – Land use and Land cover classification, 1990 & 2020.

5.3. Correlation

Pearson's Product Moment Correlation coefficient(r) technique is applied to show the association among the Land use and Land cover classes. The value of 'r' lies between ±1 , value of r = +1.0 indicates a perfectly direct or perfectly positive correlation, and value of r = −1.0 indicates a perfectly inverse or perfectly negative correlation (Sarkar 2015). Table 4 indicates the positive and negative relationship among the Land use and Land cover classes of the study area within a period. It reveals that Built-up Land positively associated with the Crop Land 0.5 and Sandy Area 0.52 and another hand, a strong negative relationship with the vegetation and agricultural field -1 and vegetation cover and built-up area -0.78.

Tab. 4 – Showing correlation coefficient (r) among the classified land use and land cover types of the study area. Source: Calculated by the authors (With 95% significance level).

LAND USE / LAND COVER CLASSES	WATERBODY	SAND	VEGETATIONAL COVER	BARREN LAND	AGRICULTURAL FIELD	BUILTUP AREA
WATERBODY	1	-0.89	0.75	0.32	-0.21	-0.45
SAND	-0.89	1	-0.5	-1	0.5	0.52
VEGETATIONAL COVER	0.75	-0.5	1	0.63	-1	-0.78
BARREN LAND	0.32	-1	0.63	1	-0.88	-0.45
AGRICULTURAL FIELD	-0.21	0.5	-1	-0.88	1	0.5
BUILTUP AREA	-0.45	0.52	-0.78	-0.45	0.5	1

5.4. Accuracy assessment

Accuracy assessment is one of the most important steps to validate the land use and land cover change detection data with referenced data. In this case 100 sample points were randomly selected from Landsat TM data 1990 and Landsat OLI/TIRS data 2020 to examine the classification accuracy. The column of the error matrix shows the ground truth data and rows show the reference data. The diagonal elements of the error matrix indicate the number of corrected classified pixels. Overall accuracy and the Kappa statistical value were most important for accuracy assessment. The overall accuracy of both classified Landsat satellite images were 81% (1990) and 78% (2020) respectively.

Tab. 5 – Accuracy assessment of LANDSAT TM 1990. Source: Calculated by the authors.

LAND USE / LAND COVER CLASS	WATERBODY	SAND	VEGETATIONAL COVER	BARREN LAND	AGRICULTURAL LAND	BUILTUP AREA	USER	
WATERBODY	12	1	0	0	1	0	14	
SAND	0	8	1	0	1	1	11	
VEGETATIONAL COVER	0	0	19	0	2	1	22	
BARREN LAND	0	0	0	11	1	0	12	
AGRICULTURAL LAND	0	0	2	1	22	2	27	
BUILTUP AREA	0	1	2	1	1	9	14	
PRODUCER	12	10	24	13	28	13	81	100
OVERALL ACCURACY	0.81						100	
USER ACCURACY	0.857142857	0.72727	0.863636364	0.9166667	0.814814815	0.642857		
PRODUCER ACCURACY	1	0.8	0.791666667	0.8461538	0.785714286	0.692308		
KAPPA STATISTICS	0.765432099							

LAND USE / LAND COVER CLASS	WATER BODY	SAND	VEGETATIONAL COVER	BARREN LAND	AGRICULTURAL LAND	BUILTUP AREA	USER	
WATERBODY	12	1	0	0	1	0	14	
SAND	0	6	1	0	1	1	9	
VEGETATIONAL COVER	0	0	15	0	2	1	18	
BARREN LAND	0	0	0	8	1	0	9	
AGRICULTURAL LAND	1	0	2	2	25	2	32	
BUILTUP AREA	0	1	3	1	1	12	18	
PRODUCER	13	8	21	11	31	16	78	100
OVERALL ACCURACY	78						100	
USER ACCURACY	0.857142857	0.666667	0.833333333	0.888888889	0.78125	0.666666667		
PRODUCER ACCURACY	0.923076923	0.75	0.714285714	0.727272727	0.806451613	0.75		
KAPPA	0.724621354							

Tab. 6 – Accuracy assessment of LANDSAT OLI/ TIRS 2020. Source: Calculated by the authors.

The Kappa coefficient statistical value of both classified Landsat satellite images were 0.76 and 0.72 respectively which is remarked as a good result

5.5. Change Detection

The study area is mainly classified as agricultural or vegetation based area except some urban sector and industrial part in Farakka township surrounding area. There has been significant spatial change that occurred within a thirty year time span, two massive land use changes such as – agricultural field and built-up area. Spatial changes including surface organization of land use and land cover and their interrelationship with a focus direction and spread are well explained.

• Water body: It is mainly focused as a river, canals, ponds etc. In the year of 1990 and 2020 water bodies covered area was 12.24% and 11.64%, so negative value has been found -0.6% that indicates partial water bodies converted into built-up area nearly

Tab. 7 – Change detection from 1990 to 2020. Source: Calculated by the authors.

CLASSIFICATION	Sq. Km	% of Area 1990	Sq. Km	% of Area 2020	Change Sq. Km.	Change % of Area
WATERBODY	16.68	12.24489796	15.51	11.64383562	-1.17	-0.60106234
SAND	5.14	4.081632653	8.56	6.164383562	3.42	2.082750909
VEGETATIONAL COVER	31.5	23.80952381	16.19	12.32876712	-15.31	-11.4807567
BARREN LAND	16.05	12.24489796	9.08	6.849315068	-6.97	-5.39558289
AGRICULTURAL FIELD	36.37	27.21088435	46.91	34.93150685	10.54	7.720622496
BUILTUP AREA	27.56	20.40816327	37.05	28.08219178	9.49	7.674028516

Tab. 8 – Change detection Within Class and Outside Class from 1990 to 2020. Source: Calculated by the authors.

SL.NO.	CHANGE CLASS	% OF AREA
1	WATERBODY - WATERBODY	6.184643101
2	WATERBODY - SAND	1.53485732
3	WATERBODY - VEGETATION	0.238320899
4	WATERBODY - BARRENLAND	1.379992985
5	WATERBODY - AGRICULTURAL LAND	1.128731117
6	WATERBODY - BUILTUP AREA	2.052793857
7	SAND - WATERBODY	0.749371147
8	SAND - SAND	1.556085594
9	SAND - BARRENLAND	0.583569382
10	SAND - AGRICULTURAL LAND	0.0577485
11	SAND - BUILTUP AREA	0.912420596
12	VEGETATION - WATERBODY	0.655463378
13	VEGETATION - SAND	0.229846621
14	VEGETATION - VEGETATION	4.882089829
15	VEGETATION - BARRENLAND	0.532670531
16	VEGETATION - AGRICULTURAL LAND	9.394876322
17	VEGETATION - BUILTUP AREA	7.946021679
18	BARREN LAND - WATERBODY	1.078999124
19	BARREN LAND - SAND	1.27641791
20	BARREN LAND - VEGETATION	0.33250815
21	BARREN LAND - BARRENLAND	1.7144672
22	BARREN LAND - AGRICULTURAL LAND	5.710278112
23	BARREN LAND - BUILTUP AREA	1.923589656
24	AGRICULTURAL LAND - WATERBODY	1.141034883
25	AGRICULTURAL LAND - SAND	0.524941348
26	AGRICULTURAL LAND - VEGETATION	4.899430223
27	AGRICULTURAL LAND - BARRENLAND	0.996657657
28	AGRICULTURAL LAND - AGRICULTURAL LAND	13.30691186
29	AGRICULTURAL LAND - BUILTUP AREA	6.395117442
30	BUILTUP AREA - WATERBODY	1.839629907
31	BUILTUP AREA - SAND	1.309705741
32	BUILTUP AREA - VEGETATION	1.791481267
33	BUILTUP AREA - BARRENLAND	1.601571101
34	BUILTUP AREA - AGRICULTURAL LAND	5.565891497
35	BUILTUP AREA - BUILTUP AREA	8.571864063

2.05% (Table 8).

• Sand: Sand area mainly found in the river floodplain. In the year of 1990 and 2020 sand covered area was 4.08% and 6.16 %, so positive value has been found 2.08% that is indicated mainly high intention river bank erosion each and every year in rainy seasons and flood even occurred in the fringe region of Jharkhand Bengal border built-up area into sand or point bar area nearly 0.91%(Table 8).

• Vegetation Cover: This land cover mainly classifies Deciduous Forest Lands, Gardens, Mixed Forest Lands, Roadside or Riverside vegetation areas etc. In the year 1990 and 2020 vegetation cover covered area was 23.80% and 12.32%, so negative values were found -11.48% . So, that area mainly converted into agricultural fields 9.39% (Table 8).

• Barren Land: This type of land mainly found in the fringe region of West Bengal and Jharkhand and some patches of dumping ground of industrial waste. In the year 1990 and 2020 barren land covered area was 12.24% and 6.84 %, so negative values were found -6.97% . So, that area mainly transformed into an agricultural field 5.71% with help of irrigation process, land reclamation method and uses of modern techniques of agriculture.

• Agricultural Field: It is the most dominating land use type in that region. In the year of 1990 and 2020 agricultural field covered area was 27.21% and 34.93 %, so positive value has been found 7.72 % that indicates mainly fertile land, intensive use of irrigation and implementation of modern techniques of agriculture which indicates the high productivity in the agricultural sector.

• Built-up Area: It covered 20.40% land in 1990 and 2020 it was covered 28.08% so a positive trend have been found 7.67% due rapid process of urbanization, industrialization development and easy accessibility of urban services

6. Identification of major problem associated with land use and land cover changes

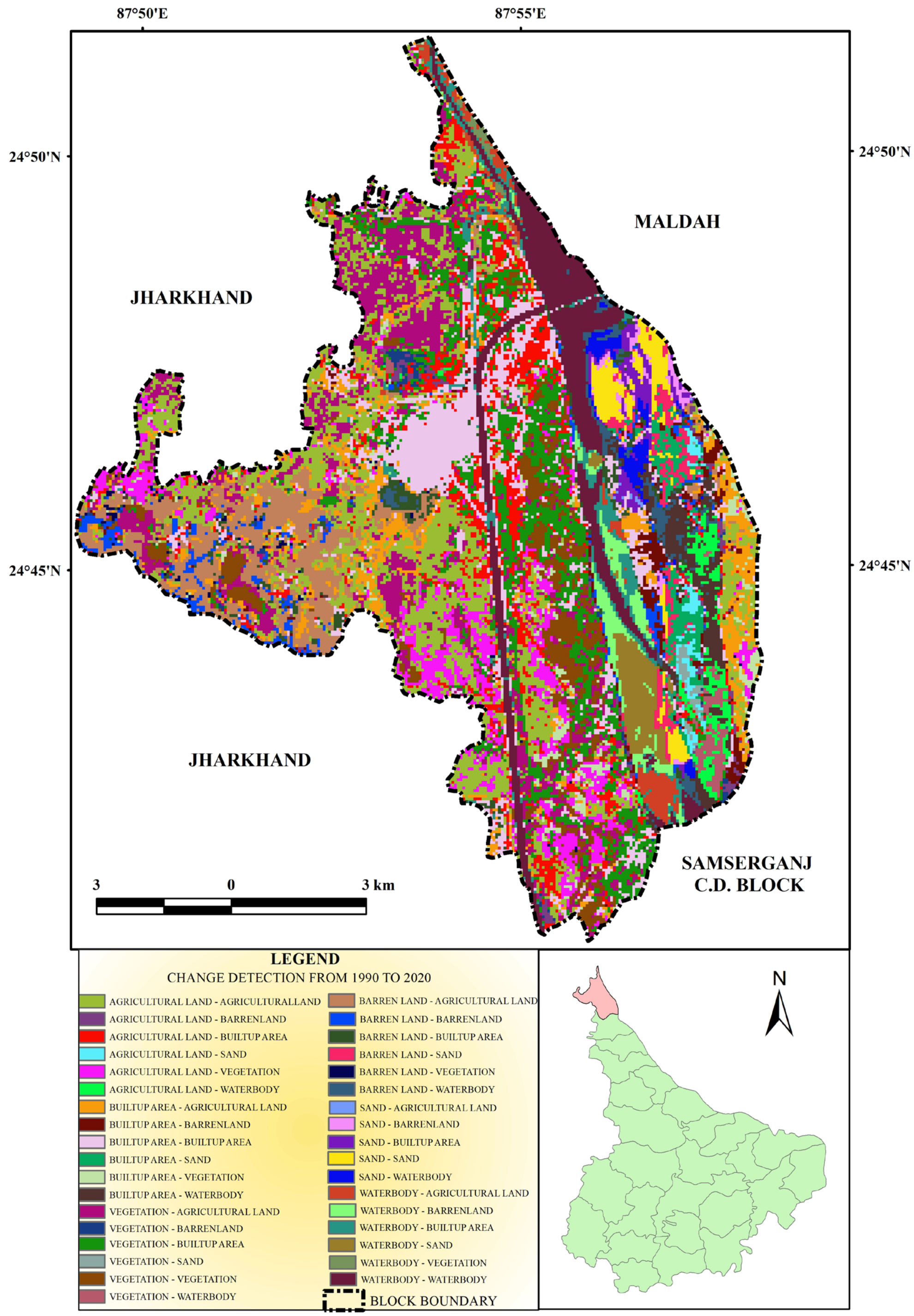
• Rivers by nature actively erode their banks, they change their courses by eroding one bank and depositing eroded materials in another bank. Riverbank erosion gets momentum during the rainy season when a discharge of water in the channel bed increases (De & Jana, 1997). According to the District Disaster Management Plan 2020 - 21 report of Murshidabad district, the 6 k.m long channel of Bhagirathi river represents a highly vulnerable zone of riverbank erosion.

• Flood is a natural as well as a man-induced phenomenon that causes severe erosion and total crop damage (De & Jana, 1997). According to the District Disaster Management Plan 2020 - 21 report of last year Arjunpur, Bahadurpur, and Beniagram gram panchayats nearly 11000 people are highly affected by flood activity.

• Deforestation creates problems about land use through increased rate of soil erosion, the addition of sediment load in the rivers, siltation, reduction of agricultural production, etc.

• Excessive use of Irrigation water gives rise to waterlogging and salinity increases

Fig. 5 – Interrelation of Change Detection of Land use and Land cover classes from 1990 to 2020.



gradually (De & Jana, 1997). It has been observed that feeder canal irrigation results in salt layer creation on surface soil which reduces the amount of agricultural productivity on the land. And the use of chemical Fertilizers deteriorates the physical-chemical condition of the soil and ultimately the land productivity decreases.

• Solid waste is another significant problem in this region, Solid waste is the waste matter which is generated by domestic, commercial, industrial, healthcare, agricultural activities, etc, and accumulates in the study area.

7. Probable solution for proper management of land use and provide standard of life in study area

- Use of modern techniques for crop selection according to soil and use of organic fertilizer instead of chemical fertilizer to maintain soil health.
- Use of wetlands for more fishing purposes.
- Improvement of river channel modification, proper maintenance of Farakka barrage and creating some floodways to ensure high river discharge in rainy seasons.
- Prepare proper flood and river bank erosion zone mapping and continuous structural and non structural management.

8. Conclusion

This present study mainly focused on change detection from 1990 to 2020 and identifies the major problem and some probable solution. Supervised image classification, accuracy assessment and Pearson's Product Moment Correlation coefficient(r) are helps to identify the present scenario with the help of satellite images and statistical measures. It is pertinent to mention that changes in land use and land cover, the timely remedial measures are important for optimum and sustainable utilization of land resources and prevention thereof from further undesirable deterioration. River bank erosion is a physical phenomena but it can damage both life and property at an expansive rate. We can't stop this event but some structural and non measures can help to mitigate the vulnerability and provide sustainable life for local human beings. There is further scope for research in this arena to look into agricultural changes, cropping patterns, productivity and fertility of the region, NDVI and NDBI change, causes of river bank erosion and impact of Farakka barrage in river health . This may be further studied in relation to overall biophysical and human-induced changes in the region (Patra & Gavsker, 2021).

Fig. 6 – Showing different types of Land use Problem in Study area. (Sl. No. 1 – River Bank Erosion, Sl.No.2 – Structural Measures, Sl. No.3- Flood, Source: E- Anandabazar Patrika 30.05.2021, Sl. No.4 – Transformation of Land, Sl.No.5 - Excessive use of Chemical Fertilizers).

Endnotes

In the paper, is it possible to find the following abbreviations:
1. CD Block – Community Development Block.
2. TM – Thematic Mapper Sensor.
3. OLI/ TIRS – Operational Land Imager / Thermal Infrared Sensor.
4. GIS – Geographic Information System.
5. WGS – World Geodetic System.
6. Sq. Km.- Square Kilometer

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