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Accuracy Assessment and Analysis of Land Use Land Cover Change Using Geoinformatics Technique in Raniganj Coalfield Area, India

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Abstract

Raniganj coalfield area has a complex land use land cover degradation scenario due to opencast mining and associated development activities since 1960 [1-20]. Miscellaneous mining aids like dumper, dozer and dragline caused enormous amount of land degradation. Indeed the degraded land covers are changed into other land uses in due course of time. That's why it is urgent necessary to understand and compute the land use conversion and transformation in Raniganj coalfield area and its surroundings. Land use change is occurred due to open cast coal mining and associated development activity is measured by assessing the change detection analysis in ERDAS Imagine environment using the algorithm of Zhang (1992) in 1973 to 2015. On average 30% forest is converted into other land use within only 10 years in Sonepur, Satgram, Sripur and Khottadih area. Contrary fallow land, agriculture, urban and quarry land retained and gained its original own land use. The changing process will tell us the inter class transformation rate and dominant land cover in Raniganj mining area in near future.

Keywords: change detection, land use conversion, accuracy assessment, changing parameter

Introduction

The researchers try to interpret land use land cover changes pattern in the focal areas of Raniganj coalfield and its surroundings using remotely sensed data. Opencast coal mining affects the local landscape, adversely causes widespread environmental decay especially land alteration and mutation [1]. Therefore preparation and identification of land use land cover change map in temporal manner for any particular area is very crucial nowadays in earth science in order to detect the temporal changes in land use land cover [2]. These anthropogenic changes put forwarded by mining and associated development activities are measured by computing the combine analysis in Arc GIS. Here the researchers compute parameter wise change detection for any particular land use class. Total Five parameter like decreased, some decrease, increased, some increased and unchanged are calculated.

Research Area

Raniganj coalfield is located within four districts of West Bengal i.e. Burdwan (71%), Birbhum (9%), Bankura (8%) and Purulia (7%). This coalfield is elliptical in shape where east-west extension is about 75 km and north-south extension is about 35 km. Raniganj coalfield has an area of about 1530 sq km and falls within latitudes 23° 30' N to 23° 52' N and longitudes 86° 38' E to 87° 23' E. As on 2016 this coalfield has 17 running OCPs and 21abandoned OCPs within 11 areas (ECL 2015). Mean elevation is 98.45m with broad undulation [2] (Figure 1).

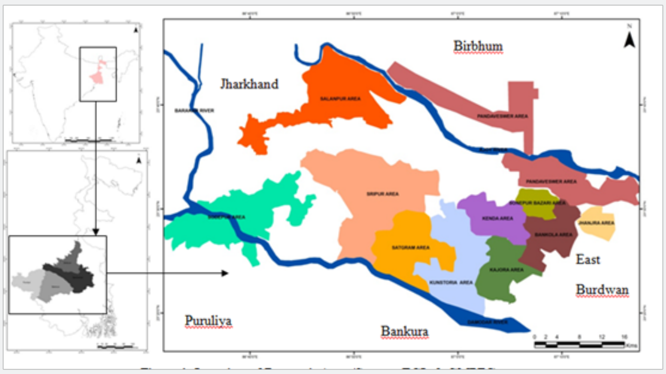

Figure 1: Location of Research Area (Source: ECL & CMPDI).

Materials and Methods

Remote Sensing Data Sources

Five temporal cloud free satellite data is gleaned from USGS Earth Explorer portal in order to prepare land use land cover map from 1973 to 2015. Information about satellite data is shown in Table 1. Topographical maps with a scale of 1:50000 namely 73M/1, 73M/2, 73M/5, 73M/6, 73I/13 and 73I/14 from Survey of India is applied to built the base layer of these satellite data.

Table 1: Details of remote sensing satellite data, Raniganj coalfield.

Year	Date of Acquisition	Path/Row	Spatial Resolution	Description	Projection
1973	18th & 20th March	149/44 & 150/43	60 m	Landsat MSS	World Geological Survey 84/ UTM, Zone 45
1992	15th March	139/44	30 m	Landsat 5 (TM)	
2002	19th March	139/44	30 m	Landsat 7 (TM)	
2010	25th March	139/44	30 m	Landsat 7 (TM)	
2015	15th March	139/44	30 m	Landsat 8 (ETM+)	

Data Processing

Data processing tasks are done from spatial and spectral enhancement menu of image interpreter tab in ERDAS Imagine software. In order to extract the entire research area for the year 1973 image stretching is performed using mosaic tool from data preparation tab [2]. Image enhancement techniques like histogram equalization, contrast stretching and tail trimming are accomplished in order to improve the visual interpretability of remotely sensed image. RGB to IHS and the reverse IHS to RGB colour space transformation functions are also accomplished for the year 2002 and 2010 to extract more information.

Classification Scheme

Beyond of visual interpretation signatures are selected by using AOI tool followed by parametric statistical method from the signature editor menu bar with region growing properties in Erdas Imagine. Signatures are collected from multiple areas throughout the image for a single class and are merged which belong to the same class and renamed after a land use land cover class [3]. In this manner ten distinctive land use land cover classes are captured. These are-forest, agricultural land, fallow land, river, river sand, water body, exposure, mining lagoon, urban and excavated. On average 125 forest signatures, 153 agriculture signatures, 165 fallow signatures, 60 river signatures, 120 river sand signatures, 75 water body signatures, 87 exposure signatures, 50 lagoon signatures, 155 urban signatures and 80 excavated signatures are determined for one temporal image. Signature alarm and contingency matrix utility is also used to evaluate signatures that have been created from AOI in the image. After all these evaluations, supervised classification is performed with a distance file from classification tab/signature editor menu bar/classify/supervised to perform a supervised classification. Under parametric decision rule, maximum likelihood is selected. Then ok is clicked in the supervised classification dialog to classify the image [4]. Post classification filtering is applied from the viewer menu bar/select raster/filtering/statistical filtering (median filter) to remove unwanted discrete pixels from the thematic image and to producing homogeneous region permanently (Figures 2-4).

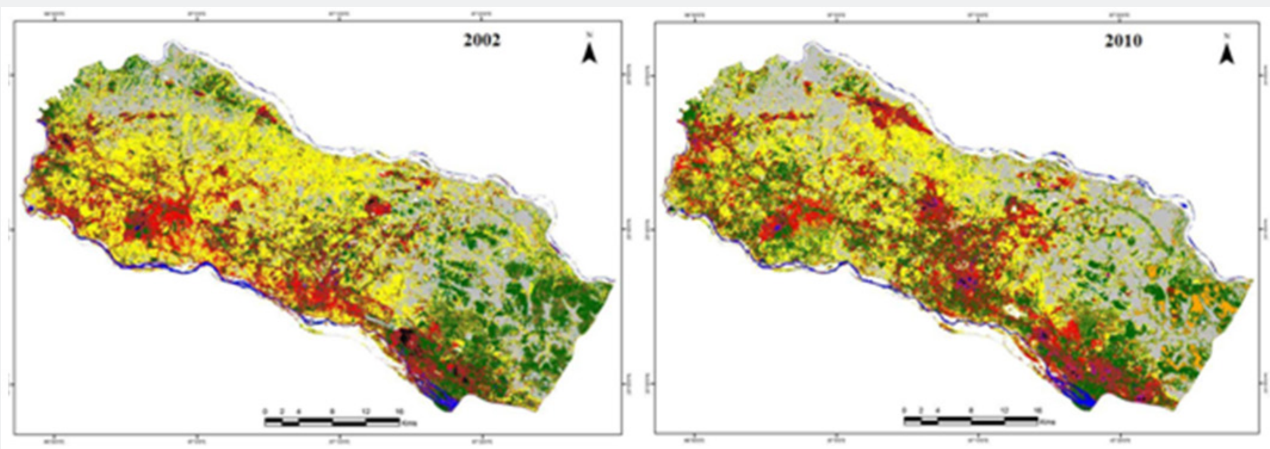

Figure 2: Landscapes map of 1973 and 1992 (clock wise), Raniganj coalfield.

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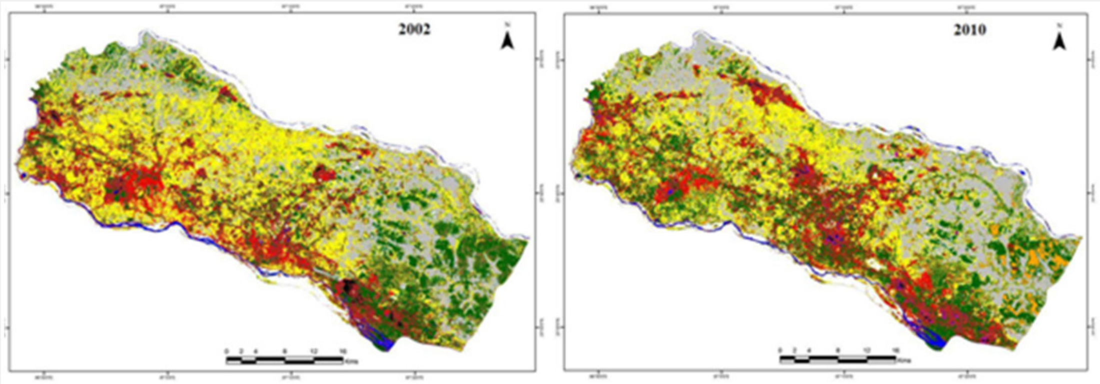

Figure 3: Landscapes map of 2002 and 2010 (clock wise), Raniganj coalfield.

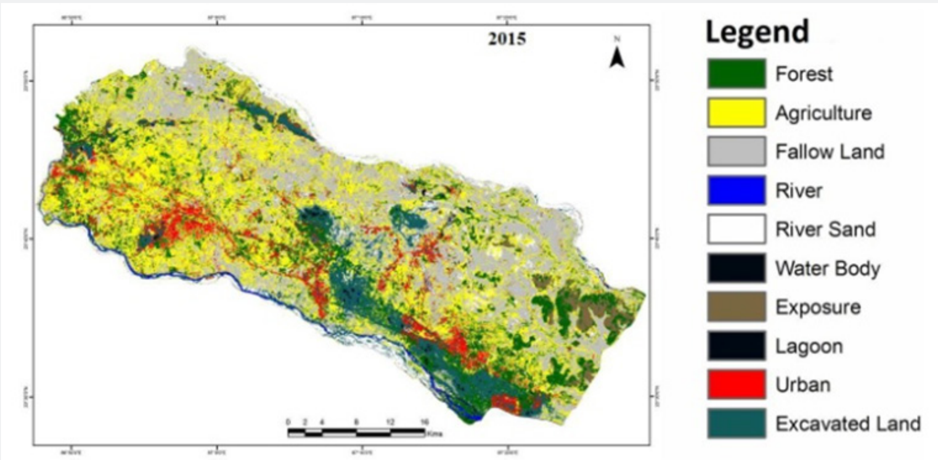

Figure 4: Landscapes map of 2015, Raniganj coalfield.

Ground Truth and Training Data Map and Photographs

With the help of Google Earth and GPS device [5] 950 ground truth data has been gathered for full and accurate characterization of ground truth geographic coordinates, land use and land cover attributes, species information of different landscapes using stratified random sampling method [6]. 950 in-situ GPS waypoints are plotted in the study region according to its geographical co ordinate value shown in Figure 5. Photographs of different landscapes are collected and linked to the classified map according to its geographical coordinate system with the help of Google Earth in an aim to verify the classified land use land cover map with the actual surface features [7]. Forest and excavated quarry land photograph is taken from Purusattampur area (23°42'10''N and 87°16' 16''E) and Sonepur Bazari area (23°39'40''N and 87°11'0''E) respectively shown in Figure 6. Photograph of agriculture and urban is taken from Kandra area (23°25'42''N and 86°42'41''E) and near Barakar railway station and bus stand area (23°54'22''N and 87°03'34''E) respectively shown in Figure 7. Fallow and river sand photograph is taken from Mithali area (23°43'00'' N and 87°03'00'' E) and river bed of Ajay (23°32'25''N and 86°20'15''E) respectively shown in Figure 8. Photograph of exposure land and water body is captured from Sonepur Bazari area (23°38'26''N and 87°12'12''E) and Dalurband area (23°42'36''N and 87°01'52''E) respectively shown in Figure 9. Photograph of river and mining lagoon is captured from Barakar river (23°59'12''N and 87°04'10''E) and Poidih abandoned mine (23°29'30''N and 87°12'25''E) respectively shown in Figure 10.

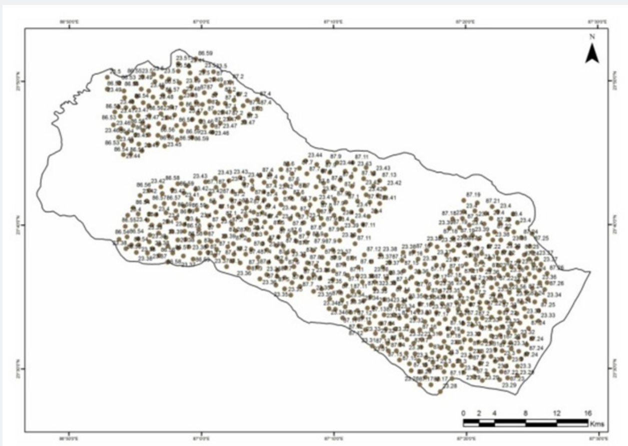

Figure 5: Ground truth verification waypoints map, Raniganj coalfield.

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Figure 6: Landscape photograph of forest and quarry (clock wise), Raniganj coalfield.

Figure 7: Landscape photograph of agriculture and urban (clock wise), Raniganj coalfield.

Figure 8: Landscape photograph of fallow and river sand (clock wise), Raniganj coalfield.

Figure 9: Landscape photograph of exposure and water body (clock wise), Raniganj coalfield.

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Figure 10: Landscape photograph of river and mining lagoon (clock wise), Raniganj coalfield.

Accuracy Assessment

This work is done in ERDAS Imagine software followed by classification tab and accuracy assessment tool. The accuracy assessment algorithms are shown in Tables 2-7. Firstly stratified random sampling method is used to furnish the 878 ground truth reference data. These ground truth points are overlain on the land use land cover map and value is extracted [8]. After that a confusion matrix is generated and placed such that class membership determined by ground truth values are along the x-axis, and class membership determined by image classification is along the y-axis [9]. When placed this way, correct values fall along the major diagonal of the matrix [10]. Incorrectly classified values lie in the off diagonal areas of the matrix; such that it is apparent which class they are confused with [11]. Field data for validation is not available for 1973, 1992, 2002 and 2010. So it is assumed that a similar accuracy is achieved using the same methods from the 2015 land use land over map [12]. Accuracy result for the land use land cover map of 1973, 1992, 2002, 2010 and 2015 is shown in Table 3- 7 respectively.

Table 2: Algorithms for accuracy assessment, Raniganj coalfield.

Overall Accuracy	$\frac{Total\ number\ of\ correctly\ classified\ pixels\ (diagonal)}{Total\ number\ of\ reference\ pixel} \times 100$
User Accuracy	$\frac{Number\ of\ correctly\ classified\ pixels\ in\ each\ category}{Total\ number\ of\ classified\ pixels\ in\ that\ category\ (row\ total)} \times 100$
Producer Accuracy	$\frac{Number\ of\ correctly\ classified\ pixels\ in\ each\ category}{Total\ number\ of\ classified\ pixels\ in\ that\ category\ (column\ total)} \times 100$
Kappa Coefficient (T)	$\frac{(Total\ Sample \times Total\ Corrected\ Sample) - \Sigma\ (Column\ total \times Row\ total)}{Total\ Sample^2 - \Sigma\ (Column\ total \times Row\ total)}$

Table 3: Confusion matrix for accuracy assessment of LULC map 1973, Raniganj coalfield.

	Reference Data												
	LULC Classes	**F**	**AL**	**FL**	**R**	**RS**	**WB**	**E**	**L**	**U**	**EL**	**Total**	**Users accuracy (%)**
Classified Data	F	1120	65	32		3		21				1241	90.24
	AL	15	1250	65	4	5	7	6		2	2	1356	92.18
	FL	45	21	920			34		37			1057	87.04
	R	11	12	5	480	9	102	10				629	76.31
	RS	6	3	42	9	524	16			6		606	86.47
	WB	15	25	25	8	4	425		8			510	93
	E	18	30	3	6		19	285		6	4	408	69.85
	L	5	23					4	421	20		486	86.63
	U		5							1461		1593	91.46
	EL									7	545	552	98.73

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	Total	1235	1434	1092	507	545	603	326	466	1508	551	8408	
Producer Accuracy (%)		90.69	87.17	84.25	94.67	96.15	70.48	87.42	90.34	97.28	98.91		
Overall Accuracy: 88.46%													
Kappa Coefficient: 0.81													

Table 4: Confusion matrix for accuracy assessment of LULC map 1992, Raniganj coalfield.

	Reference Data												
	LULC Classes	**F**	**AL**	**FL**	**R**	**RS**	**WB**	**E**	**L**	**U**	**EL**	**Total**	**Users accuracy (%)**
Classified Data	F	1420	32	36		5		23				1516	93.67
	AL	21	1020	65	6	8	11	8		2	5	1146	89.01
	FL	54	31	906			36		25			1052	86.12
	R	2	15	5	610	9	98	21				760	80.26
	RS	4	4	42	5	826	15			5		901	91.68
	WB	8	21	22	8	6	458		7			530	86.42
	E	20	36	5	6		34	389		3	8	481	68.61
	L	9	15					9	498	25		567	87.83
	U		4							1425		1438	99.09
	EL									8	458	466	98.28
	Total	1538	1178	1081	635	854	652	450	523	1468	471	8850	
Producer Accuracy (%)		92.32	86.59	86.9	83.81	96.72	69.6	86.44	95.22	97.07	97.24		
Overall Accuracy: 88.14%													
Kappa Coefficient: 0.86													

Table 5: Confusion matrix for accuracy assessment of LULC map 2002, Raniganj coalfield.

	Reference Data												
	LULC Classes	**F**	**AL**	**FL**	**R**	**RS**	**WB**	**E**	**L**	**U**	**EL**	**Total**	**Users accuracy (%)**
Classified Data	F	1725	52	29		8		25				1839	93.8
	AL	25	1230	50	10	12		4	3		2		
	FL	69		1								1059	85.74
	R	11	25	908			32		25			789	79.21
	RS	4	32	5	625	9	102		5			749	92.12
	WB	5	4	25	2	690	21			3		689	87.23
	E	21	32	36	5	5	601		5	7	6	467	82.44
	L	36	20	4	9		36	385		36		548	85.58
	U		15					7	469	1355		1398	96.92
	EL		7							5		594	99.16
	Total	1896	1417	1057	651	724	796	425	519	1408	596	9469	
Producer Accuracy (%)		90.98	86.8	85.9	96	95.3	75.5	90.59	90.37	96.24	98.83		
Overall Accuracy: 90.04%													
Kappa Coefficient: 0.88													

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Table 6: Confusion matrix for accuracy assessment of LULC map 2010, Raniganj coalfield.

	Reference Data												
	LULC Classes	F	AL	FL	R	RS	WB	E	L	U	L	Total	Users accuracy (%)
Classified Data	F	1654	59	36		6		25				1780	92.92
	AL	29	1235	68	11	21	3	9		8	13	1397	88.4
	FL	42	25	1120			24		46			1257	89.1
	R	11	16	2	421	15	102	25				592	71.24
	RS	13	3	42	12	856	35			12		973	87.98
	WB	2	14	36	9	6	425		10			502	84.66
	E	7	30	13	8		36	285		1	2	382	74.6
	L	13	29					8	589	20		653	90.2
	U		12							1426		1451	98.28
	EL									9	582	591	98.48
	Total	1771	1423	1317	461	904	625	352	645	1476	597	9578	
Producer Accuracy (%)		93.39	86.79	85.04	91.32	94.69	68	80.97	91.32	96.61	97.49		
Overall Accuracy: 90.04%													
Kappa Coefficient: 0.88													

Table 7: Confusion matrix for accuracy assessment of LULC map 2015, Raniganj coalfield.

	Reference Data												
	LULC Classes	F	AL	FL	R	RS	WB	E	L	U	L	Total	Users accuracy (%)
Classified Data	F	1612	48	21		4		17				1702	94.7
	AL	20	1180	57	5	7	8	5		5	3	1290	91.5
	FL	56	19	1008			29		34			1146	88
	R	9	20	3	523	9	124	10				695	75.3
	RS	5	2	36	8	716	12			2		740	96.8
	WB	9	17	28	2	2	506		4			544	93
	E	13	35	7	4		23	315		2	5	408	77.2
	L	8	25					6	423	20		466	90.8
	U		8							1522		1593	95.5
	EL									3	682	702	97.2
	Total	1732	1354	1160	542	734	677	355	437	1603	692	9286	
Producer Accuracy (%)		93.1	87.1	86.9	96.5	97.5	74.7	88.7	96.8	94.9	98.6		
Overall Accuracy: 90.74%													
Kappa Coefficient: 0.92													

Identifying and Extracting Changes from LULC

Change detection from the classified images is performed from interpreter menu following the utilities tab in ERDAS Imagine software in order to measure the area and percentage of land use land cover changes between two successive periods. 'Before image - after image' algorithm is used to extract the changes following 10% increase or decrease rules [13]. Image difference file and highlight change file is also generated. Principal component analysis has been tested from interpreter menu following spectral enhancement tab in order to recognize changes from bi temporal images. Accuracy of change map is measured by multiplication method. Change maps are re-sampled to bilinear interpolation from raster menu/set resampling method tab to depict the spatial extent and locations of land use land cover changes [12] (Figures 11-13).

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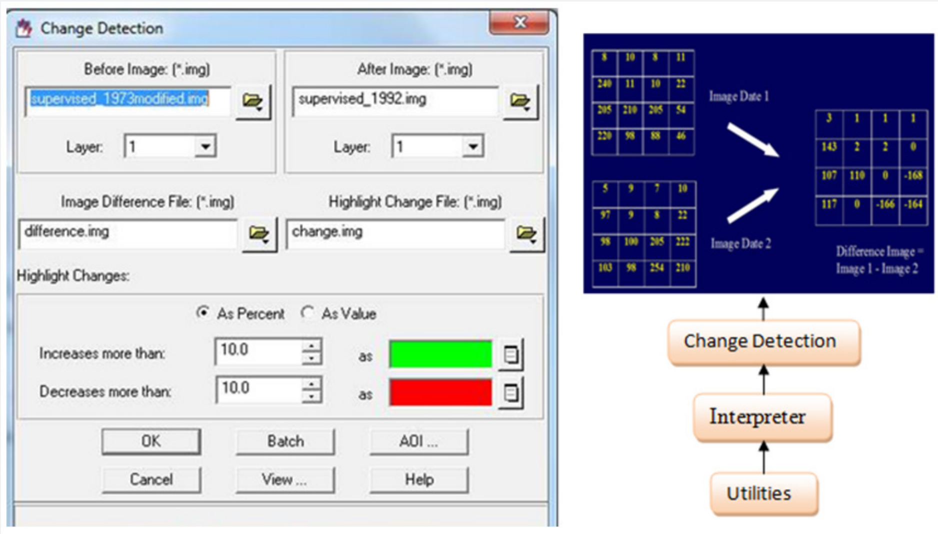

Figure 11: Development and technical process of change detection after Zhang, 1992.

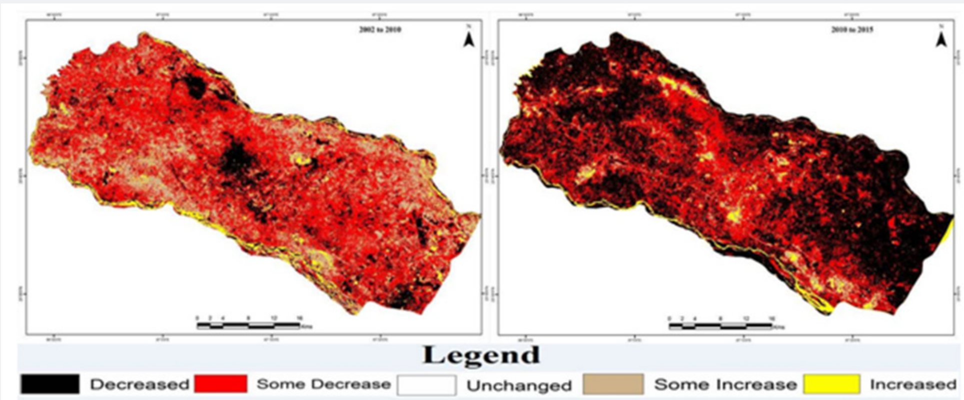

Figure 12: Change map 2002 to 2010 and 2010 to 2015 (clock wise), Raniganj coalfield.

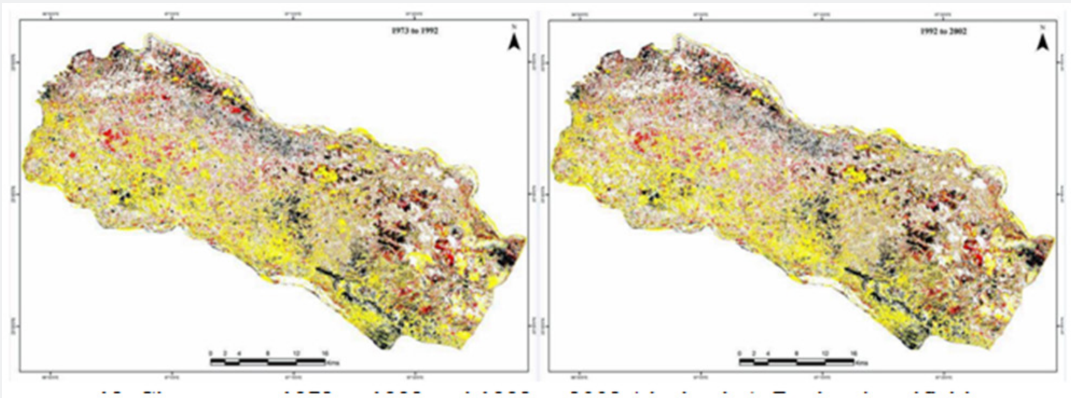

Figure 13: Change map 1973 to 1992 and 1992 to 2002 (clock wise), Raniganj coalfield

Result and Discussion

878 ground truth points are accurately classified resulting in an overall accuracy is 90.74% and Kappa coefficient is 0.92 in 2015 shown in Table 7. Forest, agriculture, fallow, river sand, mining lagoon, urban and excavated have similarly high user and producer accuracy value. These land use classes never fall below 88% accuracy. River shows a low user accuracy of 75.3. It indicates that about 24.7% of time pixels that is classified as river is actually a member of another class. Water body has lowest producer accuracy with a value of 74.7%. This means about 25.3% of time pixels that was actually water body was incorrectly classified to another class. Similar results are calculated in the same manner or true for the year 1973, 1992, 2002 and 2010

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shown in Table 3- 6 respectively [14]. Inaccuracies in the error matrix are as follows-forest confused with agriculture and exposure. Water body confused with lagoon, excavated confused with fallow and urban, fallow land confused with river sand [15] (Figure 14).

The highlight change image is typically divided into five categories of decreased, some decreased, unchanged, some increase and increased [16]. Four change maps are prepared namely 1973 to 1992, 1992 to 2002, 2002 to 2010 and 2010 to 2015 shown in Figures 12 & 13. Near existing forest, agriculture, fallow, wetland and urban areas experienced the most consistent changes throughout the study area. In the map 1973 to 1992 the most prevalent area of change was from forested areas to fallow, agriculture and mining quarry. This change occurred most prevalently in the North East area and central area of Raniganj coal field. In the year 1992 to 2002 urban area experienced a noticeable amount of increase (almost doubled in area) in south and eastern parts of this coalfield. In the year 2002 to 2010 mining quarry increases vastly and some decrease of forest and agriculture. In 2010 to 2015 agriculture and urban have increased in south and south western parts respectively. And major decrease is happened in north eastern and north western parts of the study area.

Parameter wise distribution of changes is shown in Figure 14. This diagram shows that Raniganj coalfield and its surroundings exhibits maximum unchanged land use. In 1973 to 1992 unchanged area is about 244174.25 hectare followed by 225580.32 hectare in 1992 to 2002, 159449.58 hectare in 2002 to 2010 and 158870.88 hectare in 2010 to 2015 respectively. Around Sonepur Bazari, Bankola and Kenda, Sodepur, Slanpur and Pandaveswar area this unchanged land use dominated. The declining rate of unchanged land use indicates vast pressure on land use land cover. In near future the rate will be increased rapidly. Decreased land use is maximum in 2010 to 2015 that is about 89590.95 hectare near Dalurband and Shibpur. Contrary in 1973 to 1992 decreased area is about 18037.15 hectare followed by 20124.27 hectare in 1992 to 2002, 24727.77 hectare in 2002 to 2010 respectively. The increasing trend of this parameter denotes transformation and fragmentation of land use. Some decrease land use is higher in 2002 to 2010 that is 84426.84 hectare followed by 54124.29 hectare in 2010 to 2015, 12735.33 hectare in 1973 to 1992 and hectare in 15690.51 1992 to 2002 respectively. This parameter also indicates same trends of decreased. Maximum land use increased in 2002 to 2010 that is 7644.24 hectare. In 2010 to 2015 it is 4676.76 hectare followed by 35703.73 hectare in 1973 to 1992 and 33705.9 hectare in 1992 to 2010. Slanpur, Satgram, Sonepur Bazari, Kenda, Dabor, Sripur and Slanpur areas experienced highest rate of increased land use. This parameter indicates dominance of particular land use in any area. Here urban and agriculture dominates this foresaid area. Some increased area also indicates the same of increased parameter. Maximum 39754.71 hectare is increased in 2002 to 2010 and minimum 8740.26 hectare in 2010 to 2015.

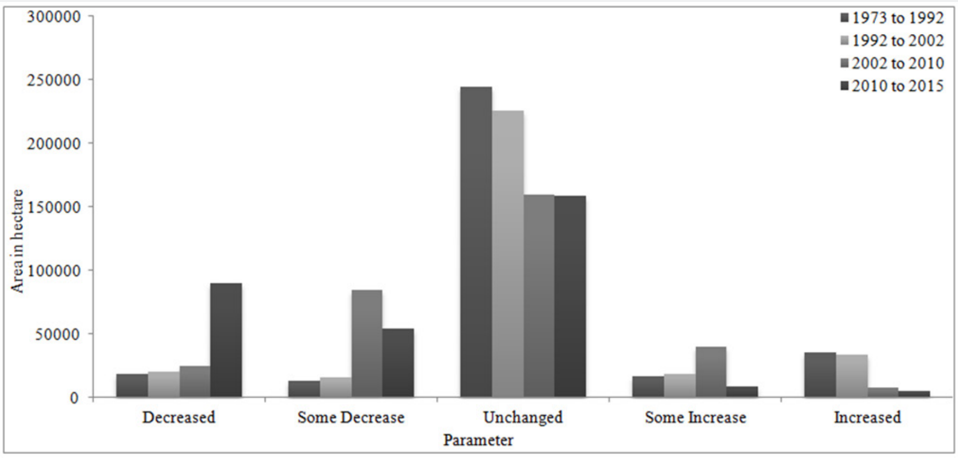

Figure 14: Parameter wise change detection from 1973 to 2015, Raniganj coalfield.

Conclusion

This huge level of land use change in Raniganj coalfield area is occurred due to extension of mining areas, development of infrastructure and residential complexes of mining industry and thermal power plants [17]. This intensive analysis indicates that forest, water body and river are acutely affected land use. These land uses are more affected in past 40 years because of around 38% change area. Forest and river are most prone to future transformation. Contrary fallow, agriculture, river sand is and moderately effective land use because of around 75% retention in last 40 years [18,19]. Urban is acutely effective land use in Raniganj coalfield area because of about 93% retention area in past 40 years. In the conclusion it can be said that agriculture and urban will dominate this area in near future. Agricultural expansion, land abandonment, illegal small scale mining, large scale opencast mining, deforestation and rapid urbanization predominately occurred in and around the periphery of Raniganj mining area will make the landscape or ecosystem more complex and fragmented in near future [20].

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References

1. Ampofo S, Sackey I, Ampadu B (2016) Landscape Changes and Fragmentation Analysis in a Guinea Savannah Ecosystem: Case study of Talensi and Nabdam Districts of the Upper East region, Ghana. Journal of Geography and Geology 8(1): 41-54.
2. Areendran G, Rao P, Raj K, Mazumdar S (2013) Land use land cover change dynamics analysis in mining areas of Singrauli district in Madhya Pradesh, India. Tropical Ecology 54(2): 239-250.
3. Bianche VB (2002) Automatic Land Use Land Cover Classification System with Rules Based Both on Objects Attributes and Landscape Indicators.
4. Doktoringenieur G, Buchroithner M, Dresden TU (2010) Assessing processes of long-term land cover change and modelling their effects on tropical forest biodiversity patterns a remote sensing and GIS based approach for three landscapes in East Africa.
5. Garg M, Joshie A, Choudhary S (2013) Land Use Land Cover Classification in Jamuna Kotma Coal Field Region, Anuppur District MP 6(2): 38-43.
6. Kindu M, Schneider T, Teketay D, Knoke T (2013) Land Use Land Cover Change Analysis Using Object Based Classification Approach in Munessa Shashemene Landscape. pp. 2411-2435.
7. Kumar R, Nandy S, Agarwal R, Kushwaha SPS (2014) Forest cover dynamics analysis and prediction modeling using logistic regression model. Ecological Indicators 45: 444-455.
8. Limited MC (2014) Report on vegetation cover mapping of Raniganj coalfield based on satellite data of the year 2013.
9. Maitima JM, Mugatha SM, Reid RS, Gachimbi LN (2009) The linkages between land use change, land degradation and biodiversity across East Africa. 3(10): 310-325.
10. Morgado P, Toger M, Abrantes P, Fiegel J (2012) A Bottom Up Approach to Modeling Habitat Connectivity Dynamics Through Networks Analysis.
11. Mundia CN, Murayama Y (2009) Analysis of Land Use/Cover Changes and Animal Population Dynamics in a Wildlife Sanctuary in East Africa pp. 952-970.
12. Pradesh H, Ramachandra TV, Kumar U, Joshi NV (2005) Landscape Dynamics in Western Himalaya Mandhala.
13. Reddy CS, Satish KV, Pasha SV, Jha CS (2016) Assessment and monitoring of deforestation and land-use changes (1976-2014) in Andaman and Nicobar Islands, India using remote sensing and GIS. 111(9).
14. RHU, Suocheng D (2013) Land Use Dynamics and Landscape Patterns in Shanghai, Jiangsu and Zhejiang. 4(2): 141-148.
15. Samanta P, Technical S, Manager P, Consultants T (2015) Impact Assessment and Changes Analysis of Land Use/Land Cover Due to Open Cast Coal Mining Activity : A Case Study of Raniganj Coal Field Area. 4(5): 17-27.
16. Sapena M, Ruiz LA (2015) Analysis of Urban Development By Means Of Multi Temporal Fragmentation Metrics From Lulc Data. p. 11-15.
17. Sarma K, Kushwaha SPS Coal Mining Impact On Land Use/Land Cover In Jaintia Hills District Of Meghalaya, India Using Remote Sensing And Gis Technique. p. 1-14.
18. Srivastav S, Roy SK, Krishnamurthy PS (2016) An Analysis Of Land Use And Land Cover Dynamics And Causative Drivers In A Thickly Populated Yamuna River Basin Of India. 14(3): 773-792.
19. State J, Kumar A, Pandey AC (2013) Evaluating Impact of Coal Mining Activity on Landuse/Landcover Using Temporal Satellite Images in South Karanpura Coalfields 2(1): 183-197.
20. Sarkar A (2017) Remote Sensing Approach To Define Landscape Dynamics In Raniganj Coalfield Area Through Trend Line Analysis 8(9): 5546-5555.

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