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RESEARCH ARTICLE

ASSESSMENT OF LAND USE AND LAND COVER CHANGES THROUGH SATELLITE REMOTE SENSING: A CASE STUDY OF PURBASTHALI-I&II BLOCKS, BURDWAN DISTRICT, WEST BENGAL, INDIA.

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ABSTRACT

The landscapes on the earth are more or less sculptured with the foot points of human civilization. The anthropogenic activities changed the natural landscape significantly with the passage of time. Presence of human being on earth and his use of land had profound effect on the natural environment and vice versa; which results into an observable change in the land use and land cover over time. Information of land use land cover in the form of maps and data is very important for spatial planning, management and utilization of land. Land use land cover scenario in India has undergone a radical change since the onset of Green Revolution. Remote sensing provides scientific and systematic information for change detection and monitoring of human uses and bio-geographical coverage of land. The present study attempts to identify the spatio-temporal changes of land use land cover in Purbasthali region over the time span of 86 years, using the topographical maps and satellite images of the years 1918, 1973, 1990 and 2004. We have adopted digital and visual land use land cover classification method to produce series of land use land cover maps. The study reveals that agricultural land use has dominance over the other Land use Land cover categories and it covers almost half of the study area but, very recently it is decreasing at a slow pace. Vegetation cover of the region is almost wiped out; Built-up land is extending quite usually with growing population pressure. But recently, due to river bank erosion of river Bhagirathi along the eastern margin of the region it has been shifted to some other areas. The major negative changes occurred in current fallow category due to proficiency in agricultural practice, farm mechanization, and other socio-economic causes.

INTRODUCTION

A change in land use land cover is being increasingly recognized as critical factors influencing the global change (Sharma *et al* 2008) and study on the land use land cover change provides information for better understanding of previous practices, current land use pattern and future land use trajectory. Changing land use land cover always exercises; it dominant control on environmental change in all spatial and temporal scale (Turner, 1994). Monitoring land use land cover changes create credible information about our landscape and allow the managers to take fundamental decision. In modern era for better administration, business, establishment of industries, planning, natural resources management and environment protection etc. adequate information is needed in order to make rational decisions. Land use land cover is one of such key aspect. The knowledge about land use land cover has become gaining importance day by day as the nations plans to overcome the problems of hazard and uncontrolled developed, deteriorating environment quality, loss of agricultural lands, destruction of important wet land, encroachment and loss of fish and wild life habitat. Here we must keep in mind that though the term land use and land cover are often casually assumed as identical to each other but there is basic difference between these two. Land use is the functional dimensions of land for different human purposes and economic activities and is often shaped by human, socioeconomic and political influences (Sharma *et al.,* 2008) while land cover may be defined as the bio-physical coverage of earth surface. Remote Sensing integrated with GIS, provide an effective tool for the analysis of land use land cover change remote sensing and GIS technology have the potential for cost effective and timely representation of natural resource.

One of the prime prerequisites for better use of land is to deduce information on the existing land use patterns and about the changes in land use land cover through time and space. Knowledge about the present distribution and areal coverage of different land use land cover classes as well as their changing properties is not only useful for the researchers, planners etc, but it is now readily using by legislators, planners, govt. officials to determine better land use policy. In this dynamic situation, accurate meaningful current data on land use land cover are essential for rational planning. What is

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more, land use land cover now has been recognized as an important driver of environmental change in all spatio-temporal set up (Turner *et al*., 1994). Thus for environmental concern understanding of land use land cover change in respect of space and time is needed. Information regarding what changes in land use land cover occur, where, when and how is very important (Lambin *et al*., 2003).

Review of Literature

The study of land use dates back to as early as eighteenth century and most of them are based on rural agro resources. Adam Smith (1776), Von Thunen (1826), Alfred Marshall (1890), was some of the pioneers of the early land use studies. Their works are still serving as foundation of the most of the present day theories. On the other extreme Hurd (1903) introduced a theory for urban land use. Subsequent studies in this field are extended and modified by Burges (1925), Haig (1926) and Wingo (1961) in a systematic and methodical way. Here we must mention that L.D. Stamp was one of the greatest workers in land use studies. His valuable work has provided primary guidelines to the geographers and planners to carry out research work on land use in different parts of the world. Next land use survey of England and Wales are done by Colemann and Maggs and reports were published. In United States land survey was carried out to record the use of selected land unit as well as to assess the degree of limitations to land use. At 1949 Hocken. Smith Teele reviewed the existing work on land capability assessment. A comprehensive hand book of land use was published 1961 (Klingebiel and Montgomery, 1961). Hudson (1971), Young (1973, 1976), Olson (1974) of US department of Agricutlure have contributed a lot in this regard. In 1963 the Cannadian land inventory unit did the land capability assessment in Canada to provide basis for resource and land use planning. Gradually the countries like Britain, USA, Canada, France, Poland, Italy, etc. are concentrating on land use studies. Inspired by the classical work of Stamp the Indian Geographers initiated land use studies in different parts of the country. Chatterjee (1941) pointed out the agency of land use study in India. According to him (1953, 1956, 1962) different types of land use land cover reflect an intricate pattern which needs geographical investigation in respect to their physical environment. He carried out land use land cover survey on 24 Parganas and Howrah district of West Bengal (Chatterjee 1945, 1952).

The study reveals poor drainage condition of the district although with large rivers and also discussed the impact of soil and climate on land utilization, population pressure on land, trade and transport, nature of land utilization and agricultural implements. Sen carried out a land use land cover survey in parts of country Mayurakshi Basin of Birbhum district; based on existing land use pattern the problems of agricultural planning are highlighted. Sen and Guha made a detailed study on land use for a number of villages in Bankura District and identified the water scarcity for winter crop cultivation and soil erosion due to deforestation was the major issues in those villages. Mukherjee (1967) observed the changing land use pattern in Howrah district and suggested planning strategies for agricultural land use. Chatterjee and Jana (1975) studied the pattern of land utilization in an around Tarakeswar town of Hoogli district and Barasta town in 24 Parganas. Chattopadhyay (1980) tried to correlate hydrology and land use in the littoral tract of West Bengal. Dey measured land use potentiality of Banka Basin – Kanchannagar area of Bardhaman district. Sikder made an in depth study of agricultural land use with the help of land sat imagery and aerial photography. Change detection is the process of identifying differences in the state of an object or phenomenon by observing it at different points in time (Singh 1989). Satellite remote sensing in conjunction with geographic information system, has been widely applied recognized as an effective and powerful tool in detecting land use land cover change (Ehlers *et al*., 1990, Weng, 2001). Prakasam (2010) studied the land use and land cover change in Kodaikanal region of Western Ghats in Tamilnadu State of India to observe changes during a span of 40 years from 1969 to 2008, using Landsat satellite data and performing supervised classification techniques, he found that 70% of the region was covered in forests in 1969 but has decreased to 33% in 2008, The built-up lands have increased from 3% to 21% showing that the region is affected by rapid urbanisation which is leading to adverse environmental effects for the identified bio-diversity rich region of Kodaikanal. Change detection studies based on RS and GIS technique have focused on getting information of how much, where and what type of land use land cover change occur between time interval. The present study conducted and assessment on land use land cover change of Purbasthali block I and II through satellite images taken on different times with an aim identifying changes due to human activities and impact on the land resource. In the present study we have studied the general spatial pattern of land use land cover and made an up to date land use land cover study in Purbasthali I and II block of Burdwan district through integrating Remote Sensing and GIS technology. The study has also summarized past 85 years change of land use land cover and searched the cause behind it.

Study area

The study area is located on the Western bank of river Bhagirath-Hooghli, in the eastern part of Burdwan district. It covers an area of 340.91 km^2 area. The total population of the region is 371127 persons (2001 Census). The density of population is much higher than the district average population density i.e., 1073 persons / km^2. The latitudinal and longitudinal extension of the study area is 23°20′N to 23°35′N and 88°10′E to 88°25′E respectively (Fig.1). Physiographically the region is a typical flood plain and endowed with many fluvio- geomorphologic resources viz. levees, active channels, cut offs, meander loops, ox-bow lakes, back swamps, inter level depressions wet lands etc. (Biswas, 2010). The monotonous alluvial flood plain have regional slope from north to south and south east with convexity towards east. The soil is very much fertile and suitable for the production of different types of food crops and cash crops. Soil texture varies from sandy-loamy type to silty loamy type. The climatological records shows that the average air temperature in this region vary from 17 to 18°C in winter and 30-32°C in summer. The mean annual precipitation is 120-150 cm on the other hand during the period of work the average rainfalls is about 6.78 cm. with sufficient amount of humidity i.e., 65%. Thus suitable physio-climatological conditions allow enough dynamicity in land usage and land cover. To identified the land use land cover changes over past 86 years through RS & GIS technology for Purbasthali block I and II. To identify and

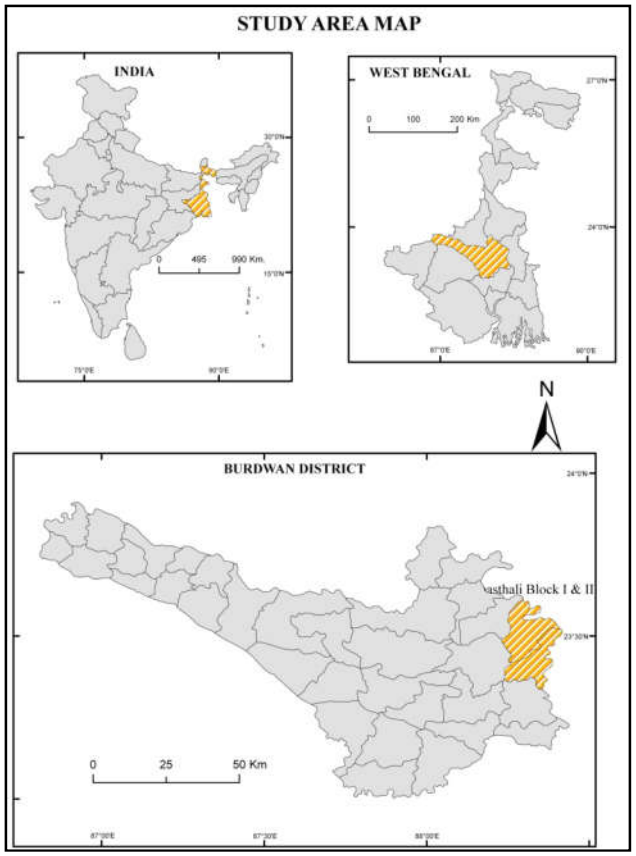

Fig. 1. Study area location

analyse the spatial pattern of changes in land use land cover of the concerned region.

METHODOLOGY

We have identified the spatial and temporal Land use land cover changes of past 86 years from United States Army topographical map (1918), Survey of India topographical maps (1973), Land sat 5 (Thematic Mapper, 1990, November and 2004 November) Table 1. Present study we adopted visual and digital land use land cover classification techniques to explore the reality of the space. Topographical maps classified through visual interpretation and satellite imageries classified through supervised classification method, the field knowledge is employed to perform the classification. Arc GIS 10.0 and Erdas Imagine 9.2 are powerful tools for extracting the land use, land cover layer, from satellite imageries and topographical maps. The land use land cover categories include agricultural land, natural vegetation, built-up, marshes, surface water bodies, fallows etc. This classification is performed based on the standard classification scheme.

Land use Land cover Classification

Land cover classification is a systematic framework to describe the situation in the field using well-defined diagnostic criteria (Di Gregorio and Jansen, 1998). A classification system provides names of classes, the criteria used to distinguish them, and the relationship between classes. Researches have developed numerous classification systems to characterized landscapes around the world. Some of the systems are a priory defined, and the observations are made to fit into the classification system, while others allow the data, a posteriori, to determine the classification system, similarly same system. Thus for studying the land use land cover dynamicity in our studied region we designed our own classification system for proper harmonization and validation. The main purpose of our study is to monitor land use land cover change and create credible information about the landscape which might be useful for taking fundamental decision, planning and environmental management of the concerned region. An attempt has been made to include sufficient details about the presented scheme to provide a general understanding in each category.

Agricultural land

Agricultural land denotes the land suitable for agricultural production, both crops and livestock. The standard classification (used by FAO) divides agricultural land into the following components which are arable land, orchards and pastures. Precisely we may define agricultural land as the plots used for agricultural purposes and includes any farms and fields. The present study incorporate cropland nurseries, orchards, areas are under horticulture and livestock farming etc. For identification of agricultural land properly we used Survey of India topographical map of the Purbasthali block I and II region made comparison with other geographical features (i.e., associational effect) and field checks have been done by adopting observational survey method.

Vegetation Cover

Vegetation is a general term use to refer the plant life of a region, thus it is the ground coverage provide by plants with out referring any particular taxonomic class, life forms structure, spatial extent or any other specific Botanical or Geographic characteristics (wekipedia).In the present work we include all the natural vegetative patches viz. shrubs, grass lands and woody trees. The primary vegetation type is deciduous and shrubs, which has severely degraded form the region at the cost of economic consideration of the people. (Bora, 2011)

Built up land use

Built up means settled areas. It is defined as land area occupied for residential, commercial, industrial and infrastructure purpose including both built up land and associated vegetated areas. Rising standard of living combined with economic societal structural changes has led to a continuous increase in land used for residential, industrial, commercial and infrastructural purposes. It also includes man made vegetated areas such as green urban areas leisure facilities, green grass land and shrubs associated with transportation network. Here we consider settled areas, areas under transportation network and shrubs associated with it, greeneries and orchards with the homestead, parks, many other commercial, industrial, buildings and transport network (road, Railway) as built up areas.

Marshy land

Marshy land is a tract of soft wet land, commonly covered partially of wholly with water. It is low lying wetlands with grassy vegetation usually is a transition zone between the land and water. Marshes can be seen near ponds, lakes, river

Table 1. Data Base

Data	Month & Year of observation	Spatial Resolution / Scale
US Army Topographical Map (NF 45-2, Series U502)	1918	1: 250000
Survey of India Topographical Map (73 A/2, 3, 6 & 7)	1973	1: 50000
Land sat – 5 (TM)	1990 (November)	30 mts. Resolution
Land sat – 5 (TM)	2004 (November)	30 mts. Resolution

Land use Land Cover Categories	1918		1973		1990(November)		2004 (November)	
	Area in Hectare	Area in Per cent	Area in Hectare	Area in Per cent	Area in Hectare	Area in Per cent	Area in Hectare	Area in Per cent
Agriculture	19938.8	58.48	22529.2	66.09	18770	55.06	18807.99	55.17
Fallow Land	1972.2	5.79	1130	3.31	285.32	0.84	222.93	0.65
Current Fallow					1075	3.15	908.44	2.66
Vegetation Cover	6939.3	20.36	960	2.82				
Marshy Land	609.5	1.79	421.6	1.24	3965.15	11.63	4549.36	10.87
Permanent Water Bodies	1980	5.8	2971	8.71	3924.42	11.51	3704.29	13.35
Semi-Permanent Water Bodies	746.2	2.19	1931.2	3.02				
Built-up	1905	5.59	5048	14.81	6071	17.81	5897.99	17.3
Total Area	34091	100	34091	100	34091	100	34091	100

Name of Water Bodies	Areal Coverage in Hectaire	Nature of Water Bodies
Mullar Bil	56.04	Semi-Permanent
Unir Bil	107.4	Permanent
Salte Bil	45.19	Permanent
Dedab Bil	19.14	Permanent
Santler Bil	65.45	Permanent
Krishnabati-Chander Bil	35.7	Permanent
Basadar Bil	47.87	Semi-Permanent
Bara Bil	31.33	Permanent
Kobla Bil	16.8	Semi-Permanent
Beter Bil	306.7	Semi-Permanent
Nartil Bil	32.88	Permanent
Jalangi Bil	8.09	Permanent
Ural Bil	36.82	Permanent
Laltin Bil	5.46	Permanent
Shalkona Bil	46.98	Permanent
Athle Bil	10.9	Temporary
Karmul Bil	5.22	Temporary
Ranipur Bil	109.3	Permanent
Moalia Bil	35.83	Permanent
Lohachur Bil	31.75	Permanent

LULC Categories	Year 1918	Year 1973	Positive/Negative Change	Category wise Spatial change out of total change in%
Agriculture	58.48	66.08	7.6	36.98
Fallow Land	5.78	3.31	-2.47	12.02
Vegetation	20.35	2.82	-17.53	85.3
Marshy Land	1.79	1.24	-0.55	2.68
Water Bodies	8	11.73	3.73	18.15
Built Up	5.59	14.81	9.22	44.87

LULC Categories	Year 1973	Year 1990	Positive/Negative Change	Category wise Spatial change out of total change in%
Agriculture	66.09	55.06	-11.03	98.04
Fallow Land	3.31	3.99	0.68	4.83
Vegetation	2.82	NI	NI	NI
Marshy Land	1.24	11.63	10.39	73.85
Water Bodies	11.73	11.51	-0.22	1.96
Built Up	14.81	17.81	3	21.32

meanders. They stay under the water for most of time throughout the year; some grow and shrink with flood and dry condition, grass and weeds vegetation grow on them and are deeply rooted in the squishy mud. They vary greatly in their size and act as a natural sponge of the low lying flood plain. Present area of study typically endowed with lot of marshy

LULC Categories	Year 1990	Year 2004	Positive/Negative Change in %	Category wise Spatial change out of total change in%
Agriculture	55.06%	55.17%	0.11	5.64
Fallow Land	3.99%	3.31%	-0.68	34.87
Vegetation Cover	NI	NI	NI	NI
Marshy Land	11.63%	10.87%	-0.76	38.97
Water Bodies	11.51%	13.35%	1.84	94.36
Built Up	17.81%	17.3%	-0.51	26.16

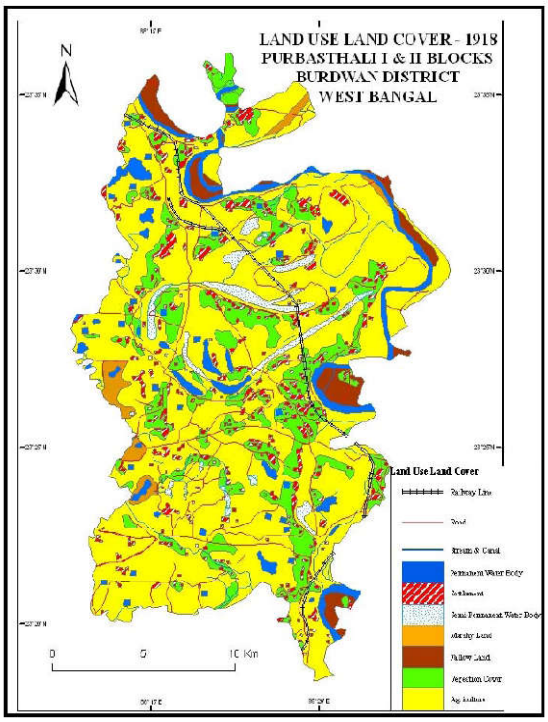

Fig. 2. Land use land cover – 1918

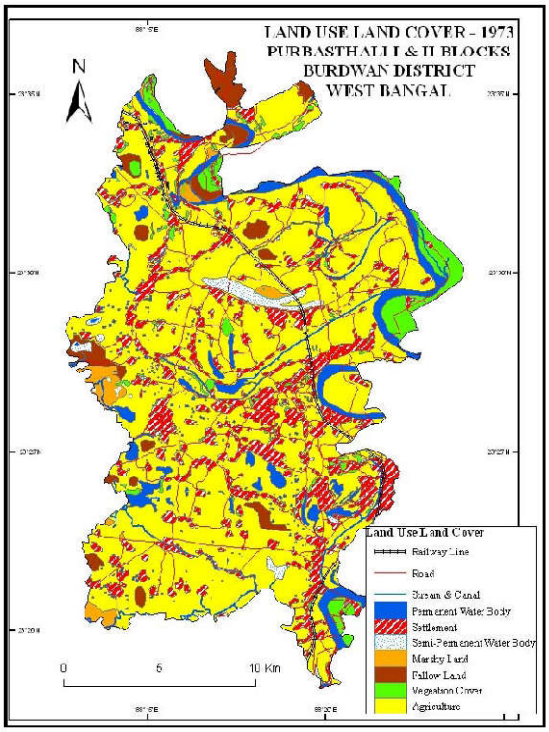

Fig. 3. Land use land cover – 1973

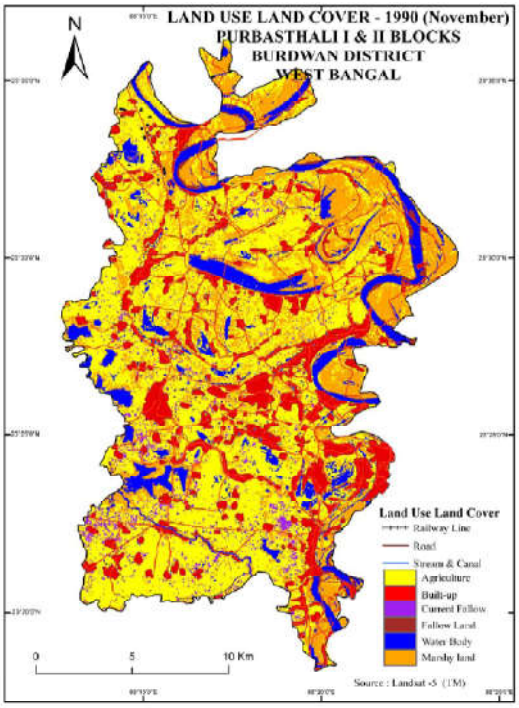

Fig.4.Land use land cover – 1990

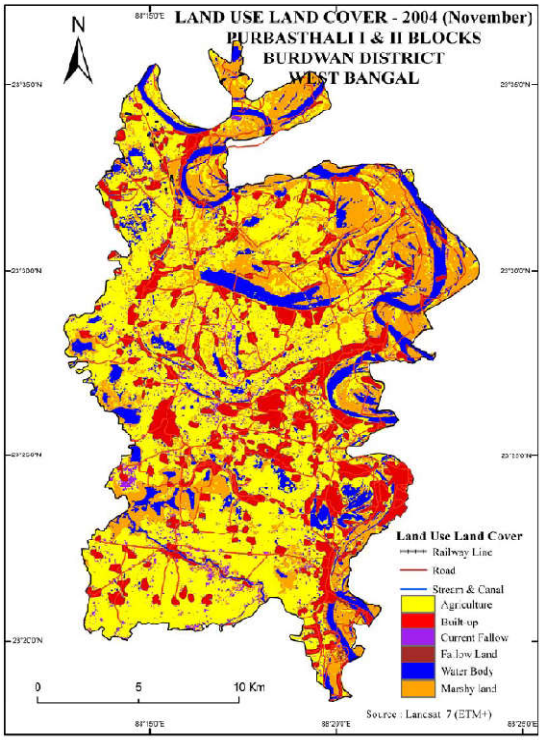

Fig. 5. Land use land cover – 2004 (November)

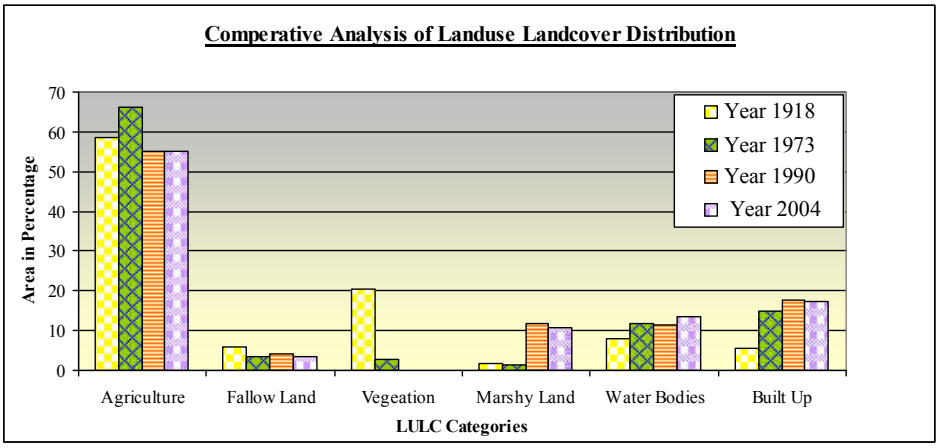

Fig. 6. Comparative analysis of land use land cover distribution

land along the Bhagirathi River, channel, ox-bow Lake, meander cut-off, abundant channels and along the major bills. These marshy lands are also varies in areal extension from year to year and season to season. All these are combined into this category.

Water bodies

A body of water accumulated over the land and covered the topographically depressed areas. It includes large accumulation of water such as oceans, lakes, seas etc. and small body of water like ponds, rivers, cannels, bills etc. some of them are artificial viz. channels, reservoirs, harbors etc. but most of them occurred naturally. They also varies in nature, some of them are flowing in nature viz. rivers, channels streams but some are stationary viz., Pond, bills, ox bow lakes, cut offs etc. In Purbasthali, there are few running water bodies flowing across the region. Some permanent or semi-permanent water bodies are also there i.e., ponds, bills, ox-bow lakes, meander scrolls, cut-off abundant channels etc. The vast flood plain region comprises different large to small mass of water bodies covers the significant portion of land. All are assembled together in this category.

Fallow land

The lands left uncropped for more than one year, or permanently not suitable for agricultural purpose it includes this category. This may be done for accumulate moisture, improve soil structure or induce mineralization of essential nutrient. But present study mainly the barren land of recent sand deposits, sand bars emerging char lands and the abundant fields are grouped in this category.

Current fallow

A class of land use that comprises cropped areas, which are kept fallow during the current year or session only. For example if any seedling area is not cropped again in the same year, it may be treating as a current fallow. During study we accept only the harvested land or cultivable area is not cultivated again in the current year due to some socio-economic or individual cause of the farmer.

RESULTS AND DISCUSSION

Land use land cover study and maps over Purbasthali block I and II have identified six general categories of land use land cover types from the year 1918 to 2004 using Remote Sensing and GIS technology Figure 2 to 4. Purbasthali region is agriculturally developed enough in the Burdwan district. So it is quite common that agriculture dominates all other Land use Land cover categories and comprises all most half of the total area Table 2. We have extended our study to Category wise land use land cover trend analyses just to identify and explore the reality Fig.7, 8, 9, 10, 11 and 12. Trend line is the visual representation of pattern, direction and pace of change. A trend line is the practice of collecting information and attempting to sign a definite pattern. To identify the underlying land use land cover pattern over the past 86 year time span, we have adopted trend analysis technique by applying polynomial regression model of 3rd degree. Polynomial regression model have been adopted to analyze and identify the expected value of dependent variable `y' in terms of the value of independent variable `x'. The 3rd order polynomial regression model is used as its R-squared value is 1 in respect with the data set which represents the reliability of the represented trend line.

Agricultural Land use and changes

In the year 1918 agricultural land consist 58.48 percent area of the region which increased up to 7.60 percent of the total area during the 1st lap of temporal analysis extended from 1918-1973 Table No: 4 and then decreased up to 11.03 per cent Table No: 5 . Where as in 3rd phase of temporal analysis it again experience minute increase of 0.11 per cent Table No: 6. The subsistent agricultural practice is the basis of rural economy here and some time supplemented by household weaving industries also. Crop cultivation is carried out on the flood plain dominated region thoroughly except some alluvial rises, levees and swamps. Different types of crops are cultivated; the most predominant one is paddy, which is followed by jute a dominant cash crop in the region. But during the time of our study Aman (paddy) is the mature standing crop in the field in November month and second dominated agricultural practice is the rabi cultivation. As the region have lot of surface water resources viz. paleo-channels abundant channels, oxbow lakes and flowing rivers etc. thus there is enough scope for irrigation what is more lot of shallow tube wells, deep tube wells, medium duty tube wells were installed for the purpose of irrigation which ultimate the Rabi crop cultivation. Potato is the major Rabi crop except that

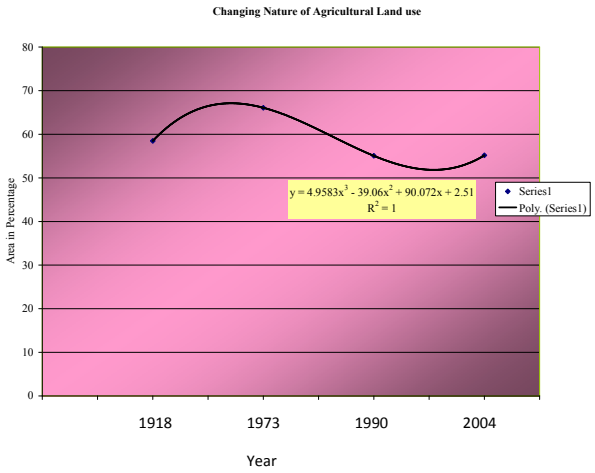

Fig. 7. Changing nature of agricultural land use

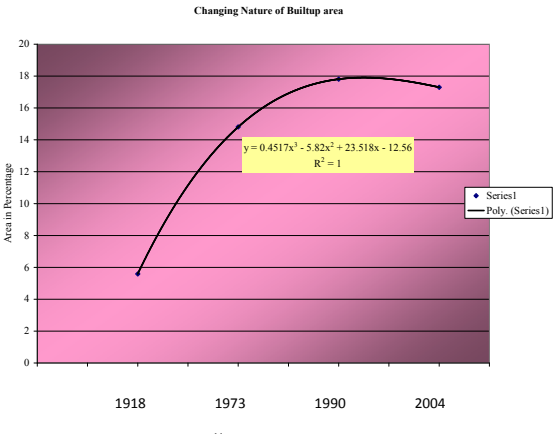

Fig.8. Changing nature of builtup area

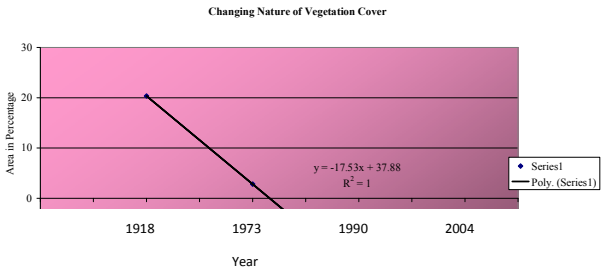

Fig. 9. Changing nature of vegetation cover

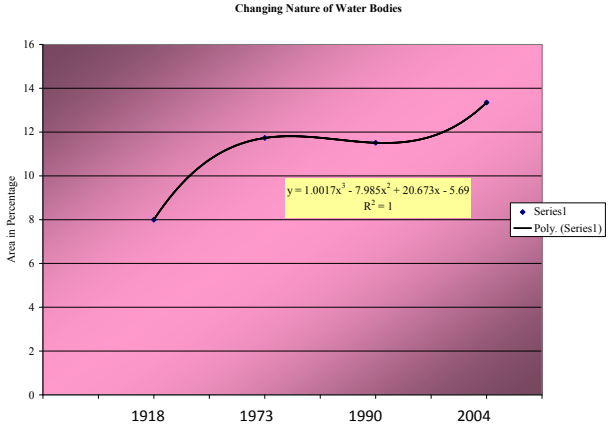

Fig. 10. Changing nature of water bodies

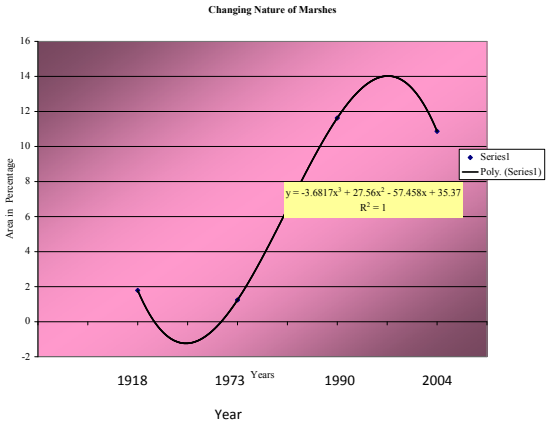

Fig. 11. Changing nature of marshes

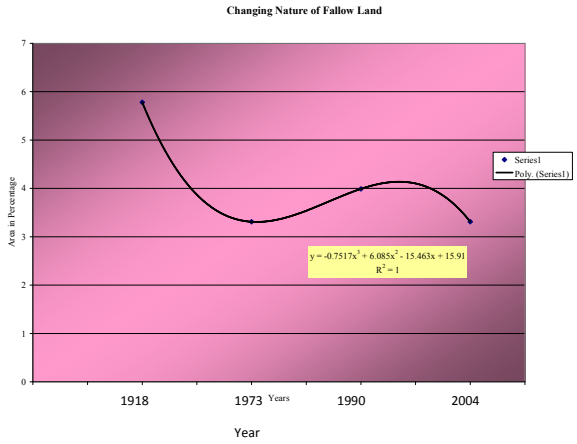

Fig. 12. Changing nature of fallow land

musur, mascalai, khesari, Til, Mastard, Gram, wheat, onion, chili, dhania, and many other vegetables are cultivated. In some areas fruits like papine and guava also cultivated. From first phase of study from 1918-1973 revealed that agriculture is the dominant land use type present in the study area and the spatial coverage under the land use class increased quite steadily; mainly due to mechanization in agriculture, extension of irrigation facility and use of High Yield Verity seed etc. have increased the yield and motivate the rural people to cultivate the existing land resource intensively and acquire all the lands covered with natural vegetation, existing fallows and riverine low-lying areas to cope with the growing demand of the population. But the growth rate declines abruptly in the second phase of temporal analysis i.e., from 1973 to 1990 because of rapid growth in built up sector.

Another important break point is that, in 1973 topographical map we can not able to identify the land under current fallows but in contrast the1990 image (Land sat, TM) of late November finds lot of current fallows. We can also cross check it with fallows, where we find positive increase in this category due to addition of current fallows with this category. The final phase experience minute growth in agriculture sector because of the fact that subsistence intensive agricultural practice reached its ultimatum. Thus very little growth is found as the farmers now a days adopting crop diversification and gradual reclamation of low lying shallow wet lands into agricultural fields. For the better understanding, polynomial

curve is represented bellow to trace the change and find out the trend Figure 7.

Built-up areas and land use change

Present study reveals that the second major land use class is the built up areas. It covers 5.59 per cent of the total area in the year 1918 Table No. 4 and usually grows up to 14.81 per cent and 17.81 per cent in the year 1973 & 1990 respectively Table No. 5. But, then suddenly, decreased slightly in 2004 and covers 17.30 per cent area of the total land; just because of, bank erosion along the bank of river 'Bhagirathi'. Here also the trend line is fitted to sign the change graphically Figure No: 8. As the region is mainly dominated by rural area thus the growth of urban built-up is limited. Lot of road, network are also developed in the last 86 years specially in post Independent time period which are mainly metal and semimetal in nature but major small roads are developed are un- metaled and muddy. Present study area no where the metaled and semi metaled roads are not extended more than 5 mts in width. The village settlements in Purbasthali are built along the pre defined lines, ranging from straight, curved and parabolic alignment along road, railways transport route, active river channels and natural flood plain rises, especially along the levees. The size of the settlement also varies from small nucleated to large clustered. Here homestead are grown up along with typically ornamented with greeneries and orchards. As the region is a low lying flood plain, thus the settlement developed in the dry points sites and flood plain rises. There are four major census town viz. Shreerampur, Hatsimla, Gopinathpur and Patuli. Among them Patuli and Shreerampur are developed along the western bank of river Bhagirathi acquiring the levee position. Where the Gopinathpur and Halsimla are developed in the inter-fluvial highland of Khari and Bhagirathi Rivers. The urban centers are concentrated along or near the major arteries viz. rail route extending from south-east to north-east direction.

Natural vegetation and land cover change

Natural vegetation is one of the major components of the environmental system and plays an important role in many direct and indirect ways to maintain the ecological stability. But, with increasing population & unconscious human desires the natural vegetation of the major floodplains of the world are under massive destruction which not only threatens the plant diversity but also leaves a negative imprint on the regional ecological community. The lower gangetic plain is not an exception; much of its natural vegetation is destroyed at the cost of urban and agricultural growth. The area under study situated on the western bank of river Bhagirathi has tropical & sub-tropical deciduous type of vegetation which includes Mango, Jam, Guava, Kathal, Bamboo, Bakul; Banana etc. are now in severely degraded condition. Maximum natural vegetation is vanished by the anthropological activities. Our analysis reveals that 17.53 % areas under natural vegetation are engulfed by the pace of development from 1918 to 1973 Table No: 4. But, here we must mention the limits of our study, i.e. the present work fails to identify and analyse the change in natural vegetation cover all through 86 years time span, just due to poor resolution of the 1990 & 2004 (TM) images.

Surface water body and land cover change

Surface bodies have significant role on the land use and land cover pattern and especially on agricultural practice and irrigation. Purbasthali region have been extensively contaminated with high amount of arsenic in ground water. (Biswas 2010) Thus the use of surface water may be taken as the major environmental management strategy. The total surface water bodies in the region covers a large share of land i.e., almost 8.00 per cent in the year 1918, which grows up to 11.73 per cent in 1973 Table No. 4 due to digging of new ponds in post-independence time period but after that it is slowly decreasing due to reclamation of shallow water bodies for agricultural purpose. Finally, at the last phase of temporal analysis it is found that water bodies are increased about 1.84 per cent Table No: 6 might be due to flooding impact or due to dynamic course of nature. To identify analyse the dynamicity of surface water bodies through out the study period we used to sign a best fit curve and represent a polynomial curve in this regard. Jute retting also degraded the quality and quantity of surface water bodies. The created maps shows that there are different types of water bodies, i.e., ponds, Bills, rivers, cannels, bow lakes, abundant channels, meander scrolls, cut-offs etc. These are also vary in nature some are permanent and some are semi permanent. Thus we prepared a table to present a brief account of major water bodies Table No: 3. But here it is important to mention that many other small and medium size water bodies are there which are not highlighting in the table which acquires the remaining percentage.

Marshy land areas and land cover changes

The poorly drained vegetation dominated marshy land areas of the region are occurring along the depressed areas of the flood plain specially the back swamp areas and covers only 1.79 per cent of the total area in 1918; which decreased up to 1.24 per cent in 1973 Table No. 4 But suddenly the satellite image processing identifies much areas under marshes and accounts 11.63 per cent of the total land are encompassed by marshes which again decreased slightly, almost 0.76% and covers about 10.87 per cent of the total land in the year 2004 Table No. 6. Trend of change are also identified and shown through best fit polynomial curve Figure No. 10. Here we find there is a growth of marshes which may be due to flooding of agricultural fields for Ravi crop cultivation, high rainfall and frequent invasion of flood in 2000-2004 time periods.

Current fallow and changing pattern

The topographical map did not provide any opportunity to identify the current fallows. So, it is not possible to identify and analyse the changing nature of current fallows through out the study period extended from 1918 to 2004. But, the satellite image provide chance to identify the change from 1990 to 2004. The images are of November month which is the growing season for Rabi crop cultivation. Though the region is proficient in agriculture and crop production but from the classified images we find considerable amount of land are lying currently fallow or harvested and did not used for any other crop production. It covers almost 3.15 per cent of total land resource in the year 1990, which decreased up to 0.49 per cent and acquires only 2.66 per cent of the total area in 2004 Table No. 2. It reveals that gradually due to extension of irrigation, cultivation of multiple crops, mechanized

agricultural technique and extension of plantation agricultural practice the current fallows are decreasing day by day and more and more land resource are coming under intensive human practice of economic consideration.

Fallow land and changing pattern

Fallows in the region are very limited due to rapid extension of agriculture and settled areas. Study reveals there is gradual decrease in fallow areas from 1918 to 2004 Table No. 2. In 1918 fallow land covers 5.78% which drop to 3.31% in the year 2004 and only 22.93 hector are remain fallow. Trend analysis also made to identify the changing nature of fallow land through out past 86 year time span Figure No: 12.

Findings and Conclusion

With in the Framework of present discourse, for the detection of possible land use land cover changes, monitoring and evaluation in Purbasthali area using Topographical maps and land sat TM data is easily realized. The digital image classification (supervised classification) conducted with GIS has been proved ability to obtain comprehensive information on the modifications and conversions of land use land covers as a result of spatio-temporal dynamics of natural and human activities. The result of present work indicates there has been important land use land cover change in between 1918 – 1973 time-periods in Purbasthali. The Statistical analysis shows that the major changes have occurred in Vegetation cover, agriculture and built up categories. Both vegetation cover and Agriculture decreased; where as built up area have increased up to considerable amount, with 36.98% of the total observed positive change occupied by agriculture while 44.87 % occupied by built up areas. Other 18.15 % areas of total observed positive change is identified in water-bodies category due to digging of new ponds in post independence period in 1973. It should be stated that these positive changes are balanced by the area lost under vegetation patches, fallow land & marshes, among which vegetation patches share 85.30% and fallows consider only 12.02 % decrease of the total observed negative change;(Table No. 4)in this time period major natural landscape covered with vegetation are destructed and used for cultivation and building roads, homestead & many other new set-ups. It happened due to improved agricultural technologies, extension of irrigation facility, use of high yielding seed and multi crop cultivation etc; where as built up areas have been increasing for the high population pressure and it accounts for 21.32 % of the total observed positive changes found in 1973- 1990. (Table No. 5) From the year 1973-1990 the scenario is something different, as the invested land for agriculture decreased significantly and covers only 55.06% instead of 69.09% of the total area in 1973 and shares most of the lands where negative growth are experienced. (Table No. 5)It is also necessary to state that in this phase fallows and marshes increased. Where as fallows increased due to merging of current fallows with the fallow land as the 1990 (TM) image is of November month which is the harvesting season and marshes accounts for 11.63% of the total area due to flooding of agricultural fields for *'Boro'* seeding and *'Ravi'* crop cultivation; which is one of the major limitations of our study.

In our final phase of study it is found that agriculture is growing slowly and tries to attain stability. Except that lands covered with water-bodies are also increased due to heavy rainfall and frequent floods in 2000-2004 time-period. These observed positive changes are counter balanced by the reduction of lands under fallows & marshes. Where as reduction in built up category might be arranged to the bank erosion of river *Bhagirathi* along the eastern margin of the study area as the river is meandering and actively migrating laterally. So, it can be cropped up that land use of ecological signature is gradually engulfed by land use of economic consideration.

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