VILLAGE LEVEL LAND USE LAND COVER CHANGE DYNAMICS AND BRACKISH WATER AQUACULTURE DEVELOPMENT: A CASE STUDY IN DESOPRAN BLOCK, WEST BENGAL, INDIA USING MULTI-TEMPORAL SATELLITE DATA AND GIS TECHNIQUES

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Abstract

A study has been made on the growth pattern of commercial aquaculture activity and its effect on traditional land use land cover in coastal part of West Bengal, India. The analysis of series of multi-temporal satellite data provided the accurate quantification and therefore, understanding the land cover changes during 2006 to 2014 using GIS technique. One block in Purba Medinipur district, West Bengal was selected for pilot study, which is Desopran Block. In the study various types of data have been used. It includes satellite data of different years, thematic maps and primary ground truth data. The whole work has been performed in two major parts: I) Construction of plot level (LR plot) Geo-Special information of fisheries sector. II) A chronological study of growth pattern of fishery sector.

Introduction

Transformation of rice fields into shrimp farms has changed the land use/land coverage of the densely populated coastal areas in tropical Asia and Latin America (Gujja and Finger-Stitch, 1996, p. 14; Dewalt et al., 1996, p. 1193; Flaherty et al., 1999, p. 2047). Net profit from shrimp is 12 times higher than that of high yielding variety (HYV) rice (Shang et al., 1998). Because of its high profit, shrimp farming has emerged as the most attractive land use practice that contributes to the economic development of the coastal districts of Bangladesh (Hossain et al., 2004).

The geographical position and climatic condition of Purba Medinipur District in west Bengal have made her coastal areas one of the highly productive areas of the state. One of the unique features of the coastal areas of Purba Medinipur district is the influence of the Saline water and Soil, which help to grow a high number of fishes and other commercially important aquatic organisms. The Inland and Marine fishery have been playing considerable roles not only in the Social and economic development of the study area but also in increasing the National economic development.

For sustainable development of the coastal resources, both for aquaculture/fisheries and agriculture needed monitoring of the changes and selection of suitable sustainable sites for aquaculture. This requires I) detailed survey and monitoring of the present situation, and, II) exhaustive micro level database creation. Remote sensing and GIS techniques are gainfully used or such a comprehensive analysis which lead to identification of suitable aquaculture site. So, it is necessary to conduct detailed surveys of the different classes of water bodies such as tanks/ponds, brackish fishery and river, streams, canal, for developing coastal aquaculture using remote sensing technique.

By using Remote Sensing and GIS technique is being used as a tool to know location, extent and spatial and temporal changes of coastal aquaculture, especially coastal shrimp farming area. (Krishnamurthy et al. (1996) discussed if for Tamilnaru Coast and discussed it for West Bengal and Gujrat coast. (Nayak et al. 1995)

Objective

The present study aims to generate village level spatial database on past and present (2006-2014) inland water bodies of Desopran block of Purba Medinipur District, West Bengal to develop aquaculture/fisheries information system by using

Remote Sensing and Geographic Information System. This requires I) an exhaustive micro level database creation on the land use pattern of the past and II) detailed survey and monitoring of the present situation. Remote sensing and GIS techniques are gainfully used or such a comprehensive analysis which lead to identification of suitable aquaculture site. So, it is necessary to conduct detailed surveys of the different classes of water bodies such as tanks/ponds, brackish fishery and river, streams, canal, for developing coastal aquaculture using remote sensing technique.

Description of the study area

The study area Purbo Amtoliya Mouza (JL NO.447) of Desopran block is situated at the south-East end of Purba Medinipur district in West Bengal. Located between latitudes 21049'56''N to 21051'12''N and 87050'50''E to 87052'21'' E longitudes. It covers an area of approximately 641.69 acres and consists of 1451 LR plot. The site selected for this study is ecologically and economically important and is a representative aquatic region for the present investigation as it is one of the shrimp farming hot spots along the east coast of India. Costal mouza selected for present study are blessed with potential riverine system, which provides considerable scope for brackish water shrimp culture. Most of the Shrimp farming activity particularly for water supply in the study area depends on creeks.
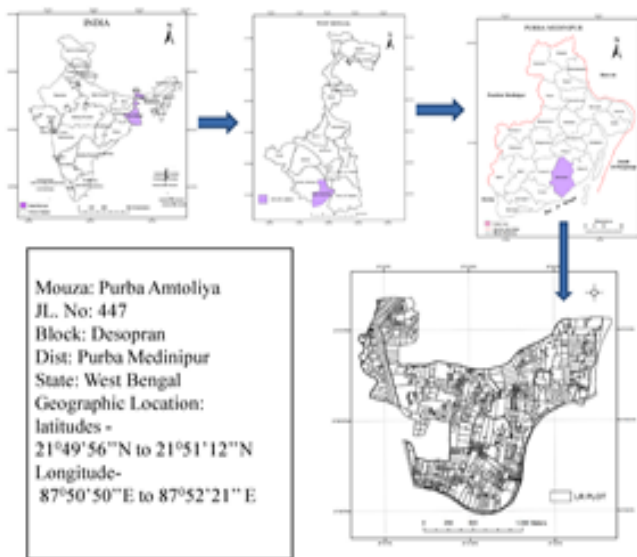

Figure 1. Map showing the study area with LR plot of Purba Amtoliya Mouza, Purba Medinipur District, and West Bengal, India.

Materials and Methods:

Satellite images acquired from the Google Earth on 1200ft eye altitude (sensors Digital Globe) in 2006, 2010 and 2014 were used for the land-cover change detection. The selection of the years was such that they could clearly indicate the changes due to shrimp farming in the study area (DDF, Dept. of Fisheries. Govt.of WB). For the accomplishment of this study different spatial data of various formats were needed for specific purposes. Including administrative map, Cadastral maps and time series satellite imageries were compiled from respective sources a mentioned in Table 1.

Table 1. Sources of spatial datasets used in the study

Data	Source	Quality/Scale
Police Station Map	DLR & S, WB	1 inch = 1mile
Cadastral Map	DLR & S, WB	16 inch = 1 mile
Satellite Image	Google Earth	Eye altitude 1200 ft
DGPS Points	Field Survey	

The Present study involved two main steps. In the first step Cadastral map is overlaid on Google map for Land use/Land cover study in different years (2006-2010-2014). Acquired satellite data is reregistered using image to map registration technique. Then each image was cropped to study area using Area of Interest (AOI) layer. These three images were reprojected to a common projection; Universal Transverse Mercator (UTM) with WGS 84 datum and Zone 45 North.

The second step concentrated on the change detection analysis in the Land use/ Land cover types. In order to handle all data and conduct the desired analysis, different softwares were used for specific tasks. Erdas Imagine 9.3 was used for registration of raster data. In addition, ArcGIS 10 was used for all analysis carried out throughout the study.
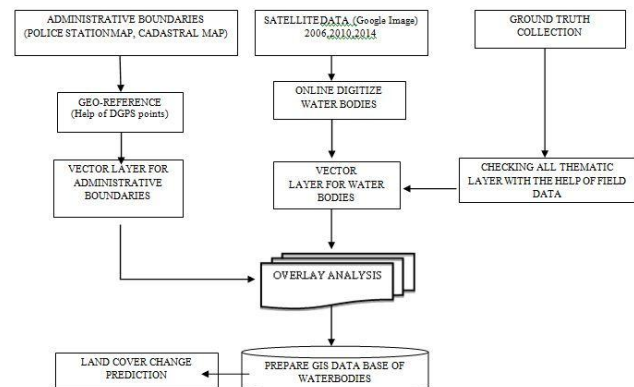

Figure 2. Flow chart for Land use/Land cover change detection and prediction.

The present study shows the dynamic nature of various land use/Land cover (LuLc) categories in the study area. It is evident from the change matrix (Table 2.) that considerable amount of land has increased or decreased (plot wise) in each category between 2006 and 2014. Total area classified into nine LuLc classes based on structure, tonal variation, vegetative association and field evidence. Present study describes how a parcel of land is used such as for cultivation, aquaculture, settlement, brick field and how vegetation cover, River/Stream/Canal, fallow land and its changes in time to time depends on economic activities.

acre in 2014. Out of the total increased of Bw tanks/ponds is 92.98 acre that more than doubled. Total decreased cultivated land is 29.73% of the total area and 28.54% brackish water tanks/ponds area increased. Others categories Land use/Land cover area is few changed. So the aquaculture extent was mainly due to its encroachment on to agriculture land.
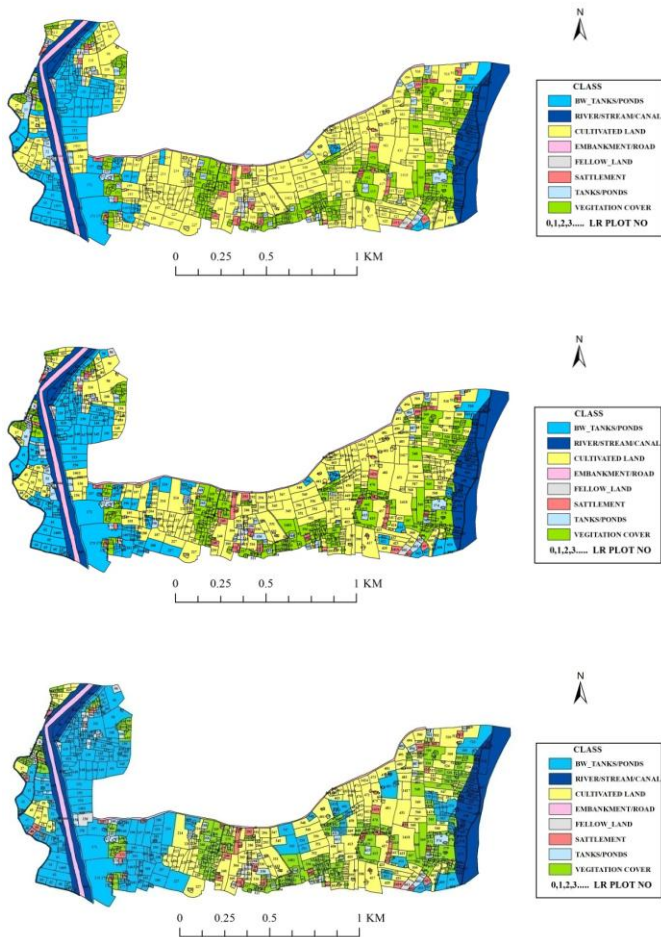

Figure 3.LR Plot wise land-cover change map for the period 2006 to 2014 of Purba Amtolia Sheet I (JL No.447)

The area under cultivated land which was about 344.55 acre in 2006 has been reduced to 302.14 acre in 2010 and 247.63 acre in 2014. Out of the total reduction of cultivated land is 96.92 acre and the other hand area under brackish water tanks/ponds (Bw Tanks/Ponds) which was about 89.8 acre in 2006 has been increased 121.52 acre in 2010 and 182.78
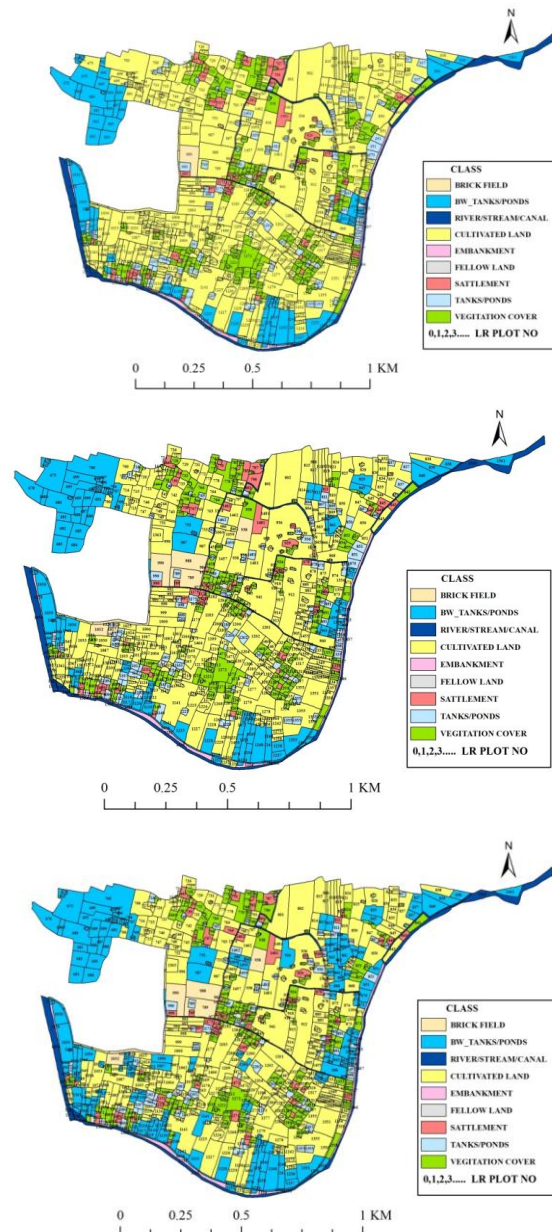

Figure 4.LR Plot wise land-cover change map for the period 2006 to 2014 of Purba Amtolia Sheet II (JL No.447)

Table 2. Landuse /landcover satistic 2006,2010 and 2014 of Purba Amtoliya Mouza (JL NO.447)

Sheet No	Lulc Category	Area Under Each Category In Acre			Area Change In Acre				Rate Of Change In %	
		2006	2010	2014	2006 to 2010	2010 to 2014	2006 to 2014	2006 to 2010	2010 to 2014	2006 to 2014
Sheet 1	Cultivated Land	168.15	150.37	107.43	-17.78	-42.94	-60.72	-4.97	-12.01	-16.99
	Bw_Tanks/Ponds	57.22	71.25	115.09	14.03	43.84	57.87	3.92	12.26	16.19
	Tanks/Ponds	12.34	12.68	10.35	0.34	-2.33	-1.99	0.10	-0.65	-0.56
	Vegetation Cover	56.31	58.33	56.94	2.02	-1.39	0.63	0.57	-0.39	0.18
	Settlement	8.24	8.88	11.22	0.64	2.34	2.98	0.18	0.65	0.83
	River/Stream/Canal	41.14	41.14	41.14	0	0	0	0.00	0.00	0.00
	Embankment/Road	10.06	10.06	10.06	0	0	0	0.00	0.00	0.00
	Brick Field	0	0	0	0	0	0	0.00	0.00	0.00
	Fellow Land	4.02	4.77	5.25	0.75	0.48	1.23	0.21	0.13	0.34
	Total Area In Acre	357.48	357.48	357.48						
Sheet 2	Cultivated Land	176.4	151.77	140.2	-24.63	-11.57	-36.2	-8.67	-4.07	-12.74
	Bw_Tanks/Ponds	32.58	50.27	67.69	17.69	17.42	35.11	6.22	6.13	12.35
	Tanks/Ponds	15.33	17.47	12.3	2.14	-5.17	-3.03	0.75	-1.82	-1.07
	Vegetation Cover	33.74	31.09	29.58	-2.65	-1.51	-4.16	-0.93	-0.53	-1.46
	Settlement	9.46	10.14	11.23	0.68	1.09	1.77	0.24	0.38	0.62
	River/Stream/Canal	11.18	11.18	11.18	0	0	0	0.00	0.00	0.00
	Embankment/Road	2.97	2.97	2.97	0	0	0	0.00	0.00	0.00
	Brick Field	1.64	8.27	8.03	6.63	-0.24	6.39	2.33	-0.08	2.25
	Fellow Land	0.91	1.04	1.04	0.13	0	0.13	0.05	0.00	0.05
	Total Area In Acre	284.21	284.2	284.22						

Figure 5: Changes in land use/ land cover proportions over the three pairs of observation year

Figure 6. Plot wise changes from paddy field and tanks/ponds to brackish water tanks/ponds since 2006, 2010 and 2014

Last four year (2010-1014) brackish water_tanks/pond increases rather than fast (2006-2010) four year. Fast four year increases 18.39% area of the total area and last four year increases 28.54 % of the total area.

Table-3: Plot wise Land use/Land cover changes during 2006 to 2014

Converted Brackish Water Tanks/Ponds form others class	2006 to 2010		2010 to 2014	
	LR Plot No		LR Plot No	
	Sheet-I	Sheet-II	Sheet-I	Sheet-II
Cultivated Land To Bw_Tanks/Ponds	34,35,36,37,96,117, 172,177,178,179,181,182,183,184,186,192,200,201,202,204, 207,208, 214,215,216,227, 421,422,424,605,609,610,1405,1441.	0,675,691,692,693,695,696,697,698,699,700,707,709, 752,753,812,813, 829,845,870,871, 872,873,987,1105,1106,1118,1136, 1137,1138,1141, 1229,1238,1356, 1367,1369,1370	47,48,75,78,87,88, 89,90,91,92,96,97, 98,108,109,114,115,116,132,136,137, 138,139,140,141,156,157,160,185,186,187,188,191,193, 194,195,196,197,199,200,201,202,203,204,207,210,214, 227,345,347,350,351,412,424,450,451,454,460,478,480, 481,482,509,547,550,551,554,556,557,558,565,658,1403,1420,1430, 1431,1432,1433	806,807,808,837,850,851,856,863,865,866,867,868,869,900,936,986,1001,1006,1007,1030,1033,1059,1060, 1066,1068,1071,1099,1141,1248,1279,1331,1332,1356,1358,1359,1360,1361,1380,1381,1461,
Tanks/Ponds To Bw_Tanks/Ponds	172,185,348,424,	694,708,1137,1138	30,38,39,52,53,54,57,208,411,642,	808,809,837,850,851,870,874,875,1021,1026,1027,1028,1029,1030,1049,1112,1117,1120,1123,1348,1384, 1140,1189,1200,1331,1332,1333,1454,1455,1456,
Vegetation Cover To Bw_Tanks/Ponds	173	808,809,861,862, 1356,		904,1273,1274, 1369
Fellow To Bw_Tanks/Ponds			172	

The various landuse/Landcover categories in the study area is clearly evident from the in Table 3, which shows the plot level data on how much land has converted one category to another category between 2006 to 2010 and 2010 to 2014.

Conclusion

Brackish water aquaculture is increasing at a rapid pace in the coastal tracts of Contai belt, as evident from the satellite imagery of 2006, 2010 and 2014.Extraction of data on spatial extents of different land use/land cover features in a plot level and its changes of the study area through GIS techniques has helped in identifying. The initial huge profit in shrimp farming in the Desopran block and the adjoining area of the coastal belt made it so popular that within a year or two a vast area from Contai to Mahisadal of Purba Medinipur district including Khejuri-I, Khejuri-II, Bhawanpur with rivers and canals of tidal saline water and

eastern part of Egra and Patashpur blocks with double and multi-cropped paddy field converted into water body. Hundreds even thousands of ponds and tanks have been dug for brackish water aquaculture.

Acknowledgments

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