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Land Use Changing Pattern Detection and Analysis in Mymensingh District: A GIS Analysis

A.K.M.M. R. Golap[1], P.K.Sarma[2], M. Akturuzzaman[3]

[1]Ph.D Fellow, Department of Agricultural Economics,

[2]Senior Scientific Officer, BAU Research System (BAURES)

[3]Professor of the Department of Agricultural Economics, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh

Abstract: ***The land use pattern of Bangladesh is rapidly changing over the time for climatic changes, population growth, and urbanization as well as changing sub-system of commercial farming. This study aims to examine the trend of land use changes due to transforming rice land into fish farming in three Upazilas of Mymensingh district. The major focus was to see the agricultural land use pattern and the trend in change of land uses. For analyses data, Landsat MSS-1977, TM-2006, TM-2011, and TM-2016 and GIS techniques were used and secondary data were collected from with ERDAS Imagine Software because GIS is the best accuracy method for assessing reference data sets derived from high-resolution satellite data and ground truth field investigation data. Evidence shows that agricultural land of the study area has been decreased by 20.04% during the past 10 years and at a rate of 2.00% per year which is more than national level (1.00%). On the other hand, 13.07% agricultural land transforming into fish farming in the past 10 years and at a rate of 1.31% per year due to water logging. The fish farming is more profitable than rice farming as well as seasonal casual labour shortage in the study area, it indicates that traditional agriculture is becoming capital intensive day by day. If this rate continues, the agricultural land will be totally eliminated in future. These land use transformations posed a serious threat to crop land resources. Hence, the realistic land change scenarios may be considered for natural resource management and furnish meaningful decision-making by the policy planners of Government of Bangladesh.***

Keywords: Land use, Changing pattern, GIS Analysis

1. Introduction

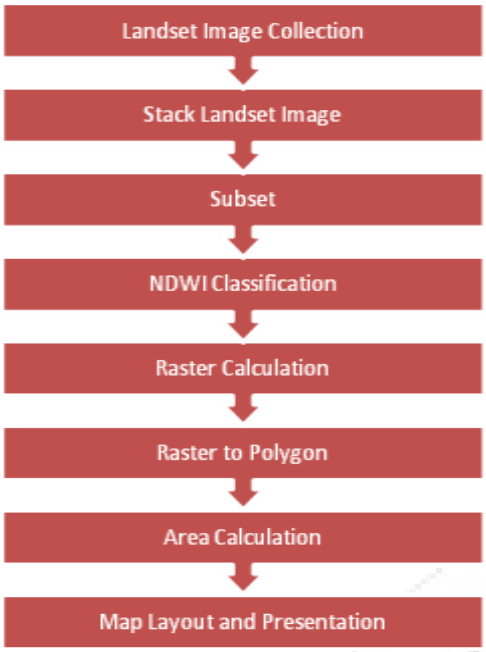
Land is one of the most important resources in a highly populous and land-scarce country like Bangladesh. The land use changing pattern detection in the study areas is an outcome of natural and socio-economic factors and their judicious utilization by man in time and space is seriously concerned. The terms “land use (LU)” and “land cover (LC)” are often used simultaneously to describe maps that provide information about the types of features found on the earth’s surface is called land cover and the human activities that is associated with them. Land cover is an in the study areas. Bangladesh used to face many factors in recent years that divided land use and land cover changes (LUCC) such as population dynamics; rapid changes in economic growt, climate change, construction of roads and highways, electrification, more advanced agriculture, technology and irrigation facilities, extended education; improved health services, new residential infrastructure (Uddin *et. al.*,2010). In Bangladesh, few studies so far have been conducted (Hasan *et al.*, 2017; Shapla *et al.*, 2015; Ghosh *et al.*, 2012; Zaman *et al.*,2011; Islam et al., 2011) land used detection by using GIS and RS techniques. Few of them focused on land use changing pattern in the context of transformation rice land into fish farming. Therefore, the main objective of the present research was to utilize GIS technologies to examine the transforming crop land into fish farming and identify the influencing factors of land use in the study areas. The findings of the study furnished meaningful decision-making for policy planners to conserve and/or exploit land resources in Bangladesh in a more sustainable manner. Important input parameter for a number of agricultural hydrological and ecological models, which constitute necessary tools for development planning and management of natural resources

2. Material and Methods

The study carried out in three upazilas (namely, Muktagasha, Fulbaria and Trislal) under Mymensingh district of Bangladesh. Three Upazilas were purposely selected for the study due to rapidly changing urbanization, commercial utilization of land and fact that a considerable amount of land converting into fish farming. The purposive sampling technique was used in this study and a total of 600 respondents surveyed from three Upazilas. Field level data were collected by pre-determined interview schedules and that of satellite data were collected by ERDAS Imagine software because GIS is the best accuracy method for assessing reference data sets derived from high-resolution satellite data and ground truth field investigation data. Collected data were analyses by using descriptive statistic, regression analysis and Landsat MSS-1977, TM-2006, TM-2011, and TM-2016 image analysis by GIS techniques. The subsequent steps were followed during the study (Fig. 1).

Figure 1: Steps Followed to Conduct the Study

Steps of Work



Land set Image Collection

2006-2011 image are Landset 5 TM Image

Band	Resolution	Wavelength µm	Description
1	30m	0.45-0.52	Blue
2	30m	0.53-0.61	Green
3	30m	0.63-0.69	Red
4	30m	0.78-0.90	Near Infrared
5	30m	1.55-1.75	Short-wave infrared
6	60m	10.4-12.5	Thermal Infrared
7	30m	2.09-2.35	Short-wave infrared

2011-2016 image are Landset 8 TM Image

	Bands	Wavelength µm	Resolution (meters)
Landsat 8 operational land imager (OLI) and Thermal Infrared Sensor (TIRS)	Band 1- Ultra Blue (costal/aerosol)	0.435-0.451	30
	Band 2- Blue	0.452-0.512	30
	Band 3- Green	0.533-0.590	30
	Band 4- Red	0.636-0.673	30
	Band 5- Near Infrared (NIR)	0.851-0.879	30
	Band 6- Shortwave Infrared (SWIR) 1	1.566-1.651	30
	Band 7- Shortwave Infrared (SWIR) 2	2.107-2.294	30
	Band 8- Panchromatic	0.530-0.676	15
	Band 9- Cirrus	1.363-1.384	30
	Band 10- Thermal Infrared (TIRS) 1	10.60-11.19	100* (30)
	Band 11- Thermal Infrared (TIRS) 2	11.50-12.51	100* (30)

NDWI Classification Formula

$$\text{NDWI Landset 8} = \frac{Band\ 3 - Band\ 5}{Band\ 3 + Band5}$$

$$\text{NDWI Landset 5} = \frac{Band\ 2 - Band\ 4}{Band\ 2 + Band4}$$

3. Results and Discussion

3.1 Changes of Land Use Pattern

Two types of data (land use and water body) were analysed in this research. Satellite data that comprised of three years multi- temporal satellite imageries (Landset 7 imageries of 2006, 2011 and 2016) for the month of February acquired from the USGS GLOVIS website shown in Fig.1 and Fig. 2 respectively. The total agricultural land of the study area has been decreased by 20.04% during the last 10 years and at a rate of 2% per year which is more than national level (1.00%) of Bangladesh (Table-1). This trend suggests that the agricultural land is converting into other type of land use, especially applicable for the low lying rice field into fish farming and also infrastructural development for rapid growth of urbanization.

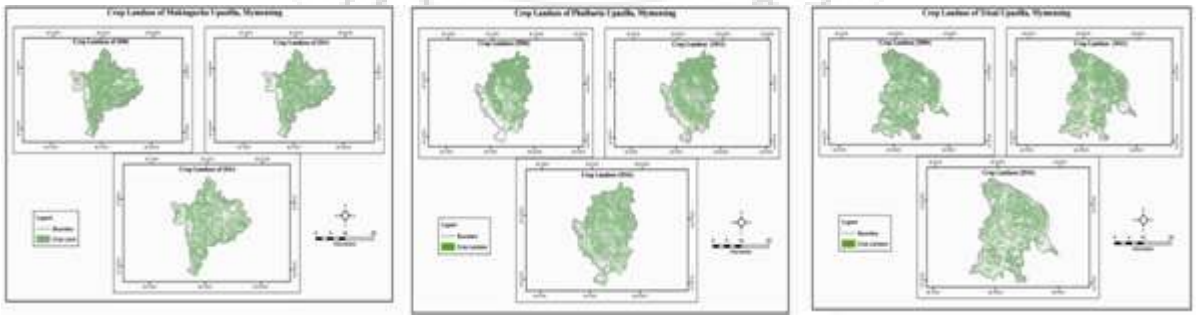


Figure 2: Upazila wise land use change in Mymensingh District

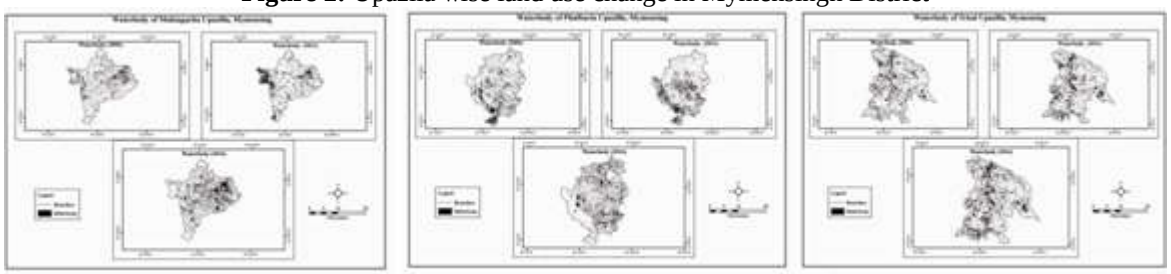


Figure 3: Upazila wise water body use in fish farming in Mymensingh District

Sources: *Landset Satellite Image collection from earth by* ERDAS softwere *(2006, 2011, and 2016)*

Table 1: LULC change detection analysis in Mymensingh District for the years 2006-2016 (Ha)

Upazilas	Changes of agricultural land over the time (Ha)					% land decreased from 2006 to 2016
	Year 2006	Year 2011	% land decreased from 2006 to 2011	Year 2016	% land decreased from 2011 to 2016	
Muktagacha	17422.41309	15543.55308	10.78	14722.09384	5.28	15.5 (1.55%)
Fulbaria	19281.16799	17947.06814	6.92	15948.04357	11.14	17.29 (1.73%)
Trishal	17005.61717	14768.69885	13.15	12273.94322	16.89	27.82 (2.78%)
Total	53709.19825	48259.32007	10.28	42944.08063	11.10	20.04 (2.01%)

Note: Figure in the parentheses indicate the percent change per year
Sources: *Landsat Satellite Imageries (1977, 2006, 2011, and 2016)*

Table 2 shows that total low level water body in the study area has been increased by 13.07% during the last 10 years and at a rate of 1.31% per year due to water logging. The fish farming is more profitable than rice farming. Secondly, seasonal casual labour shortage in rice farming induced converting low lying inland into fish farming. The similar findings also supported by Sarker *et al.* (2006). They reported that the economic profitability of fish farming was higher compared to cultivating rice or any other crops, thus, farmers converted their rice fields into pond fish culture. It reveals that the area of agricultural land decreased by 15.5%, 17.29%, and 27.82% and converted to fish farming by 13.35%, 8.93%, and 16.95% in the year 2006, 2011 and 2016 for Muktagacha, Fulbaria and Trishal upazilas of Mymensingh district, respectively.

Table 2: LULC changes of water body in Mymensingh District for the year 2006 to 2016 (in Ha)

Upazilas	Changes of water body over the time (Ha)					% land decreased from 2006 to 2016
	Year 2006	Year 2011	% land decreased from 2006 to 2011	Year 2016	% land decreased from 2011 to 2016	
Muktagacha	2357.334458	2519.40000	6.87	2672.06250	6.06	13.35 (1.34%)
Fulbaria	2570.150333	2683.96000	4.43	2799.71345	4.31	8.93 (0.89%
Trishal	2576.242246	2819.69002	9.45	3012.80000	6.85	16.95 (1.70%
Total	7503.727037	8023.05002	6.92	8484.57595	5.75	13.07 (1.31%)

Note: Figure in the parentheses indicate the percent change per year
Source*: Satellite Images of Landsat 1977-MSS, 2006-TM and 2016-TM analysis*

2.2 Factors Influencing on Land Use and Land-Cover Change

Socioeconomic factors which were considered and tested by using binary logistic regression model shows the increase of education, population growth, demand of fish, shifting rice to fish farming, fish prices, farm size and land tenure, etc, was positively influenced on convent rice field into fish farming. The regression coefficient expect education and population growth the coefficients indicate these factors have significant influenced on land used changes in the study areas which is supported by the findings of Lyaruu (2002) and Tiffen (2003); Kilimanjaro (2003); Kikula (1997); and Kajembe and Luoga (1996). The adjusted R^2 value is 0.94 which indicates the above-mentioned variables explained 93%of factors influencing land-use and land-cover change.

Table 3: Factors Influencing Land-Use and Land-Cover Change

Variable	Coefficient (ß)	Standard error	Sig.
Education	-1.409	1.721	0.504
Population growth	1.290	0.810	0.283
Demand of Fish	3.315*	1.763	0.061
Shifting rice to fish farming	2.439*	0.792	0.029
Fish prices	2.551*	0.616	0.026
Farm size	0.941*	0.536	0.022
Land tenure	2.106*	1.102	0.051
Constant	-6.022	1.279	0.000
Adjusted R^2	0.943		
Chi-square	34.756		
Log likelihood	69.58		

*N.B: *= Statistically significant at 5% level*
Sources: Field Survey Data 2016

4. Conclusion and Policy Implications

By Using GIS techniques, it was found that farmland in the study area decreased by 2.01% per year. If this trend continues, no agricultural land will be available in the future. To address the challenges for protecting agricultural land, some recommendations have been proposed;

The infrastructure should be developed vertically and zonal growth planning should be accumulated:

1) Rules and taxes can be imposed for new infrastructures on agricultural land;
2) Awareness should be developed among the people
3) Adoption of an appropriate urban planning and zoning to protect agricultural lands from urbanization encroachment, sand drift, etc

5. Acknowledgments

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