



## STUDY ON LAND USE AND BIODIVERSITY OF SONADIA USING REMOTE SENSING AND GIS

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### ABSTRACT

The present paper deals with the investigation of the land use and biodiversity of Sonadia, Moheshkhali. It is rich in plant and animal diversity. The main objective of this study is to make a land use map of the study area showing the various land utilization including plant and animal diversity. In this study combined remote sensing and field survey system have been used to find the mangrove plantation cover change, shrimp farm, fishery, turtle habitats, human habitats and birds. The study shows that the total land area is about nine square kilometer where about 2000 people live. The mangrove plantation had been raised long time ago in this area and about 2629 hectare is physically available now. Long sand bars have been developed at the south eastern side of Sonadia. It is the abode of birds, fish, mollusk and turtles. The beach and the shallow soil surrounding the site provide an excellent staging and winter ground for migratory water fowl and other shore birds. Red crabs always roam in the area. About forty thousand birds have been estimated by different national and international survey teams. More than 70 species of migratory and shore birds visit the area for resting, feeding, nesting and wintering. The paper has presented a land use map of the study area which could be used for development planning of the study area. A bird sanctuary has been suggested to be establish in Moheshkhali for the conservation of biodiversity.

**Keywords:** Land use, Biodiversity, Remote sensing, GIS

### 1. INTRODUCTION

Biodiversity refers as the species diversity and richness including the totality of genes, species and ecosystem. According to the convention on biological diversity (CBD), it is the variability among the living organisms from all sources including terrestrial, marine and other aquatic ecosystem. It includes diversity within a species, between species and ecosystem within a particular place or within globe. Bangladesh possess a vast diversity of ecosystem, flora and fauna but due to tremendous population pressure, rural poverty and unemployment it has been decreased noticeably. Biodiversity has become an issue of global concern for its rapid reduction and change. Any deltaic plain consists of a number of ecological zones, each with their associated flora and fauna. The diversity is mainly determined by hydrological condition, seasonal variation of climatic parameters, topography, soil, salinity etc. Typical ecosystems are partly natural and partly man made. In our study we analyzed both the natural and man-made ecosystem of Ssonadia. The ecosystem consists of wide variety of species diversity including important endangered species. In some ecosystem the population of most species has declined due to population pressure but the flora and fauna diversity is still high. The study of biodiversity is important for conservation of nature and its ecosystem.

### 2. OBJECTIVE

The objective of the study is to prepare land use map, using remote sensing & geographical information system (GIS) including the assessment of biodiversity of plant and animals. The detail objectives are as follows:

1) Preparation of land use map of the study area using remote

sensing and GIS.

2) Visually change detection study of the selected area during the period 2004, 2007 and 2010.

3) Assessment of the animal and plant biodiversity of the selected area.

### 3. STUDY AREA

The Moheshkhali Island including the Sonadia and Materbari located within 21°46' 08" and 21° 27' 40"N latitude and 91° 50' 20" and 91° 59' 57"E longitude. Moheshkhali channel separates it from main land. In the western, north-western and south-western side is open to the Bay of Bengal. The topography of Moheshkhali categorized by hilly topography encircled by coastal plain and this land is geologically classified into four classes i.e. dynamic coastal plain, young coastal plain, old coastal plain and hilly areas with piedmont plain (Islam et al., 2011). Two different depositional systems prevail in Moheshkhali closed to semi closed system in southern part and open to semi closed system in northern part (Majlis et al., 2011). Moheshkhali is in accretionary phase with a rate of 1.2 sq.km. per year since 1972. Sonadia is an union of Moheshkhali upazila in the district of Cox's Bazar, Bangladesh. It is on the south west side of Moheshkhali upazila beside the Bay of Bengal.

Figure 1: Location of the Study Area.

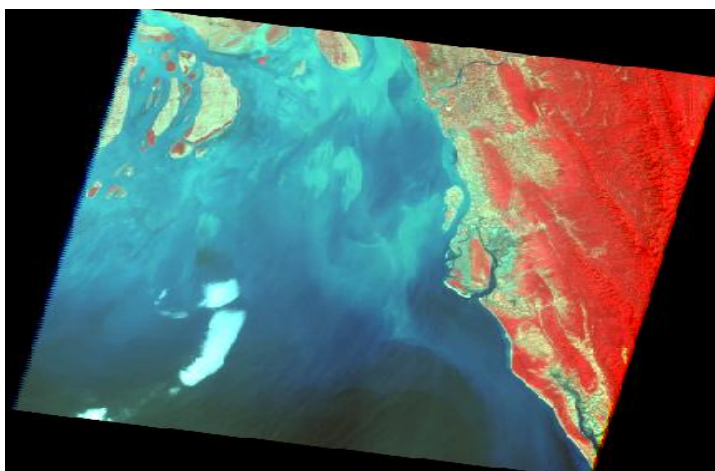
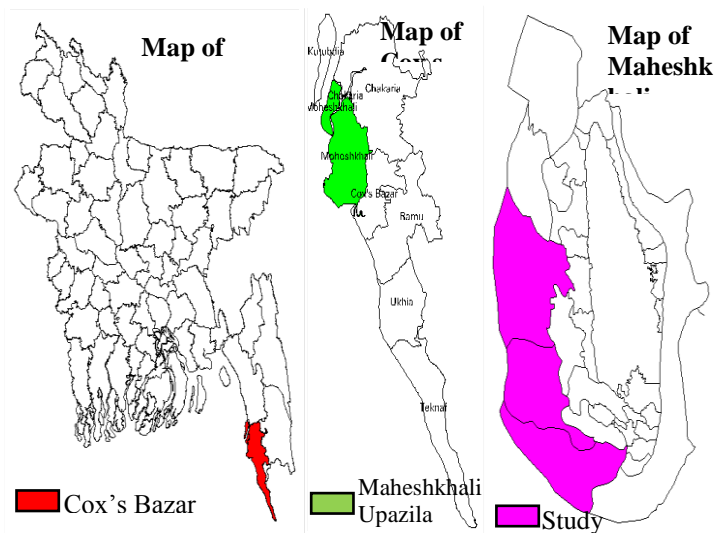


Figure 2: Geo-referenced image of Landsat 5 TM, 136/45 frame of 24 Feb. 2010

#### 4. DATA USED AND METHODOLOGY

##### 4.1 Remote sensing and other data

Landsat-5 Thematic Mapper (TM) data of 30 meter resolution of 2004, 2007 and 2010 covering the study area have been used in the study. Table-1 shows the Landsat-5 TM frame number & acquisition dates and figure 2 shows the Landsat frame 136/45 of 24 February 2010 covering the study area. Remote sensing data have been downloaded from glovis archive of USGS (<http://glovis.usgs.gov>). All the captured area in Geo TIFF format and converted to ERDAS imagine format. The coastal and wet-land biodiversity data are obtained from ministry of Environment (MOE) 2008.

Table 1: Satellite Data used in Land use classification of Sonadia Island

Satellite/ Ancillary Data	Sensor	Number of Spectral Bands	Acquisition Date and Time		Frame	Remarks
Landsat-5	Thematic Mapper (TM)	7	20022004	Around 09:45 (local time)	136/45	
			04032007			
			24022010			
(Google) TerraMetrics & DigitalGlobe	Rapid Eye	5	December 2009		-	

Note: MoE- Ministry of Environment

In addition the data of biodiversity was collected through field investigate.

#### 5. DATA, METHODOLOGY, ANALYSIS AND PREPARATION OF LAND USE MAP

The data analysis involves geo-referencing of the image, visual interpretation of 2004, 2007 and 2010 imageries, Un-supervised & supervised classification of 2010 image, GIS analysis, preparation of map and statistics generation. Ground control points (GCPs) were collected from field using GPS for geo-referencing the image of 24 February 2010. Table 2 shows the GCP collected location. The rest of the images were geo-referenced using the image of 2010 as the base image.

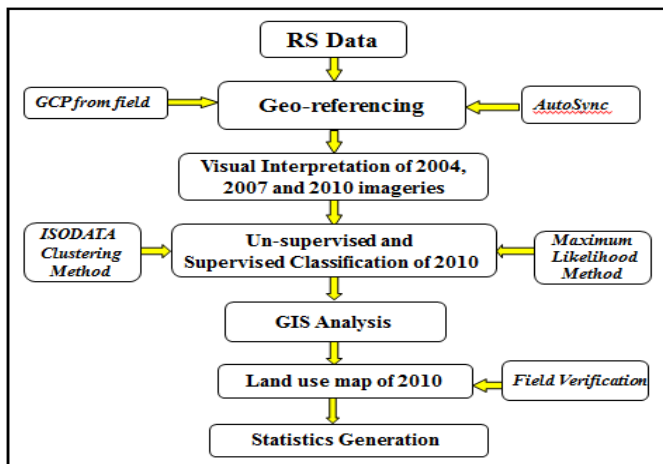
Table 2: Location of GCP collection points

Serial No.	Description of Location	Position		Remarks
		Longitude	Latitude	
1	South West corner of Maheshkhali Upazila Pond	91° 57' 54.55"	21° 31' 04.48"	Data collected from field.
2	North East corner of Cox's Bazar airport run way	91°57'45.07"	21°27'43.89"	
3	North East corner of Cox's Bazar new police line	91°59'32.00"	21°25'13.70"	
4	North West corner of Kutubdia Technical & BM College	91°51'35.72"	21°51'36.15"	
5	North West corner of Chakaria Police Station	92°04'12.00"	21°45'26.36"	
6	South West corner of Teknaf Shaporijeti	92°20'29.64"	20°46'07.20"	
7	North East corner of Baitul Jannath Jame Masjid, Teknaf	92°08'34.07"	21°04'33.48"	
8	North East corner of Ramu Upazila Health Complex	92°06'00.81"	21°26'42.19"	

The multi-temporal Landsat imagery has been used which helps identification of perennial and seasonally varying features of land-use. The RGB false colour composite has been prepared for visualizing the land features. Then the multi-spectral classification of 2010 was done using unsupervised (ISODATA) and supervised classification (Parallelepiped and Maximum Likelihood techniques) and results have been compared. Based on the field investigation

and secondary data, it is found that the supervised classification using maximum likelihood provide best results, because area of land use classes of supervised classification are almost closer to field information (Table 3). The major classes such as Mangrove forest, water bodies, settlement, and shrimp/salt bed have been identified through interpretation of the classified imagery.

**Figure 3:** Procedure of Data Generation



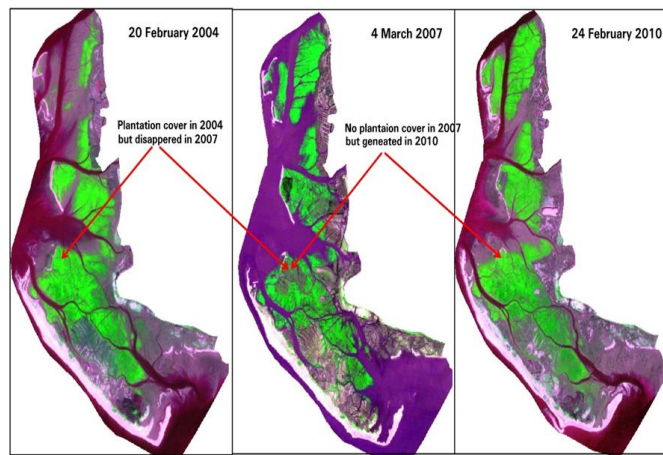
**Table 3: Statistical data of Study Area**

Description of Class	Classification		Field data Area (ha)	Remarks
	Un-Supervised Area (ha)	Supervised Area (ha)		
Mangrove	2765.6	2622.8	2618.7	Area of field data and Supervised classified area found almost same
Re-Plantation	934.7	1012.7	1008.9	
Re-Generation	109.4	166.6	170.2	
Settlement	25.7	36.6	38.1	
Jhum Plantation	70.9	91.2	87.3	
Salt Pan/Shrimp	197.2	287.3	290.8	
Tidal Mud Flat	886.8	782.8	785.2	
River/Canal	330.6	459.8	463.5	
Abandoned Area	110.4	87.1	83.9	
Fish Drying Area	24.2	8.5	11.7	
Beach/Turtle nesting ground	772.7	672.8	669.9	
Total	6228.2	6228.2	6228.2	

**6. VISUAL INTERPRETATION OF TEMPORAL CHANGES OF STUDY AREA**

The false colour composite (FCC) Landsat imagery of 20 February-2004, 4 March-2007 and 24 February-2010 has been shown in Figure-4. It is clearly seen from the figure that the young leaf pigment is shown as pure green, water blue/violet and shrimp and salt bed area as violet in the images of 2007 and 2010.

**Figure 4** Extracted FCC 5 (R), 7(G), 4 (B), 2 images of Sonadia Island during 2004, 2007 and 2010.

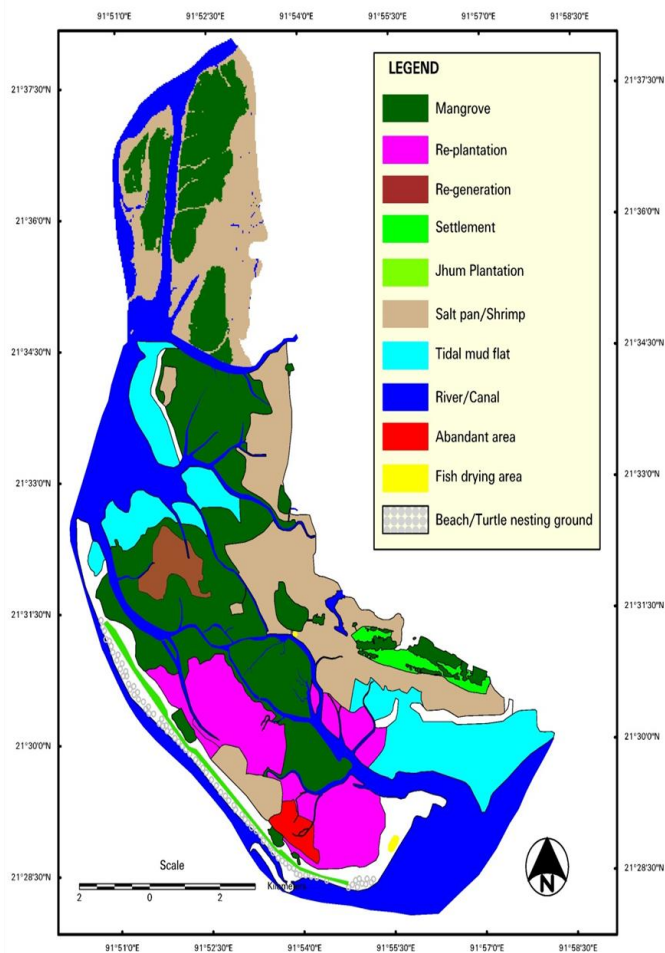


Whitish colour in all the three seasons shows the beach. It is sandy beach as well as turtle nesting ground. Some areas of image of 2004 show healthy plantation (indicated by red arrow). But it was reduced in 2007 image due to cutting of the forest for preparation of shrimp ponds. Due to proper management of Forest Department and local administration this area came under re-generation. Image of 2010 also shows healthy plantation area due to re-generation (area indicated by red arrow) of the forest. Top of the image of 2004 shows small plantation area, but in 2007 and 2010 the plantation area has increased.

Year	Mangrove Area
2004	2151.74
2007	2399.064
2010	2535.37

**7. PREPARATION OF LAND USE MAP**

For preparation of land use map, multi-spectral classification using unsupervised (ISODATA) and supervised classification (Parallelepiped and Maximum Likelihood techniques) were performed and the results have been compared. Based on the field investigation and secondary data, it is found that the supervised classification using maximum likelihood provide best results. The major classes such as forest, settlement, sandy areas and crop lands have been identified through interpretation of the classified imagery based on spectral signature, field information and visual interpretation of Google image. The features such as small settlement, turtle nesting ground, dry fish areas which are not captured by land sat imagery are obtain by on screen digitization of google image. Raster based GIS layers have been used for the layers masking. Preparation of land-use maps have been given in Figure-5.



**Figure 5: Land use classification of Study Area.**

**Table 4: Land use statistics of the study area**

Description of classes	Area in (ha)	Percentage
Mangrove	2622.8	41.90%
Re-Plantation	1012.7	16.00%
Re-Generation	166.6	2.66%
Settlement	36.6	0.58%
JhumPlantation	43.99	0.7
Salt Pan/Shrimp	287.3	4.88%
Tidal Flat	782.8	12.52%
River/canal	459.8	7.36%
Abundant Area	157.10	2.5%
Fish drying Zone	8.5	0.14%
Beach/Turtle Nesting Ground	672.8	10.76%
Total	6250.99	100%

It is evident from the Remote Sensing (RS) and GIS analysis that the major land uses of the study area are the vegetation (3802.01ha), tidal flat (782.8 ha), shrimp farm (287.3 ha) and sea beaches/Turtle Nesting Ground (672.8 ha). So the study areas constitute a wonderful coastal ecosystem for plant and animals.

**8. RESULT AND DISCUSSION**

Biodiversity of Sonadia and its surroundings have been analyzed based on the visual interpretation and multispectral digital classification of Landsat imagery. The result are presented in table-3 and fig-5. The results are discussed briefly below:

**Settlements**

The area has total population of 2500 people. The primary occupations of most of the families are fishing, cultivation and shrimp culture, which have caused the destruction of much of the mangroves between Sonadia and Moheshkhali. The seasonal (October to March) Dry Fish Center (DFC) at southern end of the island and Shrimp Fry Collection Center (SFCC) at Belekerdia during monsoon (May - September) are operated by Moheshkhali people (Figure 5). The majority of Sonadian villagers are Muslims and do not traditionally eat sea turtle eggs. According to the information obtained from the community, although this does not preclude the collection and selling of eggs.

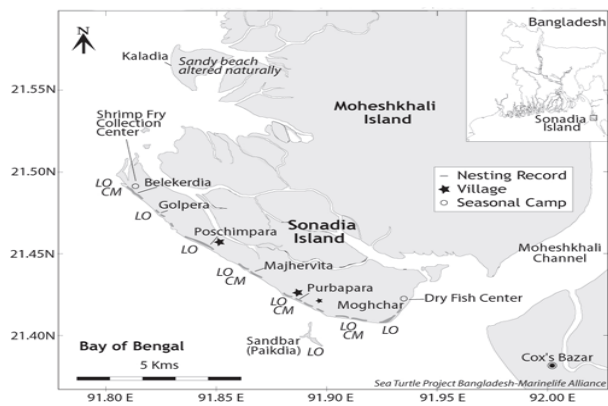
**Mangroves**

The mangroves are distributed at the sheltered inland part of Sonadia and a very narrow intertidal area on the edge of the estuary, covering an area of 560 ha, and at northern Ghotivanga, covering an area of 1162 ha and Amabashyakhali 809 ha giving a total mangrove area of 2622 ha (41.9% of total area) (table-3). The mangrove is dominated by the shrubby *Aegialitisrotundifolia* and consists of seven tree species of *Avicenniaspp* and *Aegialitisrotundifolia* which constitute the upper and lower stratum, attaining a maximum height of 3.6 and 2.4 metres respectively. The mangroves provide an excellent wintering ground for migratory waterfowl and shorebirds, and a nursing and feeding ground for fish and shrimp species.

**Mudflat**

Mudflat areas are rich in intertidal grassy vegetation and mangrove growth. The total mudflat area was estimated at 785.2 ha in 2010 (figure-5 and table-3). The largest undisturbed salt marsh area is in south Sonadia Island; other areas are along the mangrove formations north of Sonadia. The mudflats constitute important habitats for migratory and resident birds and numerous species of invertebrates.

**Sea turtle**



**Turtlesnesting areas on Sonadia (figure-6)**

Sea turtles of five species are reported to occur in the territorial waters of Bangladesh: olive ridley (*Lepidochelys olivacea*), green (*Cheloniemydas*), hawksbill (*Eretmochelysimbricata*), loggerhead (*Carettacaretta*) and leatherback (*Dermochelyscoriacea*) (Groombridge *et al.* 1989, Rashid & Islam, 2005). Unlawful harvesting of turtle eggs, catch in offshore fisheries, changes of sand dunes and housing on beach have been recognized as the main threats to the sea turtles at sonadia and other beaches of Bangladesh. Since 1980 nesting populations have declined due to severe exploitation of eggs and killing of adult turtles by fishing and other activities. Prior to 1999, sea turtle data from Sonadia were collected opportunistically during the annual waterfowl censuses conducted in 1983, 1987 and 1989, and recorded low levels of nesting of olive ridley and green turtles nested on Sonadia, nesting of olive ridley and green turtles. (Z. Islam *et al.* 2011).

### Birds

Birds of about 70 species of migratory water fowl and shorebirds visit the site for resting, roosting, feeding and wintering. These include four bird species that are listed as globally threatened the Spoon-billed Sandpiper (*Eurynorhynchus pygmeus*), Asian Dowitcher (*Limodromus semipalmatus*) Nordmann's Greenshank (*Tringaguttifer*) and River Lapwing (*Vanellus duvaucelii*). An annual waterfowl census was conducted mid-winter along the

East Asia Australasian flyway, including at two spots in Bangladesh within the ECA (Sonadia and Ghotivanga) (Sayam U. Chowdhury *et al.*).

### 9. CONCLUSIONS AND RECOMMENDATIONS

The study shows that the Landsat multi-date and multi-spectral imagery in association with high resolution Google images are capable of producing high quality land-use maps. The land-use maps have been produced for Sonadia Island and its surrounding for the year of 2010. The broad land use features are settlement, shrimp/salt bed, turtles nesting, etc. The results show large changes in the mangrove plantation. The intensive land use changes of Sonadia may be restored by the Department of Forest and Environment by declaring it as the Environmental Critical Area (ECA). For the conservation of biodiversity, the past and current land-use maps of all coastal Islands of Bangladesh will be highly useful as base information. The satellite technology offers the best and quickest means of preparing such land-use maps and monitoring the land-use dynamics. This study demonstrates the usefulness of land-sat or similar remote sensing data for country wise land-use and visually change detection mapping. A bird sanctuary may be established for attracting the national and international tourists and for the conservation of the endangered bird species.

### REFERENCES

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