Mapping and characterization of wetlands using Remote Sensing And GIS Techniques

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Abstract- *Wetlands are the transitional land that lies between the water and dry ground. Wetlands have great importance for more than one reason, most notably because they charge aquifers, conserve moisture, act as pollution filters, and are habitat for biodiversity. It is therefore necessary to make an inventory of wetlands in an area, which will enable us to monitor the changes that are occurring over a period of time. The objectives of the present study are: mapping of coastal wetland and change detection using Remote Sensing and GIS techniques, characterization of wetland using vegetation and turbidity as a parameters. The datas used in this study are LANDSAT images of 1998, 2000, 2003 year and LISS III image of 2008-09 year. The unsupervised classification has been carried out using Erdas Imagene software. Then water body extraction has been carried out using NDWI and NDVI. After that the marsh lands are extracted using TVDI for LANDSAT images and MNDWI for LISS III image. Then characterization of wetlands is carried out using Vegetation and turbidity as a parameters. Finally the accuracy assessment of delineated wetlands is carried out using GPS points and the shape files of wetland which are extracted from Google earth.*

From this analysis of wetlands it is seen that, there is a decrease in wetlands area around 97623.6 ha (including marsh land) from year 1998 to 2008-09. And the thresholding technique in wetland inventory and remote sensing index like NDWI is proved to be good in extracting wetland. In this study delineation of wetlands are carried out for a large area and this can be further used for conservation and management of wetlands present in this study area.

Keywords- Geomorphology, Landuse/land cover, Lineament and its Density, Groundwater potential zones map.

I. INTRODUCTION

A wetland is transitional land that lies between the water and dry ground. It has often been referred to as ‘too wet to plow and too dry to swim’. Wetland, one of significant components of regional ecosystem, has many functional services such as the regulation of climate, purification of environment, and balance-keeping of regional water. As a special ecosystem, it locates in the transition zone between land ecological and aquatic ecosystems, a mix of characteristics from upland areas and the characteristics of aquatic environments. Wetlands include bodies of water, such as lakes, streams, and rivers; land that is always covered by water, such as marshes and swamps; and land that is covered by water for part of the year, such as vernal pools. Wetlands can also include land that is saturated by water, even when no water is present at the surface.

Wetlands provide innumerable services like food storage, water quality maintenance and livelihood in terms of fisheries and recreation. It is therefore necessary to make an inventory of wetlands in an area, which will enable us to monitor the changes that are occurring over a period of time. In some of previous studies, remote sensing techniques were used for deriving information on the quantitative and qualitative status of wetlands. Most of those studies are focused on individual wetlands. But in this study delineation of wetlands is carried out for a large area and this can be further used for conservation and management of wetlands present in this study area.

1. Objectives

- Delineation of wetland using Remote Sensing and GIS techniques.
- Mapping and composition of delineated wetland.
- Characterization of wetland using vegetation and turbidity as a parameters.

II. STUDY AREA

The Karnataka Coastal Region, which extends between the Western Ghats, edge of the Karnataka Plateau in the east and the Arabian Sea in the West, covers Dakshina Kannada, Uttara Kannada and Udupi districts. The west coast of Karnataka from Nethravathi river mouth to Sharavathi river lies between 13˚0’ 59.58’’N to 14˚15’41.42’’N latitude and

74˚16'38''E to 74˚24'10''E and its covers an area about 10300km2 .In May, mean maximum temperature shoots up to 40 deg. C over the north-eastern corner of the State, decreasing south-westwards towards the Western Ghat region and the Coastal belt. The study area cover full coast and some part of Western Ghats extend up to Sagara, Sringeri and Dharmastala region.

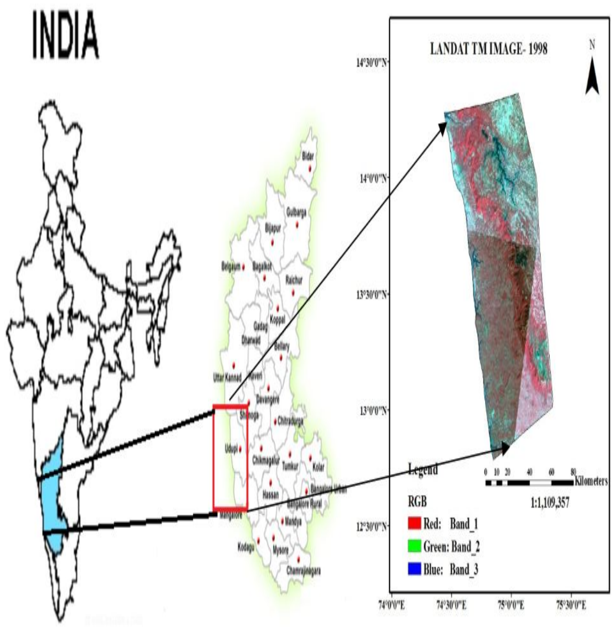

Figure 1. Location Map of Study Area.

1. DATA USED

The data used for this study are Toposheeets, satellite data and GPS data. The satellite images used are LANDSAT TM (Thematic Mapper), ETM (Enhanced Thematic Mapper) and Resourcesat-1 LISS III images are downloaded from earthexplorer.usgs.com and bhuvan-noeda.nrsc.gov.in. respectively.

2. METHODOLODY

In this study the extraction of study area has been done from satellite image using Erdas Imagine software, followed by the Unsupervised classification has been carried out using ISODATA clustering algorithm, for the satellite images of year 1998, 2000, 2003 and 2008-09. The Remote sensing indices like LST (Land Surface Temperature), NDVI (Normalised Difference Vegetative Index), NDWI (Normalised Difference Water Index) and TVDI (Temperature Vegetative Dryness Index) are retrieved using Erdas model maker tool. In this work the NDVI and NDWI images has been used to extract the water bodies. The marsh land extraction has been done using TVDI image.

The preparation of a land use and land cover map of the year 1998, 2000, 2003 and 2008-09 data has been done using Arc GIS software. Followed by the Change detection of the study area has been done using land use and land cover maps. The turbidity map has been prepared using Band ratioing method and vegetation map has been prepared for the extracted water bodies and wetlands using NDVI image. The characterization has been done for extracted water bodies and wetlands using turbidity and vegetation as parameter.

III. Results and Discussion

1. Unsupervised classification

The result shows the unsupervised classified image for the years 1998, 2000, 2003 and 2008-09 images of land use and land cover changes is listed in the figure 2 to 5. For the year 1998 image, the area under forest is high where as water body is low. The year 2000 image, the area under forest is high where as water body is low. The year 2003 image area under agriculture and plantation is high where as water body is in low and for the image of year 2008-09, the area under Agriculture is high and waste land is low.

Table 1. land use and land cover change.

Sl. No.	CLASS NAME	YEAR	Area [hectares]	Difference	Area in % age
1	Water body	1998	48607.29	---	4.7
		2000	32718.3	-15,888.90	3.2
		2003	31459	-1,259.30	3.1
		2008-09	46867.8	-15,408.80	4.6
2	Agriculture and Plantation	1998	315598.9	---	30.7
		2000	315267.2	-331.7	30.7
		2003	366515.9	51,248.70	35.7
		2008-09	405007	38,491.10	39.9
3	Built-up area	1998	175695.3	---	17.1
		2000	225590	49,895	21.9
		2003	225870	280.00	21.9
		2008-09	288467	62,597.00	28.4
4	Forest area	1998	432945.18	---	42.2

		2000	360829	-72,116	35.1
		2003	344489	-16,340.00	33.5
		2008-09	266551	-77,938.00	26.3
5	Other	1998	53,773.10	---	5.2
		2000	92,393.80	38,620.70	8.9
		2003	58,615.30	-33,778.50	5.7
		2008-09	7,469.68	-51,145.61	0.7

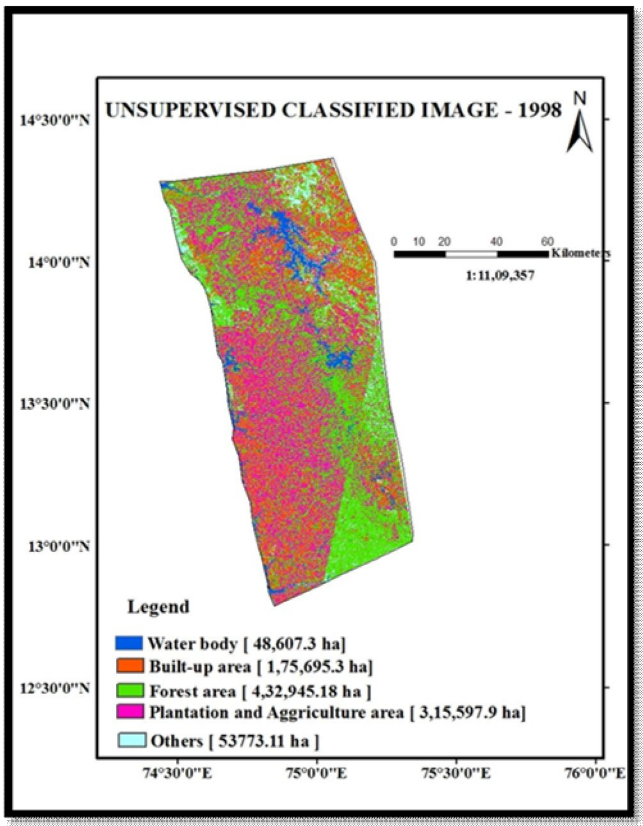

Figure 2. Unsupervised classified image of LANDSAT 1998 year.

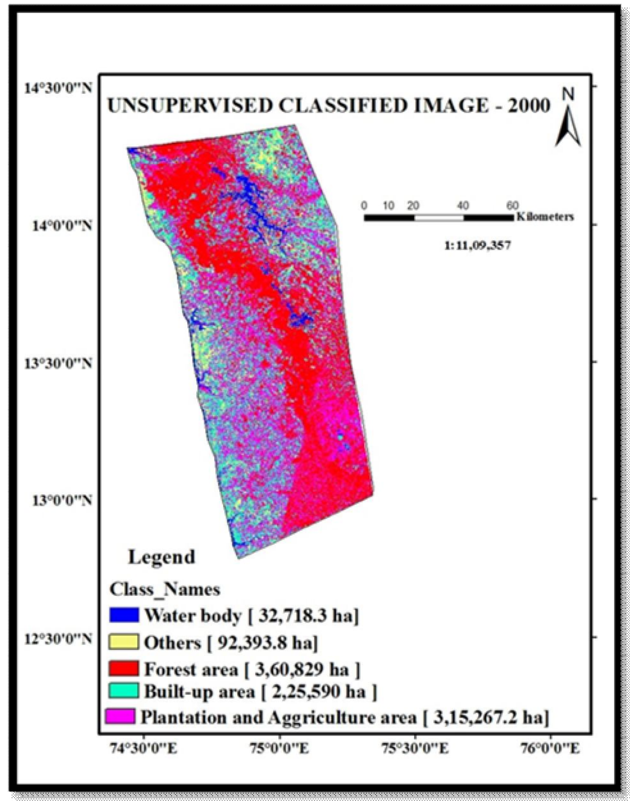

Figure 3. Unsupervised classified image of LANDSAT 2000 year.

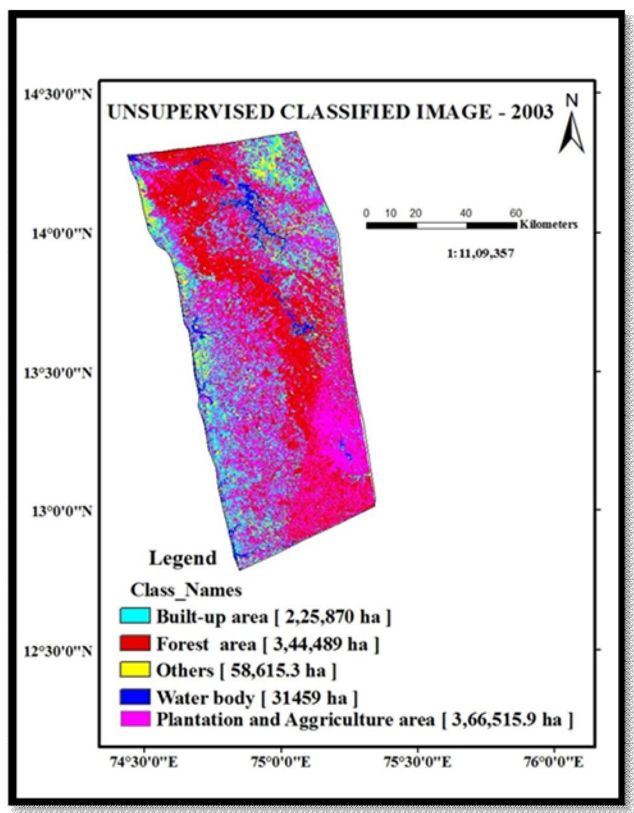

Figure 4. Unsupervised classified image of LANDSAT 2003 year.

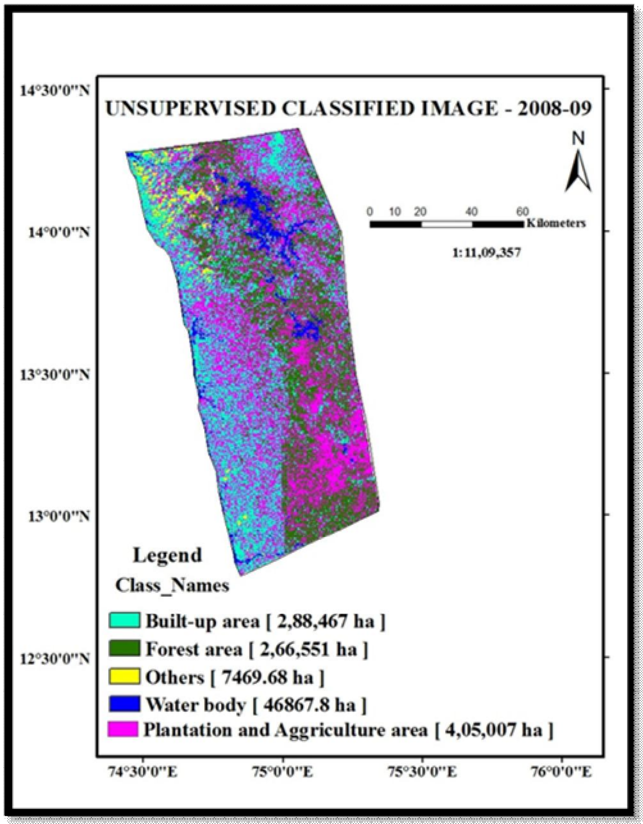

Figure 5. Unsupervised classified image of LISS III 2008-09 year

From the image of year 1998 to 2008-09 the forest area is keep on decreasing and built up and agriculture area is increasing. This is because of urbanization and increase in population within this area, so many industries have come up in the study area, which led to decrease in different land uses classes like forest, waste land and agriculture areas. And year wise increase or decrease in land use and land cover as listed in the table 1.

The classified 2003 image shows that there is increase in agricultural area and decrease in forest area. Due to increase in agricultural activities in this region, the forest areas are converted into an agriculture area. And the figure 2 and 5 shows that the area under Built up are increased continuously from 1998 to 2008-09, due to increase in urbanization in this region.

2. Water body extraction from NDVI and NDWI

Table 2. Water body from NDWI and NDVI.

Sl.no	Class name	Index	Area (ha)			
			1998	2000	2003	2008-09
1	Water body from	NDWI	37222.4	28139.9	24853.9	40675.4
2	Water body from	NDVI	34487.3	28736.91	114232.3	45363.8

Table 3. Water body from NDWI and NDVI.

Sl.no	Class name	Index	Area (%)			
			1998	2000	2003	2008-09
1	Water body from	NDWI	3.6	2.7	2.4	4
2	Water body from	NDVI	3.4	2.8	11	4.47

From table 2 and 3 shows that, the water body extraction from NDVI is over estimated compared with the NDWI. This is due to; NDVI fails to differentiate between soil and water. And NDWI is good in extracting water features.

3. Marsh land extraction using TVDI and MNDWI

The marsh lands mainly locate in the lower elevations of the landscape, such as inland valleys bottoms, flood plains and lakeside or riverside. In addition, marsh surface soil moisture value is higher than other land cover. So, according to TVDI the pixels having low values have high soil moisture, these pixels are extracted using GIS software for LANDSAT images and for LISSS III image MNDWI is used to extract marsh land. The area under marsh land for image of years 1998, 2000, 2003 and 2008-09 is around 17.42 %, 11.5 %, 11.47 % and 7.6 % respectively. The area under marsh land is decreased around 9.82 % from year 1998 to 2009.

Table 4. Marsh land area

Sl no	Class name	Year			
		1998	2000	2003	2008-09
1	Marsh land	178938.36	118232.9	117941.2	77861.8

4. Characterization of Wetlands

The characterization of wetlands has been carried out using band ratio method and NDVI. For the LANDSAT TM image of year 1998, ratio of band 2 and band 4, ETM images of year 2000 and 2003, the ratio of band 3 and band4 and the LISS III image of year 2008-09, the band 3 are used to map the turbidity level of wetlands. Based on the value of band ratio and NDVI, the turbidity and aquatic vegetation level is named as: low, medium and high. The results are listed in the figure 6 to 13.

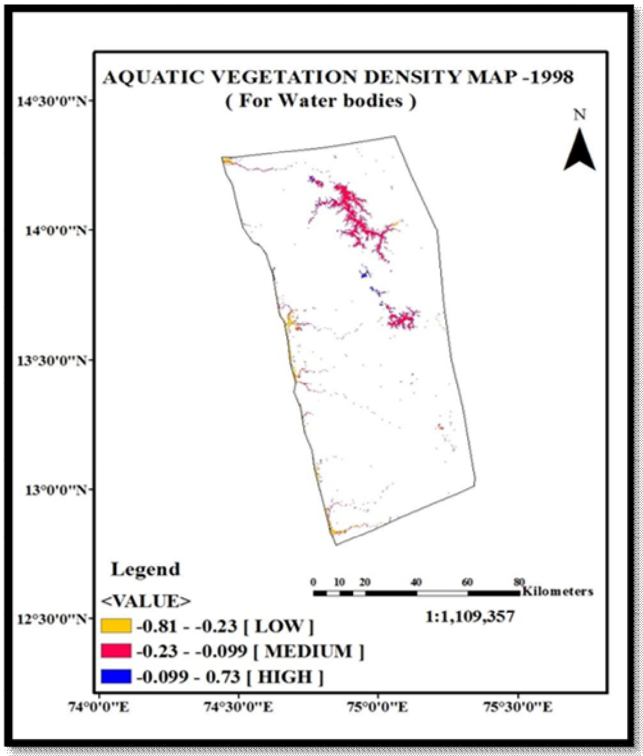

Figure 6.Aquatic vegetation density map of water bodies 1998 year.

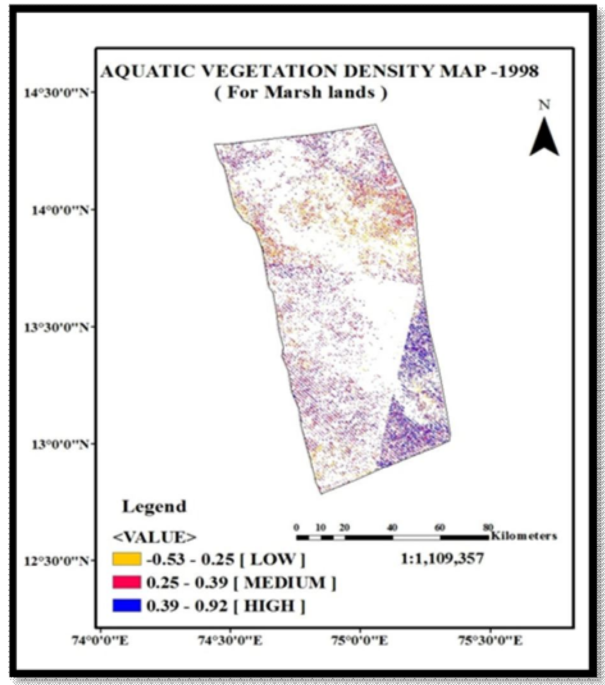

Figure 7. Aquatic vegetation density map of marsh lands 1998 year.

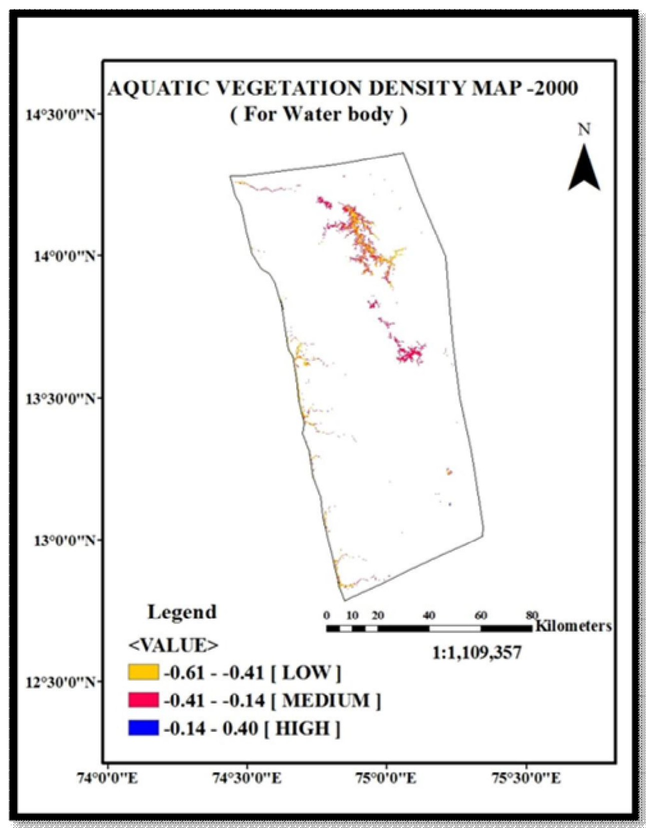

Figure 8. Aquatic vegetation density map of water bodies 2000 year.

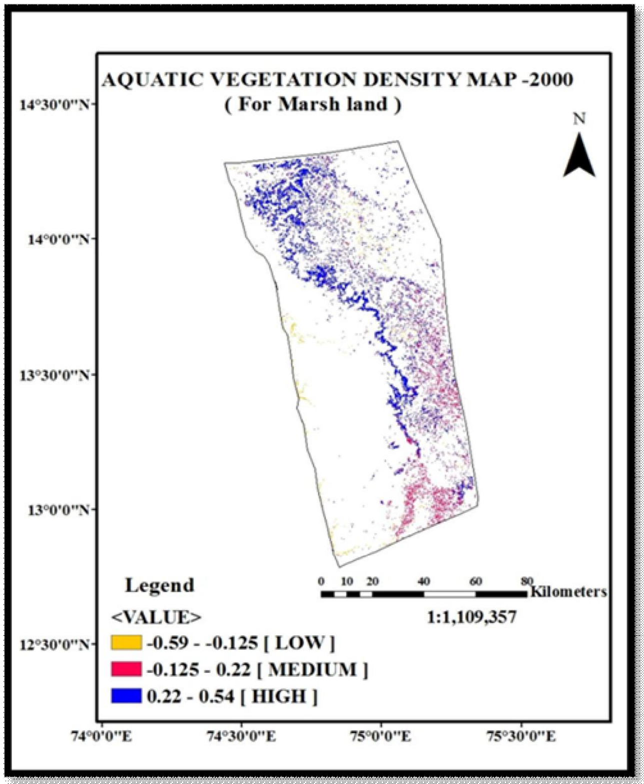

Figure 9. Aquatic vegetation density map of marsh lands 2000 year.

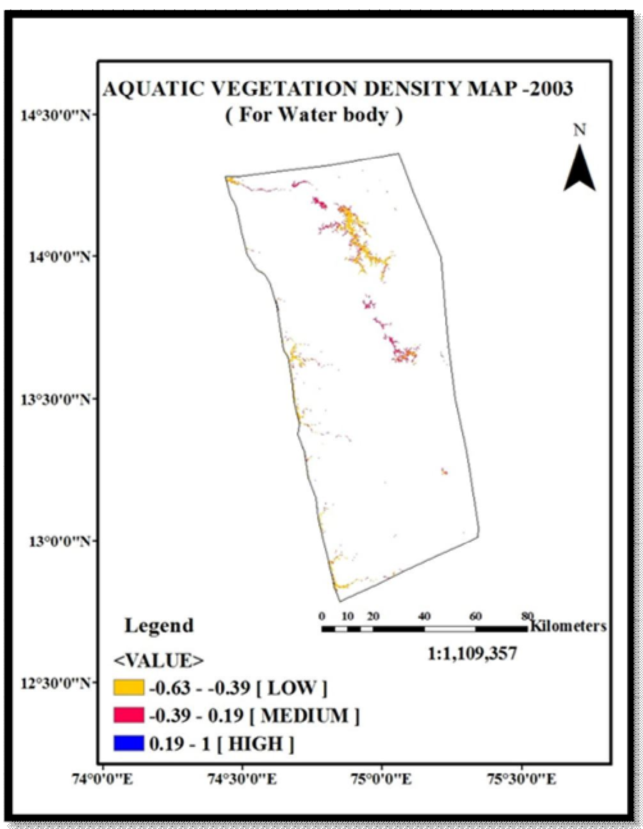

Figure 10. Aquatic vegetation density map of water bodies 2003 year.

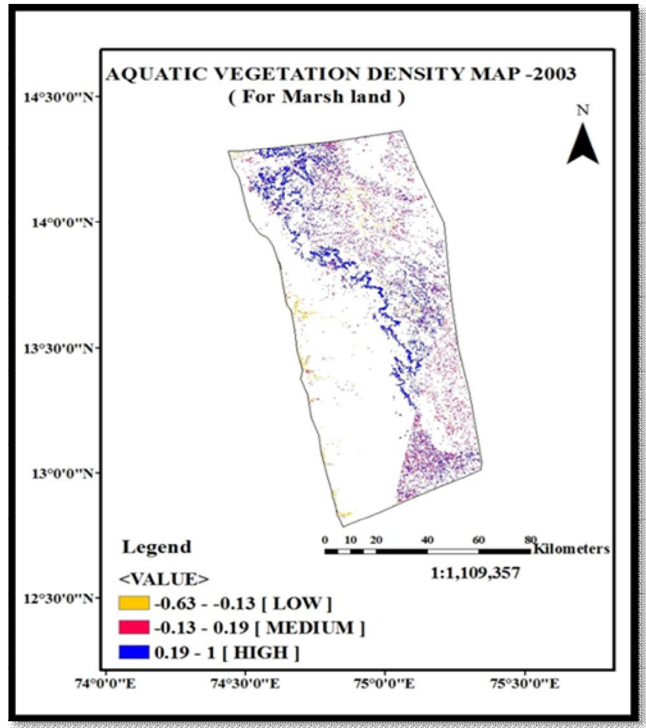

Figure 11. Aquatic vegetation density map of mash lands 2003 year.

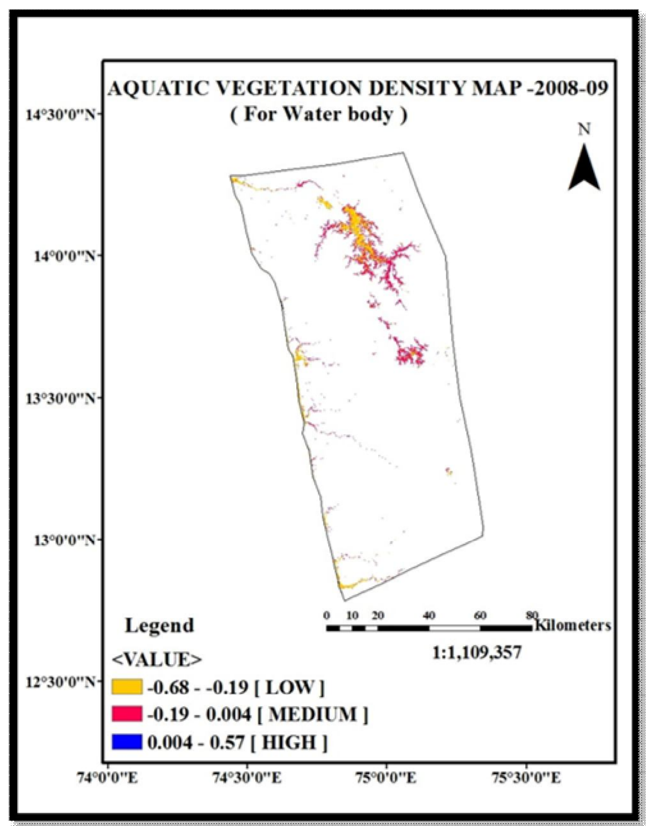

Figure 12. Aquatic vegetation density map of water bodies 2008-09 year.

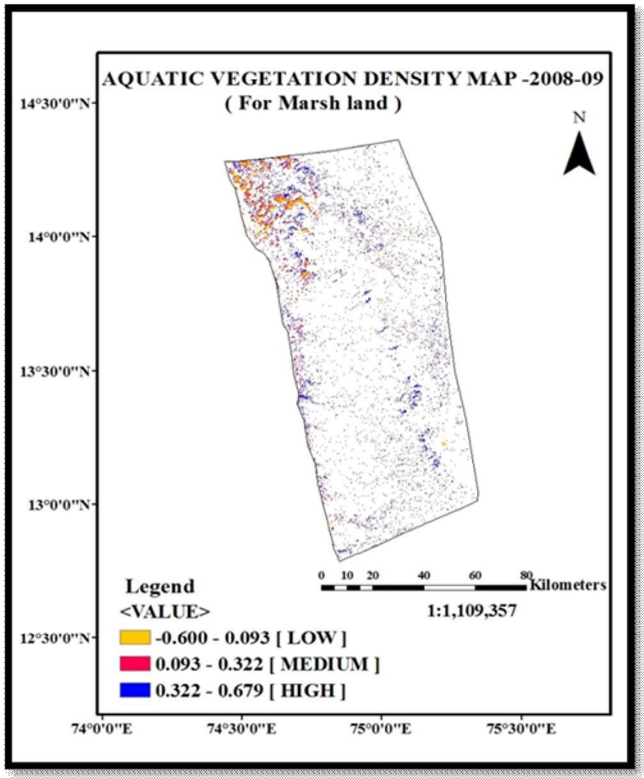

Figure 13. Aquatic vegetation density map of mash lands 2008-09 year.

Table 5. Aquatic vegetation level.

Sl no	Year	Class name	Aquatic Vegetation	Area (ha)	Area (%)
1	1998	Water body	low	7424.2	20.4
			medium	22967.01	63.2
			high	5921.82	16.3
		Marsh Land	low	43055.1	24.1
			medium	78195.6	43.7
			high	57535.7	32.2
2	2000	Water body	low	11768.13	43.2
			medium	15391.71	56.5
			high	86.76	0.32
		Marsh Land	low	5834.16	5
			medium	32537.43	27.9
			high	78058.08	67
3	2003	Water body	low	14126.58	58.1
			medium	10179.09	41.8
			high	26.28	0.11
		Marsh Land	low	8536.23	7.3
			medium	40340.07	34.4
			high	68559.8	58.4
4	2008-09	Water body	low	16012.6	40
			medium	22428.4	56.2
			high	1488.8	3.7
		Marsh land	low	14941.9	19.4
			medium	22113.9	28.7
			high	40076	51.9

Table 6. Turbidity level

Sl.no	Year	Class name	Turbidity level	Area (ha)	Area (%)
1	1998	Water body	low	53.46	0.15
			medium	30298.05	82.7
			high	6282.27	17.1
		Marsh Land	low	55741.8	31.2
			medium	75343.1	42.1
			high	47843.4	26.7
2	2000	Water body	low	4930.29	17.8
			medium	17036.64	61.6
			high	5691.87	20.6
		Marsh Land	low	93832.1	79.4
			medium	19286.4	16.3
			high	5114.4	4.3
3	2003	Water body	low	4182.6	17.2
			medium	14289.2	58.7
			high	5864.4	24.1
		Marsh Land	low	92132.4	78.1
			medium	18507.9	15.7
			high	7300.9	6.2
4	2008-09	Water body	low	28439.6	70.9
			medium	11573.8	28.8
			high	115.7	0.3
		Marsh land	low	67098.8	86.5
			medium	6177.6	7.9
			high	4279.5	5.5

The Turbidity level for water bodies shows that, for the 1998 year image, the area under 'medium ' turbidity level is high and the area under 'low' turbidity level is low. For the

2000 year image, the area under 'medium' turbidity level is high and the area under 'high' turbidity level is low. For these two year images, the turbidity level high in the river mouth regions, due to the presence of turbid particles like waste from industries and households. The 2003 year image, the area under 'medium' turbidity level is high and the area under 'low' turbidity level is low. And for the 2008-09 year image, the area under 'low' turbidity level is high and the area under 'high' turbidity level is low. For the 2003 image, the open water bodies and river mouth regions has 'medium' turbidity level and rest of the parts has 'low' turbidity level. The 2008-09 year image, the maximum portion of area is coming under 'low' turbidity lever region and a river mouth region has medium turbidity level.

The turbidity level for marsh lands shows that, the 1998 year image, the area under 'medium' turbidity level is high and the area under 'high' turbidity level is low. The 2000 year image shows, the area under 'low' turbidity level is high and the area under 'high' turbidity level is low. For the 2003 year image, the area under 'low' turbidity level is high and the area under 'high' turbidity level is low. And for the 2008-09 year image, the area under 'low' turbidity level is high and the area under 'high' turbidity level is low. In this marsh land, the paddy field has high turbidity level, due to the presence of mud water at the time harvesting

IV. CONCLUSION

The analysis result shows that, there is a decrease in wetlands (including marsh land) area around 97623.6 ha from year 1998 to 2008-09. Since from year 1998 to 2003, the area under wetland is increased due to increase in the agricultural area in the coastal region and that increased agriculture area is classified as wetlands. As well as the variations of wetlands are more for the year 2003 to 2009, this is due to variation in the urbanization and industrialization in the period of 2003 to 2009. The turbidity of wetlands increases from 1998 to 2008-09, due to increase in industrialization and urbanization in this area. This study shows that, thresholding technique in wetland inventory and remote sensing index like NDWI is proved to be good in extracting wetland.

V. ACKNOWLEDGEMENT

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