

# RS and GIS Based Coastal Wetland Inventory for Udupi District, Karnataka

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**Abstract**— Coastal wetlands, the places where the sea water meets the land are unique places in our global geography. They are endowed with a very wide range of coastal ecosystem like mangrove, coral reef, lagoon, sea grass, salt marsh and estuary. Wetlands offer myriad ecological benefits like flood control, ground water recharge and shoreline protection besides being cradles of biodiversity and habitats for waterfowl. Remote Sensing (RS) and Geographic Information System (GIS) in recent years have proved to be of great importance for effective resources management and coastal environmental monitoring. In the present study, an attempt has been made to delineate various coastal wetlands along Kollur-Chakra-Haladi, Sita-Swarna and Udyavara river systems in Udupi district of Karnataka. The study area geographically lies between the 13°10' N to 13°40' N latitudes and 74°30' E to 75°20' E longitudes. Fourteen types of wetlands are identified in the study area covering a total area of 495 ha.

**Keywords**— Coastal Wetlands, Inventory, Mangroves, RS, GIS.

## 1. INTRODUCTION

India has a 7,500 km long coastline with numerous mangroves, lagoons, estuaries and swamps which supports rich living and non-living resources. Wetlands are defined as areas of marsh, fen, peatlands or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters (Ramsar Convention, 1975). Wetlands are transition zones between terrestrial and aquatic communities (Cowardin et al. 1979). They are extremely productive ecosystems and often have a richer flora and fauna than other environments.

Mangroves make special type of vegetation found in wetlands. Mangrove has been defined as a tree, shrub, palm or ground fern, generally exceeding more than half a meter in height and which normally grows above mean sea level in the intertidal zones of marine coastal environments or estuarine margins (Duke, 1992). Mangrove areas today rated among the most productive ecosystems on the planet. Mangroves provide protective, productive and economic benefits to coastal communities like flood control, ground water recharge and shoreline protection.

In the recent years, due to encroachment and improper usage of wetlands, they are either lost or are incapable of fulfilling their ecological functions. Tools like RS and GIS are extensively used for mapping, monitoring and management of Coastal Zone. These tools are used to

identify boundaries of coastal wetlands, areal extent and condition of mangroves (Ramachandran, 1998). Importance of remotely sensed data for inventory, mapping, monitoring and management of coastal resources is well established (Shailesh et al. 2001).

The objective of the present study is to identify various coastal wetlands, map the mangrove patches and to build a wetland database for Udupi district by integrating RS and GIS tools.

### A. Area of Study

The study area is the Udupi district which is situated in the south-western part of Karnataka state between Arabian Sea and foot belt of Western Ghats. It lies between 13°10' N to 13°40' N latitudes and 74°30' E to 75°2' E longitudes with a geographical area of 3598 sq km. Udupi district is drained by three major river systems, namely (south to north)

- Udyavara river
- Sita-Swarna river system
- Kollur-Chakra-Haladi river system

The coastal zones of Udupi district, Karnataka is characterized by sand beaches, estuaries, mudflats, creeks and mangrove patches. Udupi district receives an annual rainfall of 3000-4000 mm. Temperature is very low in the early part of January and gradually increases in the subsequent months. The coastal parts record the highest temperature during the month of May and the average day temperature ranges from 16-38 °C.

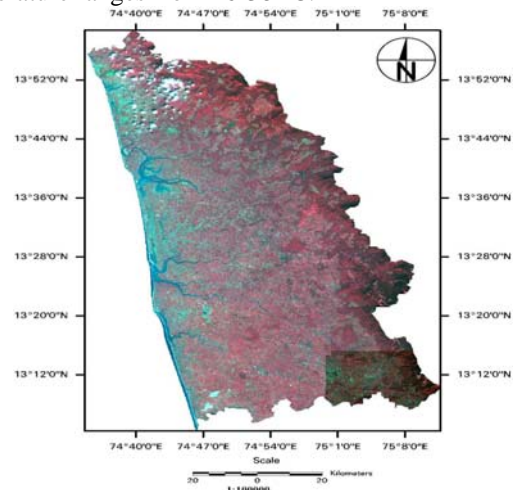


Fig. 1: Study area as viewed by IRS-P6 (LISS IV)

**II. MATERIALS & METHODS**

**A. Geometric correction of Satellite image**

LISS-IV image of IRS-P6 satellite (January, 2013) was acquired from National Remote Sensing (NRSC) Hyderabad. Survey of India Topographical map surveyed during 1967 was georeferenced and registered with UTM projection & WGS 84 datum. Satellite image was then co-registered with the toposheet by using Ground Control Points (GCPs).

**B. Wetland mapping and Database building**

For mapping and segregation of wetlands, supervised classification which uses maximum likelihood algorithm was used. Signature sets used for the classification were prepared based on the extensive field surveys.

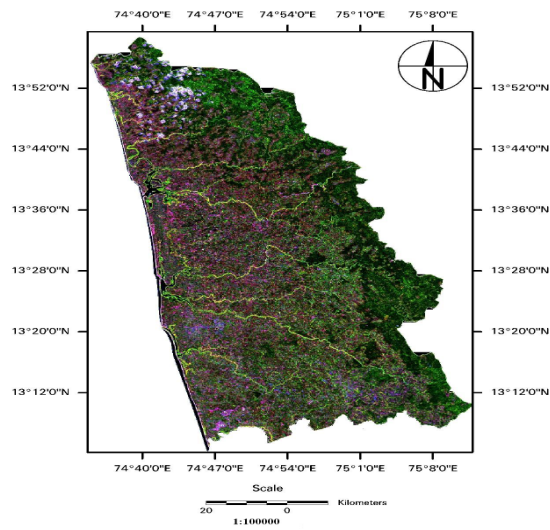


Fig. 2: Spatially enhanced image showing high waterline

The satellite image was subjected to various enhancement techniques like edge enhancement, textural analysis, NDVI and IHS for identification of high waterline, classification and clustering of features. Attribute for each class were drawn for building a GIS database.

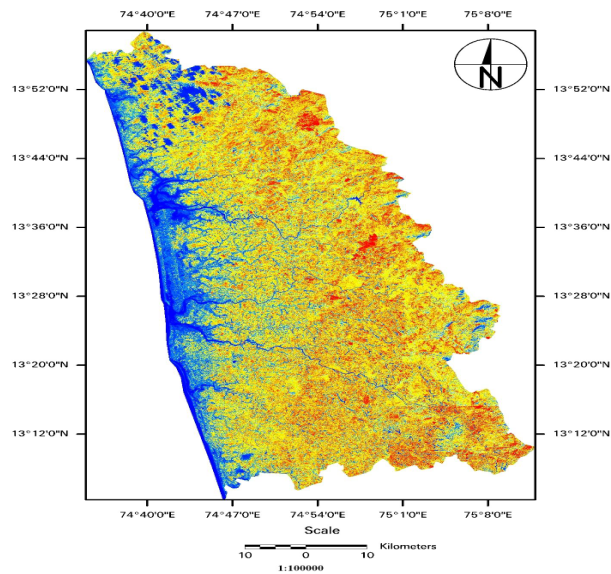


Fig. 3: NDVI Product

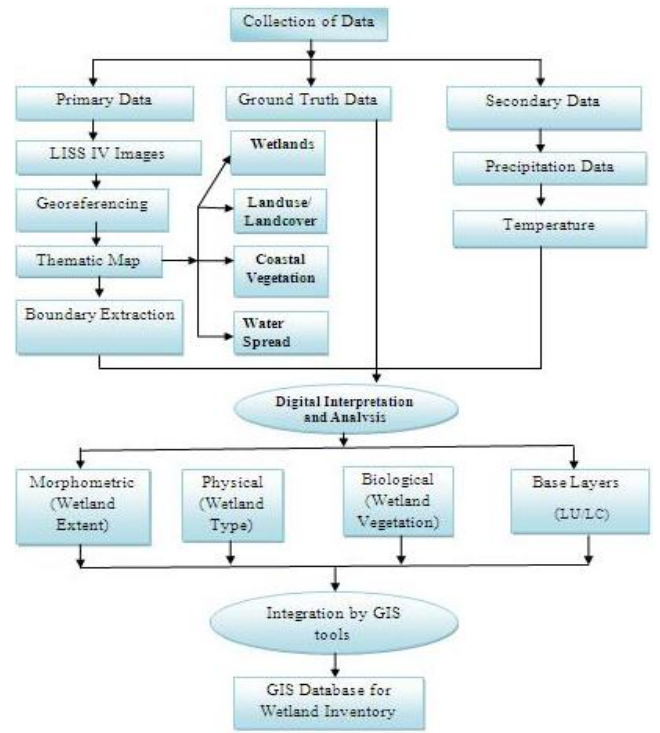


Fig. 4: Flow of work

**III. RESULTS & DISCUSSION**

Totally, 14 types of wetlands are identified covering 495 ha of wetland area including estuary, aquaculture farm, pond, tank, marsh, swamp, rocky marine island, aquatic vegetation, sandy beach, mudflats, mangroves, river, etc. (Table 1-3). A total of 4 ha of mangroves are identified accounting for about 1.5% of total wetland area. Mangrove vegetation is denser in the north-west coastal region of Udupi district. Totally, 277.6 ha of wetland area is identified in the Kollur-Chakra-Haladi river system. There is a dense growth of mangroves in Kundapur region. Mangrove trees with the height ranging from 10-12 m are found in this region. Major species observed are *Avicennia sp.*, *Rhizophora sp.*

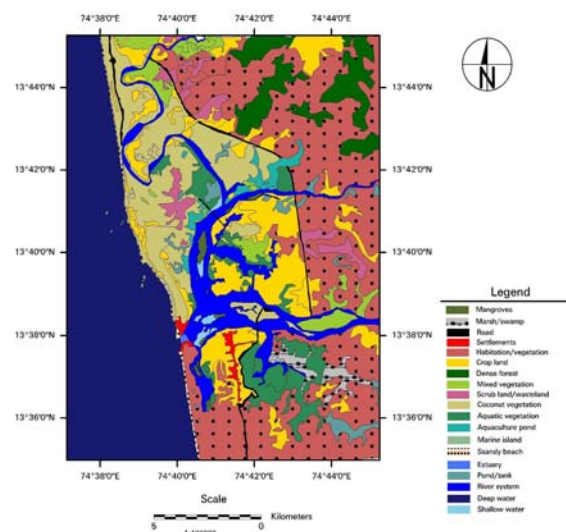


Fig. 5: Landuse/landcover of Kollur-Chakra-Haladi river system (with special reference to coastal wetlands)

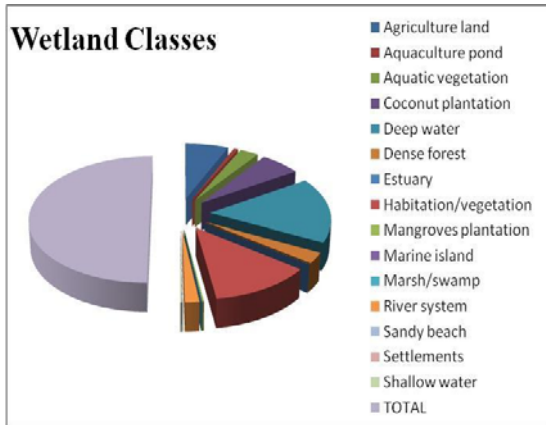


Fig. 6: Pie-chart showing the wetland classes in Kollur-Chakra-Haladi river system

Wetland Type	Wetland area (in ha)	% of Wetland area
Agriculture land	28.96	12.76
Aquaculture pond	2.9	1.28
Aquatic vegetation	12.57	5.55
Coconut plantation	27.44	12.12
Nearshore water	75.23	33.23
Dense forest	12.44	5.49
Estuary	0.11	0.05
Habitation/vegetation	56.33	24.88
Mangroves plantation	1.10	0.55
Marine island	0.06	0.03
Marsh/swamp	0.29	0.12
River system	7.89	3.48
Sandy beach	0.25	0.11
Settlements	0.09	0.03
Shallow water	0.87	0.38
<b>TOTAL</b>	<b>226.29</b>	<b>100</b>

Table 1: Wetland classes and their distribution in Kollur-Chakra-Haladi river system

Totally, 123.94 ha of wetland area is identified in the Sita-Swarna river system. The banks of Sita and Swarna rivers near the estuary have thick cover of mangroves (1.5 ha). The maximum tree height observed is 7 m. Important species in this region are *Avicennia sp.*, *Rhizophora sp.*, *Aegiceras sp.*, *Sonneratia sp.* *Excoecaria sp.*, a rare species of mangrove is also reported here.

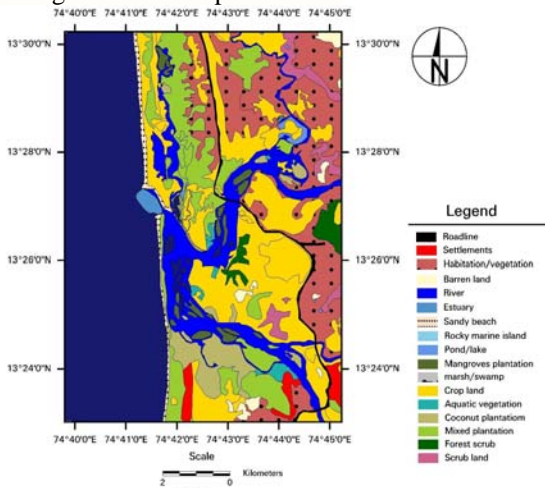


Fig. 7: Landuse/landcover of Sita-Swarna river system (with special reference to coastal wetlands)

Wetland Type	Wetland Area (in ha)	% of Wetland Area
Agriculture land	27.78	22.39
Aquatic vegetation	0.8	0.64
Barren land	1.34	1.08
Coconut plantation	4.32	3.48
Nearshore water	48.99	39.48
Estuary	0.47	0.38
Forest scrub	1.72	1.39
Habitation/vegetation	21.23	17.11
Mangroves plantation	1.53	1.24
Pond/tank	0.44	0.36
River	12.2	9.88
Sandy beach	1.33	1.07
Settlements	1.79	1.44
<b>TOTAL</b>	<b>123.94</b>	<b>100</b>

Table 2: Wetland classes and their distribution in Sita-Swarna river system

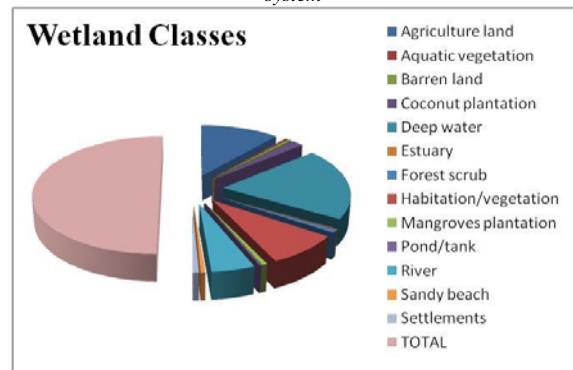


Fig. 8: Pie-chart showing the wetland classes in Sita-Swarna river system

The total wetland area in Udyavara river system is about 144.77 ha. Sparse distribution of mangroves is found along the banks of Udyavara river which is less than 0.5 ha. The poor condition of mangroves is due to intensive urbanization, unabated cutting of trees and other anthropogenic activities. The maximum tree height observed is 5m.

The rich growth and diversity of mangroves observed in Kollur-Chakra-Haladi and Sita-Swarna river systems could be due to low lying marshy land, sufficient clay mud rich in nutrients and proper mixing of marine and fresh water. Further heavy precipitation and moderate temperature conditions of the study area have favoured the growth of mangroves.

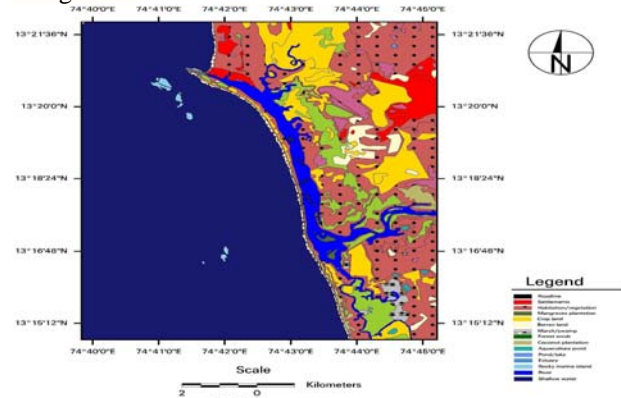


Fig. 9: Landuse/landcover of Udyavara river system (with special reference to coastal wetlands)



Type of Wetland	Wetland area (in ha)	% of Wetland area
Agriculture land	11.05	7.63
Aquaculture farms	2.77	1.91
Aquaculture pond	0.16	0.11
Barren land	1.06	0.73
Coconut plantation	2.99	2.06
Estuary	0.09	0.06
Habitation/vegetation	22.35	15.43
Mangroves plantation	0.54	0.37
Marine island	0.11	0.07
Mudflats	0.28	0.19
Pond/tank	0.55	0.37
River	5.23	3.61
Sandy beach	1.35	0.93
Settlements	2.32	1.6
Swamp/marsh	1.59	1.09
Waterlogged	2.21	1.52
Nearshore water	80.18	55.38
<b>Total</b>	<b>144.77</b>	<b>100</b>

Table 3: Wetland classes and their distribution in Udyavara river system

Sita and Swarna rivers join and form a common estuary, similarly Kollur, Chakra and Haladi rivers merge before entering the sea. This has resulted in bigger estuarine space in both the cases. On the other hand, Udyavara river has a smaller estuarine space. Further, intensive urbanization and anthropogenic activities in Udupi region have disturbed the wetlands and declined wetland vegetation in this region.

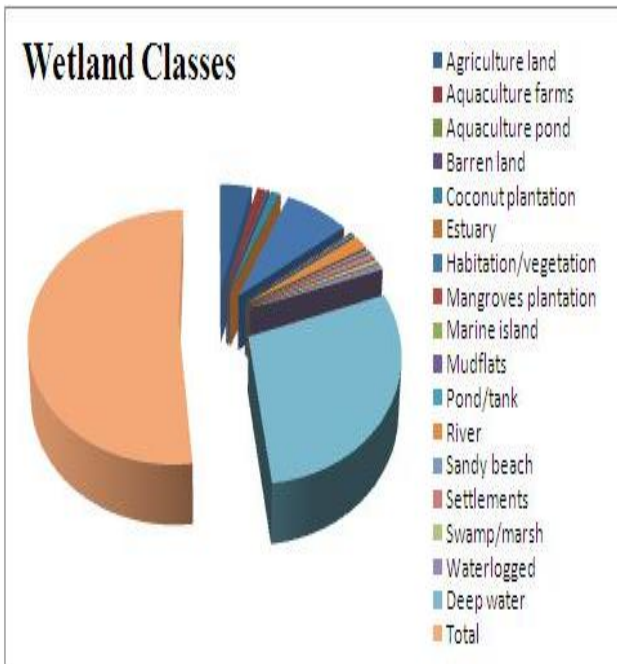


Fig.10: Pie-chart showing the wetland classes in Udyavara river system

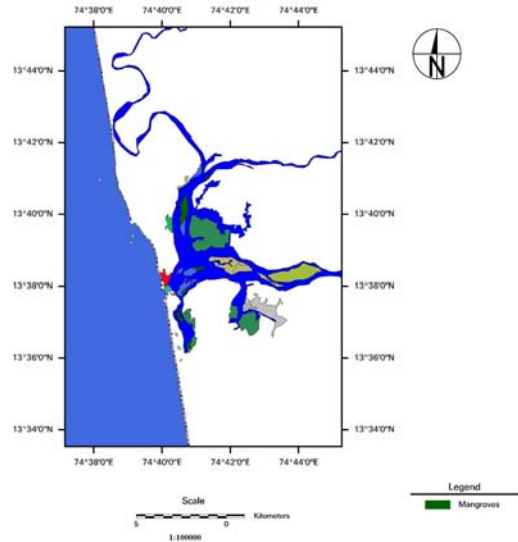


Fig. 11: Mangrove Map for Kollur-Chakra-Haladi river system

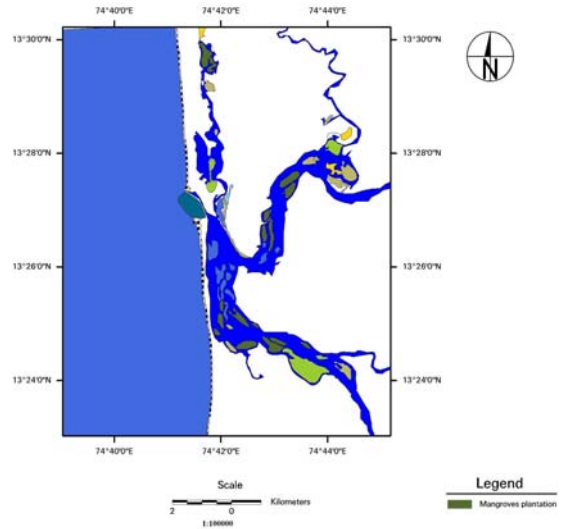


Fig. 12: Mangrove Map for Sita-Swarna river system

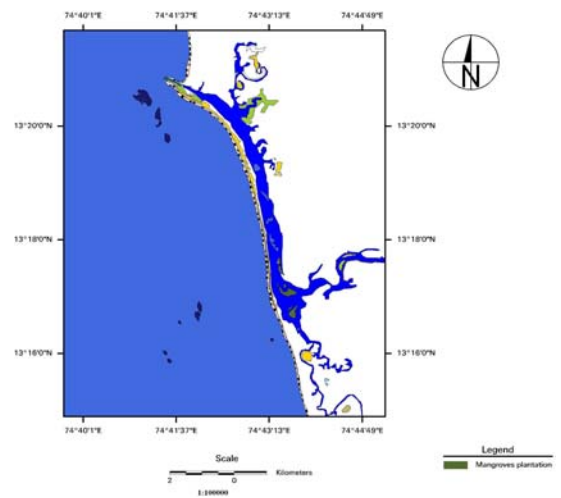


Fig. 13: Mangrove Map for Udyavara river system

#### IV. CONCLUSIONS

The study concludes that the wetlands in southern part of the study area (Udupi region) are facing threats for their ecological functioning. As Udupi is the district capital, developmental activities are more in this region which resulted in the encroachment of wetlands and damage to wetland habitats. Northern and middle parts of the study area have integrated river system with bigger estuarine space. This allows proper mixing of sea and marine water thereby supporting flourishing growth of wetland vegetation. The study highlights the importance of RS and GIS as comprehensive tools for monitoring and management of wetlands.



Plate 1: Mangroves in Kollur-Chakra-Haladi river system



Plate 2: Mangroves in Sita-Swarna river system



Plate 3: Sparse mangroves in Udyavara river system

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