Identification & Promotion of Brackish Water Aquaculture along Karnataka Coast Using RS & GIS

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Abstract:Brackish water aquaculture has emerged as one of the fast growing industries in the developing countries both for domestic consumption as well as for export. This industry not only generates foreign exchange to the country but also provides employment opportunities to the skilled and unskilled rural people. The present study identifies and quantifies appropriate sites for brackish water aquaculture development in coastal track of Karnataka using Remote Sensing, GPS and Geographical Information Systems (GIS). A color composite ETM+ image is used to identify the extent of brackish water and to find out suitable site for brackish water aquaculture. The remotely sensed data were complemented by secondary data digitized from a range of sources, including hard copy maps, to create a spatial database that included environmental and infrastructural data. A series of GIS models were developed in order to identify and priorities the most suitable areas for brackish water shrimp and mussel farming. Using qualitative and quantitative output from the models, the benefits of shrimp and mussel farming were compared, based on gross production, economic output and employment potential. Comparisons were made of brackish water shrimp and mussel culture with moderately saline-tolerant tilapia and prawn culture, freshwater carb culture and traditional rice production systems. Shrimp was identified as the most capital intensive and risky production system. The present study demonstrates the usefulness of GIS as an aquaculture-planning tool in a region where natural resources are already under considerable pressure.

IndexTerms **- Brackish Water Aquaculture, Karnataka, RS, GIS, weighted overlay method.**

I. INTRODUCTION

Remote sensing integrated with GIS can play a major role in sustainable shrimp culture development by providing information on land use/land cover, water quality, productivity, tidal influence and coastal infrastructure. These tools help to maintain the sustainability of shrimp culture through proper site selection by considering the impact of the development on other land use activities like agriculture, protected areas like sanctuaries, human uses, etc. that are part of the same ecosystem.

Aquaculture has been widely accepted as a practice that will supplement the capture fishery production, besides generating various types of job opportunities for the rural population. Coastal aquaculture has been given at most priority in many developing and underdeveloped countries due to its potential for earning foreign exchange. Brackish water fish farming is a system of aquaculture that focuses on the production of shrimp that are found in the creeks, lagoons, and estuaries through rational rearing. It can be classified under two major heads-freshwater and coastal. The latter can again be subdivided into two categories, namely, sea farming and brackish water aquaculture. Brackish water aquaculture is essentially dependent on the availability of good quality saline water from the sea, creek or backwaters. It will also improve the living standards of the rural populace by generating various types of job opportunities, both directly and indirectly. Brackish water is water that has more salinity than fresh water, but not as much as seawater. It may result from mixing of seawater with fresh water. Technically, brackish water contains between 0.5 and 30 grams of salt per litre. For analysis of the performance of brackish water aquaculture programmes in the country, there are number of problems has to be taken care such as, absence of a suitable land-leasing policy for brackish water shrimp/fish farming, inadequacy of technical staff for the implementation of brackish water aquaculture programmers, selection of sites which were later found to be unsuitable for shrimp farming & lack of local availability of suitable equipment and machinery for shrimp farming, shrimp hatcheries, feed formulation and preparation.

II. STUDY AREA

Karnataka, is located on the western edge of the Deccan plateau and is surrounded by Maharashtra and Goa on the north, Andhra Pradesh on the east, Tamil Nadu and Kerala on the south. On the western side of the state is Arabian Sea. Karnataka has a coastline of 300 km with a rich continental shelf of 27 000 sq. km and an EEZ of 87 000 sq. km with a resource potential of 0.425 million tonnes of fish production per annum. The present fish production of the state is around 0.290 million tonnes. A total of 8000 ha of potential brackish water area is available in the state. In Karnataka, traditional shrimp farming is being carried out in 2500 – 3000 ha in Gazani or Kharlands. Shrimp culture is carried on after a crop of 'Kagga', a salt resistant variety of paddy. The production of shrimp in the traditional farming is very meager and ranges between 50 – 150 kg/ ha. Presently, about 488 ha area is developed in the state under the improved traditional system of culture. It is estimated that 36.0 % of the total area is under farms of

less than 2.0 ha size; 31.0% in farms between 2.0 – 5.0 ha and 33.0% in farms above 5.0 ha size 14. The average production levels in the state is about 700 kg/ ha.

III. DATAS USED

- Different satellite data (IRS-1D LISS-IV, SRTM).
- Field-measured data and other relevant published information etc.
- The thematic maps on land-use/land cover and watershed were used.

IV. SOFTWARES USES

- ERDAS Imagine V 9.1 digital image processing software
- Arc GIS 9.1/OPS GIS V5.0 has also been used for the GIS related part
- Global Mapper V13.0

V. SATELLITE IMAGE PREPROCESSING

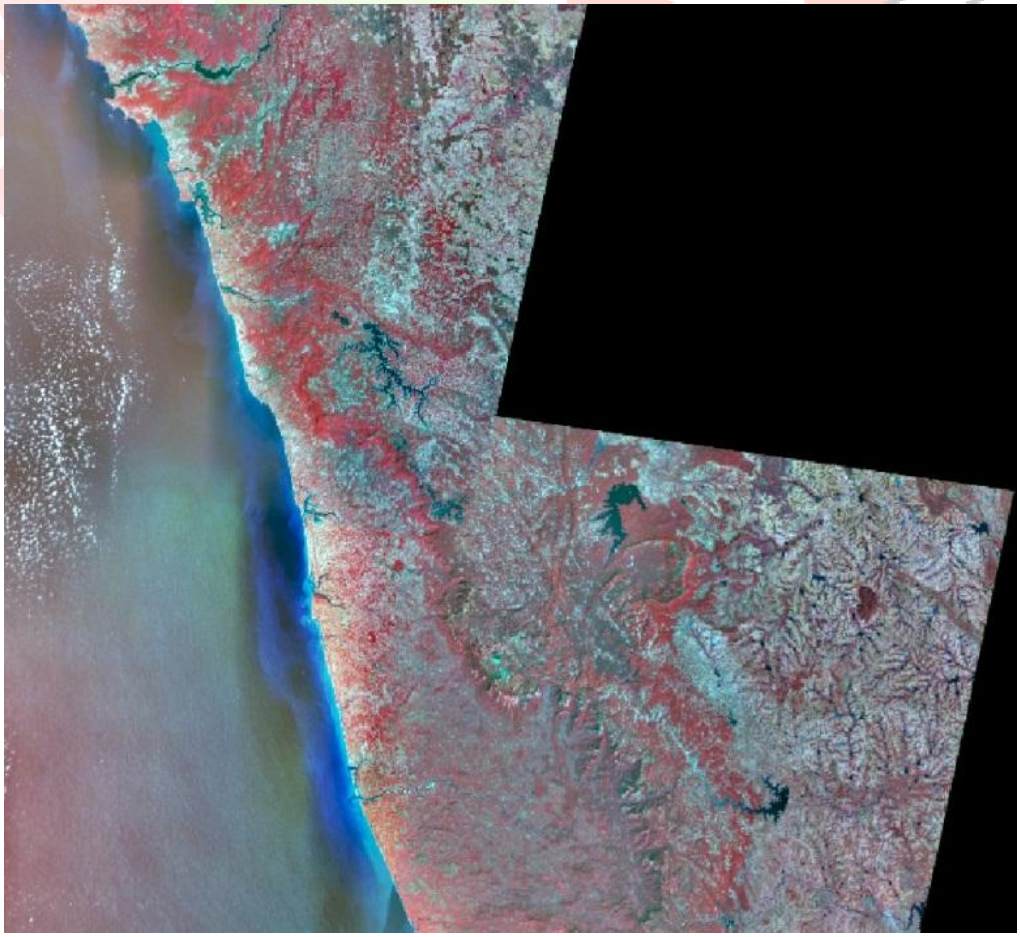
Survey of India (SOI) Toposheets of 1979 in the scale of 1:50,000 used as the base maps for Geometric correction. Image rectification and restoration procedures are often termed as image preprocessing. Random distortions are corrected by analyzing well distributed ground control points occurring in an image. The details of the radiometric correction performed on satellite images were given by various authors (Kapetsky James M; Lillesand and Kiefer, 2000).

VI. IMAGE CLASSIFICATION

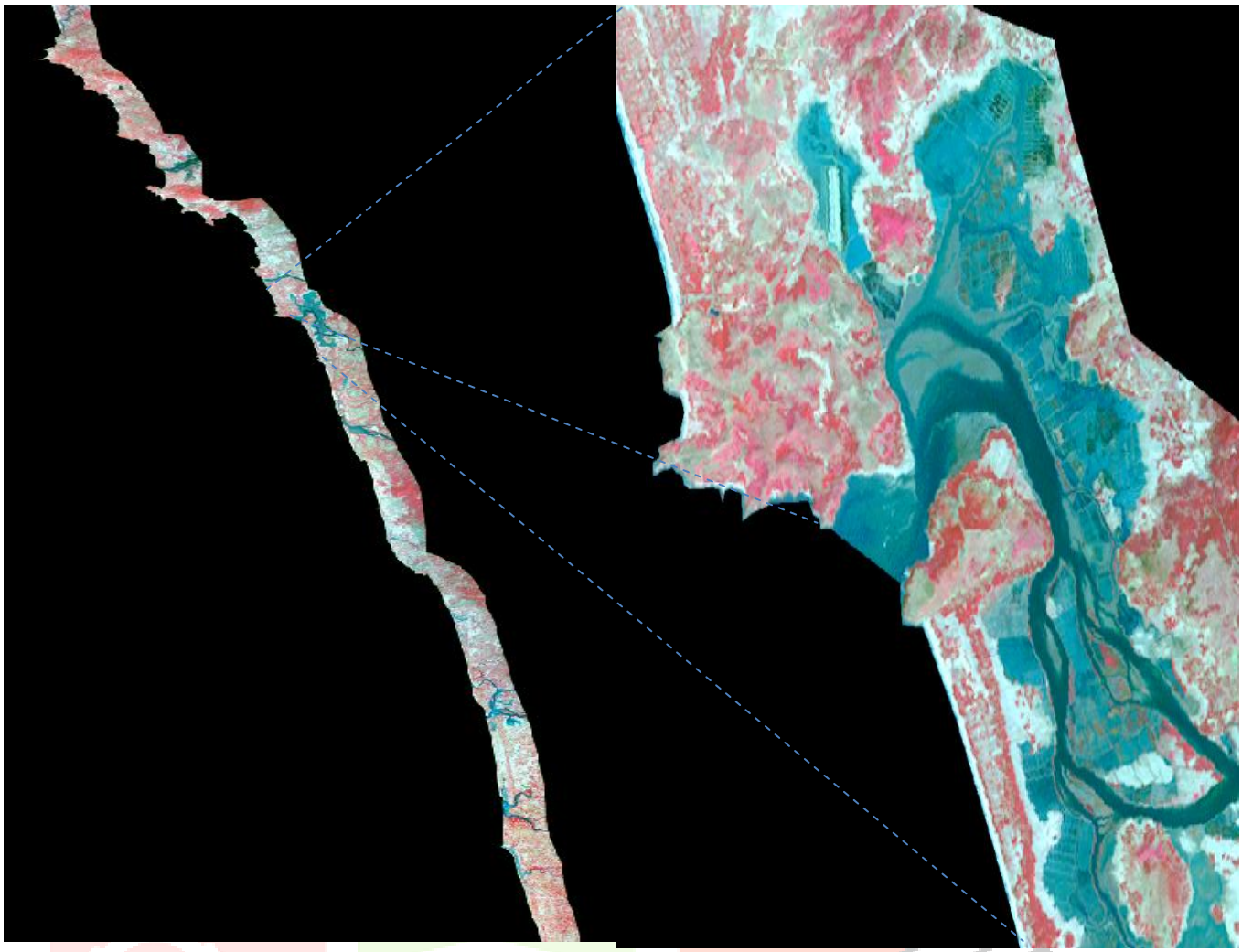
The objective of the image classification procedures is to automatically categorize all pixels in an image into land cover classes. Supervised classification is preferred for deriving the coastal land cover classes. Detailed procedure of supervised classification is described by Lillesand and Kiefer (2000). Further SRTM data is analysed using Global Mapper V 13.0 for site suitability analysis. Based on these various Thematic Maps were prepared

VII. MOSAICKING AND SUBSETTING OF IMAGES:

Mosaicking is the process of joining georeferenced images together to form a larger image or a set of images. The input images must contain all map and projection information, although these need not be in the same projection or have the same cell sizes. Calibrated input images are also supported. All input images must have the same number of layers. A reference image is selected in the reference column of the cell array. This reference image acts as the baseline for contrast matching and determines the default output map projection, cell sizes, and data type. In the present study the complete Northern Karnataka coast is covered in five scenes so mosaicking process has been used for combining all images for further processing.



Mosaicked image of Karnataka coast



(a): subset image (whole), *(b): enlarged part*

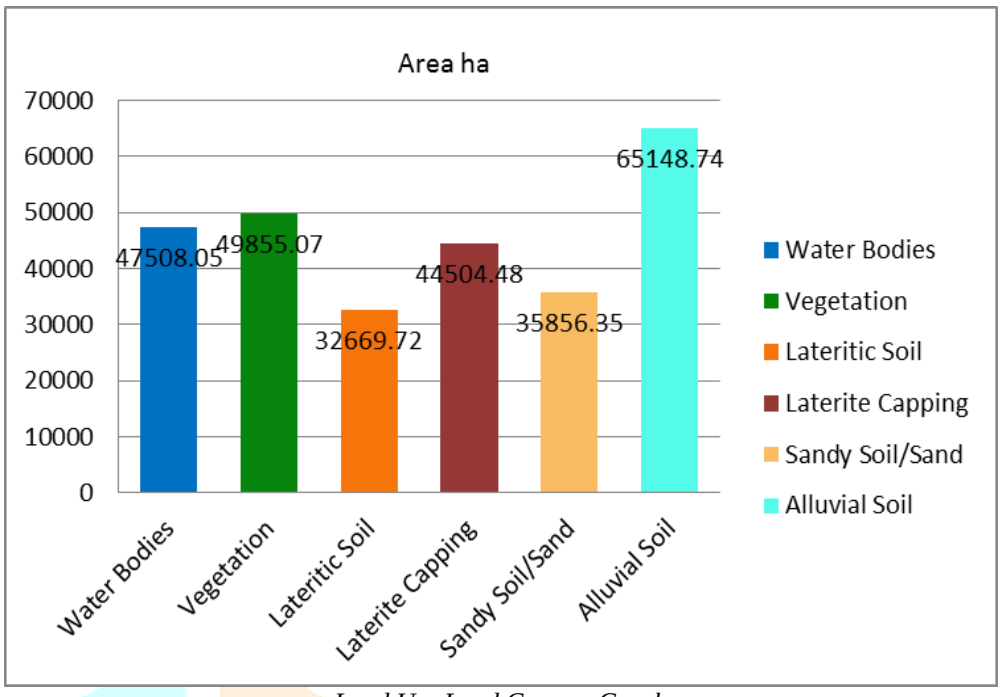
It is the process of extracting the required area after the mosaicking of the images i.e. from the combined scenes. For this purpose a vector layer of the area has been created using the base map of the catchment boundary and using this vector layer AOI layer has been generated for subseting the image. The result generated shows the image of the Karnataka coast.

VIII. RESULTS AND DISCUSSION

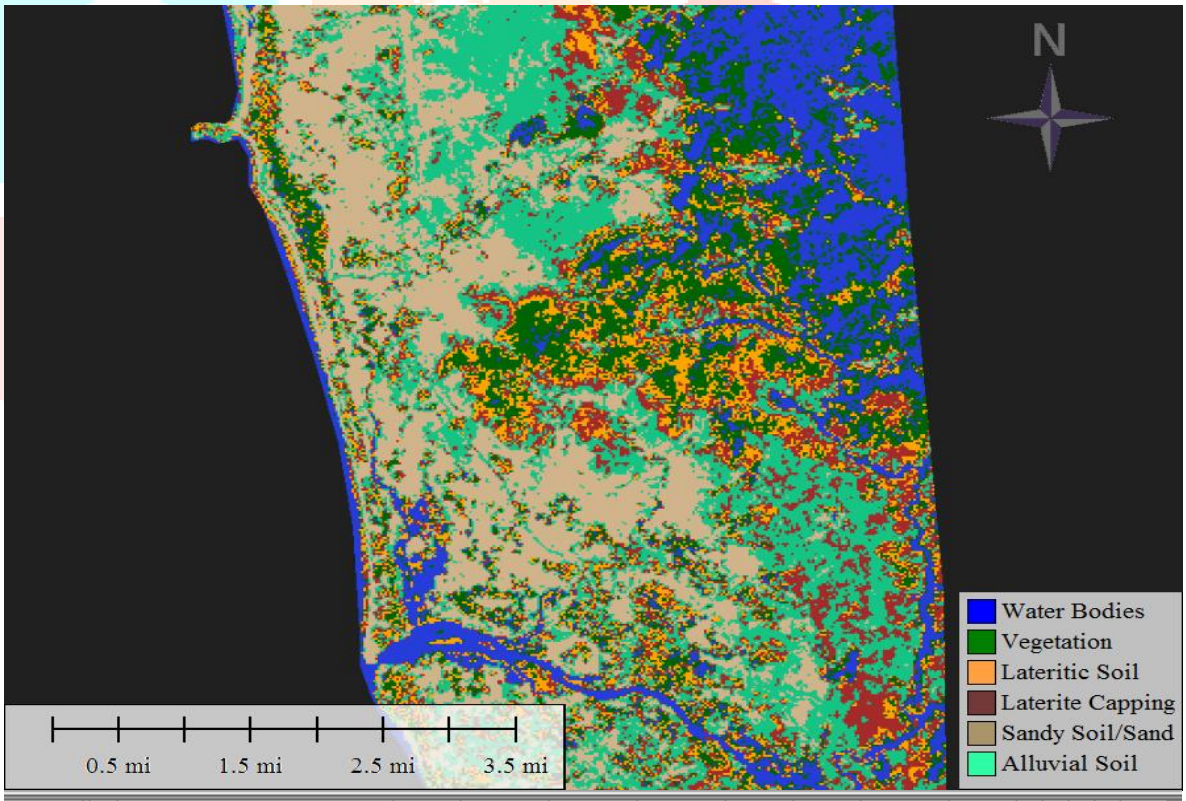
8.1 Land Use/Land Cover Map

Land use refers to the land which is occupied by human beings for various activities and land cover refers to the land covered by natural resources like forest, water resources etc. Land use land cover map was prepared for northern west part of coastal karnataka using IRS-1D LISS-IV images. On the basis of their spectral reflectance characteristics using supervised or unsupervised classification method. Various classes for LULC map are

- Water bodies
- Vegetation
- Lateritic Soil
- Laterite Capping
- Sandy Soil/ Sand
- Alluvial Soil



Land Use Land Cover – Graph



Class #	Signature Name	Color	Red	Green	Blue	Value	Order	Count	Prob.	P	I	H	A	FS
1	Class 1		0.125	0.125	0.125	1	1	30890468	1.000	X		X		
2	Water Bodies		0.150	0.240	0.850	2	2	3420283	1.000	X	X	X		
3	Vegetation		0.000	0.392	0.000	3	3	1355578	1.000	X	X	X		
4	Lateritic Soil		1.000	0.647	0.000	4	4	1618041	1.000	X	X	X		
5	Laterite Capping		0.647	0.165	0.165	5	5	1698489	1.000	X	X	X		
6	Sandy Soil/Sand		0.824	0.706	0.549	8	8	1735098	1.000	X	X	X		
7	Alluvial Soil		0.087	0.773	0.527	9	9	3741819	1.000	X	X	X		

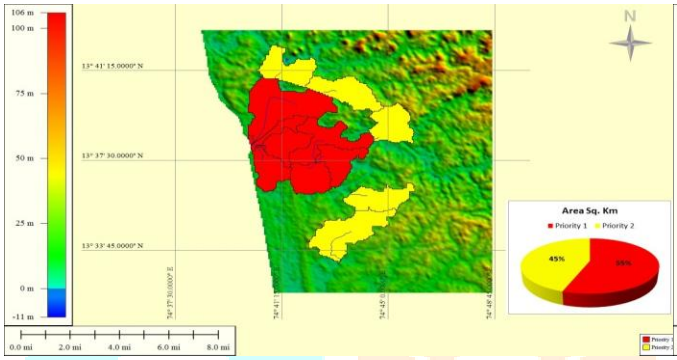
Supervised Classification (Land use/ Land cover map)

8.2Aquaculture potentiality Map for Various Rivers

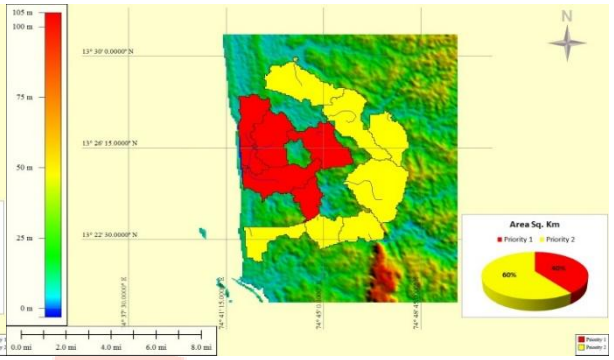
Aquaculture potentiality maps were prepared for major rivers of Karnataka using global mapper and ERDAS software's. Priority has been assigned for aquaculture sites. Based on that priority, areas for brackish water aquaculture have been selected.

Aquaculture potentiality map has been generated for the buffer zone of five kilometres from the coastal river mouth. Weightages are assigned based on the slope factor. First priority with red colour having slope of about 3 meters from the sea level indicates that the sites are best suitable for brackish water aquaculture practices. Similarly second priority with yellow colour having slope of about 6 meters are moderately suitable for brackish water aquaculture. Above 6 meters excessive pumping is needed for supplying sea water to brackish water pond.

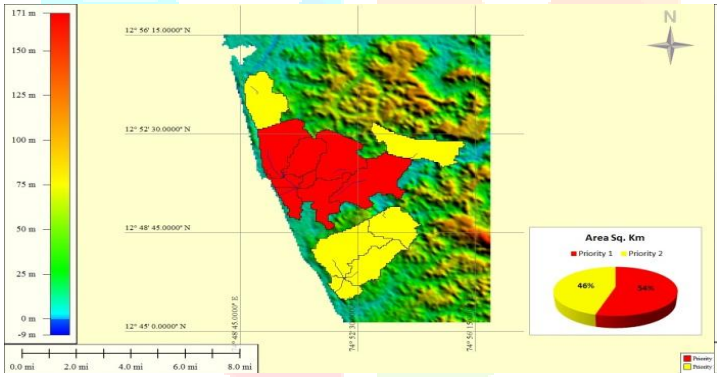
Much of the areas ranked most suitable for brackish water shrimp culture, are situated near the riverbank in the tidal zone. This is due to easy excess of saline water. However, most of the areas were ranked as moderately suitable because of lack of other facilities and getting water and draining them out. Large water bodies, which contain fresh water, were not considered due to lack of salinity. Natural forest and wild life refuges, Sundarban, roads, rivers and urban areas were not considered for culture activities.



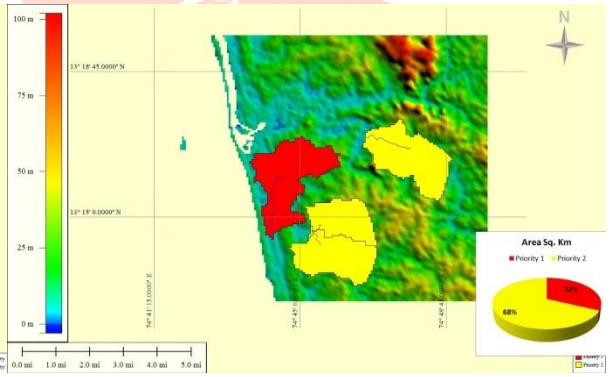
(a): Swarnadi River



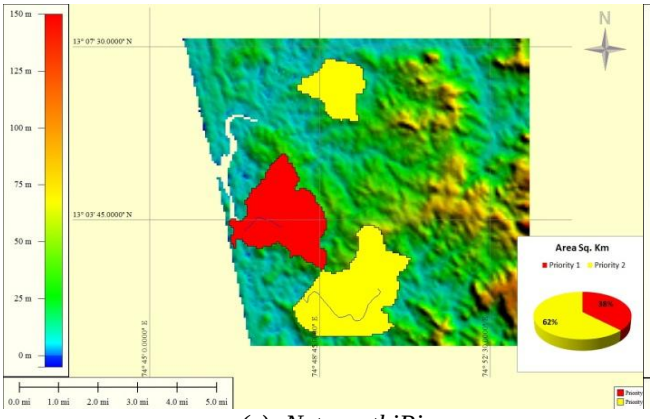
(b): Kollur River



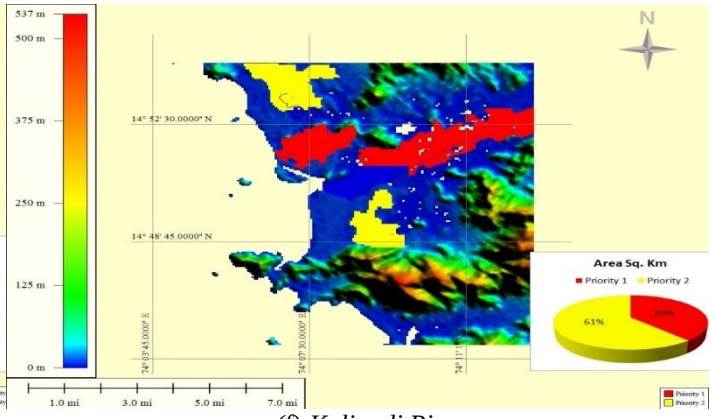
(c): Sita River



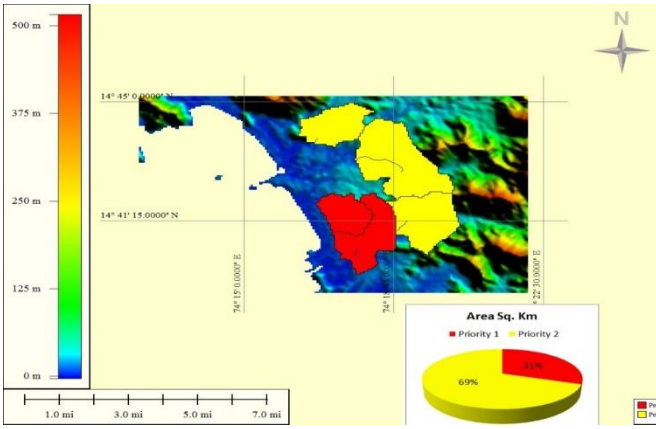
(d): Gurpur River



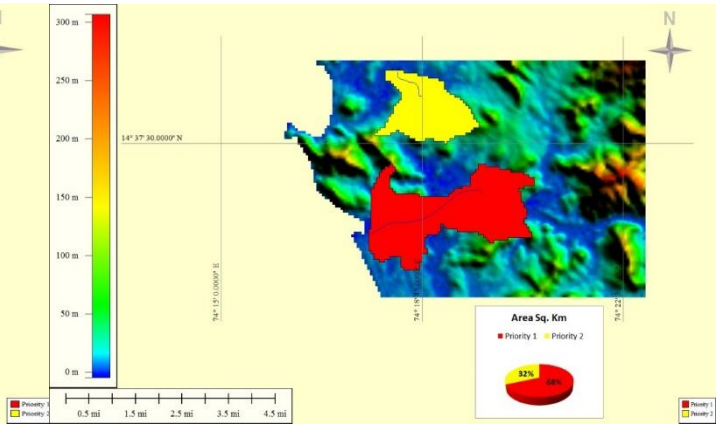
(e): NetravathiRiver



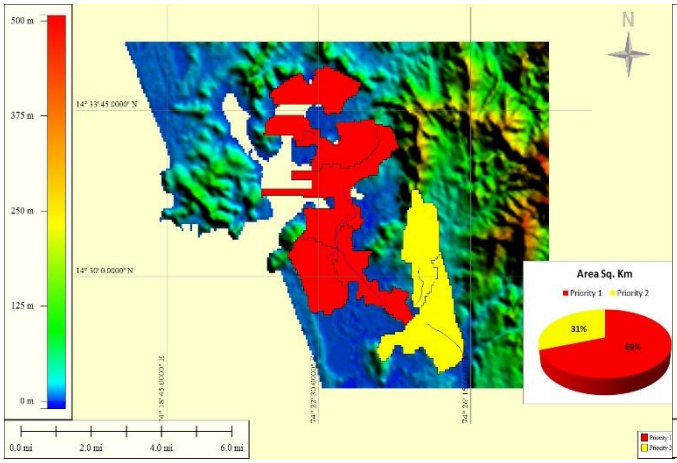
(f):Kalinadi River



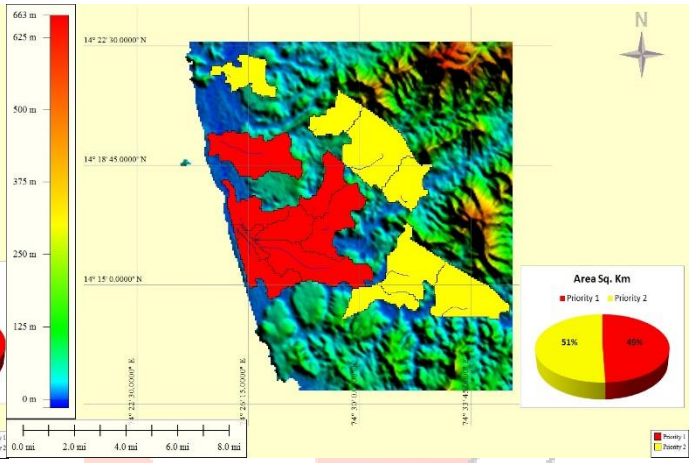
(g): Aghanashini River



(h):Gokarna



(i): Sharavathi River



(j): Gangavali River

Most suitable sites are found near coastal areas beside the rivers and tidal canals for shrimp culture where soils and topography are suitable and tidal water is abundant. However, suitable sites for freshwater prawn lie upstream beside the lakes, canals and rivers and fish culture areas are found North and Northeast beyond the saline belt.

Overall, relatively vast areas offer good economic prospect for fish farming in that a high availability of good market occur together. This is particularly the case where population density is high and where the inhabitants in the area consume high proportions of fish. Likewise, a few areas were shown to be unsuitable for fish culture due to salinity effects. Furthermore, suitable sites are located far away from the source of pollution. A trade off was then made between the proximity of one to the other for the possible integration of aquaculture culture with some types of agriculture.

IX. CONCLUSION

Aquaculture development and planning require comprehensive data on land use and water resources. Satellite data was utilised to prepare coastal land use maps along the Karnataka coast. However the number of parameters like soil and water characteristics to be considered will also depends upon the type of farming system. Brackish water aquaculture and fresh water aquaculture have different parameters. For example, in the case of brackish water aquaculture, proximity of the coast is an important factor because this kind of aquaculture requires the availability of saline water.

The use of remote sensing technology also has helped in identifying more appropriate site for brackish water aquaculture than was previously possible. Remote sensing data from satellite images can provide sub meter resolution that identify smaller features on the ground, resulting in more accurate maps to help locate sites for brackish water aquaculture that have fewer harmful effect on environment.

It is important that a detailed study can be made of the availability of crop by products, especially oil cake, rice bran, wheat bran and other products which could be used as low cost feed and their known availability could greatly enhance aquaculture development opportunities in the area.

Name of the River	Priority 1	Priority 2
Swarnadi	45%	55%
Kollur	60%	40%
Sita	46%	54%
Gurpur	68%	32%
Netravathi	62%	38%
Kalinadi	61%	39%
Aghanashini	69%	31%
Gokarna	32%	68%
Sharavathi	31%	69%
Gangavali	51%	49%

The above table describes the percentage of area, which is suitable for brackish water aquaculture. Where priority 1 is highly suitable, because it lies in the river mouth and estuaries and also it is very near to coastline with low elevated area. There is considerable potential for further exploitation of GIS for optimisation of competing aquatic production activities and their interaction with land based farming systems. The GIS planning process has an important role, particularly where land use patterns are intensive, as in most parts of Karnataka.

Agriculture has not been affected by the brackish water shrimp culture; the traditional sources of income, in addition to some new sources of income have been created by shrimp culture in the region. However, there have drastic reductions of livestock and poultry in the shrimp farming areas. Only one crop of shrimp can be cultured as the salinity of water falls to nil in the month of July-December which is suitable time for rice production and fresh water prawn and fish culture.

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