Photonirvachak
Journal of the Indian Society of Remote Sensing, Vol. 29, No. 1&2, 2001

Brackish Water Aquaculture Site Selection in Coastal Track of Cannanore (Kerala) Using Remote Sensing and GIS Techniques

M C GUPTA, V P KRISHNARAJAN* AND SHAILESH NAYAK
Marine and Water Resources Division, Remote Sensing Applications Area
Space Applications Centre (ISRO), Ahmedabad 380 053
*School of Earth Sciences, Bharathidasan University, Tiruchirappalli – 620 023, Tamil Nadu

ABSTRACT

Aquaculture has emerged as one of the fast growing industries in the developing countries both for domestic consumption as well as for the export. This industry not only generates foreign exchange to the country but also provides employment opportunities to the skilled and unskilled rural poor. On the other hand, aquaculture has also some negative impacts on the environment which are mainly due to conversion of mangroves and agricultural, salination of surface water resources and agricultural land at some places besides causing pollution and diseases. All the major shrimp farming countries of the world have faced environmental problem due to intensification, improper and uncontrolled planning by greed and unlimited profit motives of a section of aquaculture community. In view of this, a proper environmental management is a basic need to sustain the industry in the long run. Selection of a suitable site in the coastal areas is the first and the foremost step which is a crucial factor in determining the success of shrimp farming. The present paper discusses the selection of brackish water aquaculture sites using remote sensing satellite data and GIS on the Cannanore coast. Different aquaculture sites in the area were evaluated using a GIS package. Finally a prioritization map showing the sites in the descending order of their priority was generated.

Introduction

India is the second most populous country in the world. Agriculture including fisheries dominates the Indian economy. It plays a vital role in Government plans to achieve poverty reduction and protection of natural resources. Seeing the increasing health consciousness in the world, the fish and the fish products may be considered as the safest food of animal origin. In India, fisheries is a well-established sector as far as marine fishery is concerned. Marine fish production in India has almost reached to saturation due to over fishing and increase in the operational cost. On the other hand, consumption of fishery products has been increasing rapidly with exponential growth of world population. This leaves a large gap between production and

Recd. 11 Sept., 2000; in final form 23 Aug., 2001

demand which suggests exploring alternate sources of fish production. Aquaculture has emerged out as one of the alternate sources to augment fish/prawn production in the world. Among the aquaculture industries, brackish water aquaculture has gained a great momentum in South and South East Asia. As far as brackish water aquaculture resources in India are concerned, it has about 1.19 million ha brackish water area of which only around 82,500 ha area was under shrimp farming in 1993-94 (Durairaj, 1996). This shows that brackish water resources in India are under exploited. Kerala has tremendous potential for shrimp farming. The major areas where shrimp culture can be started are the estuaries of the rivers and their lower reaches within the tidal influx, brackish water lakes, etc. The important brackish water lakes of the states from North to South are the Kavayi, Kottupuzha, Valapattanam, Valiangade, Grangahore, Parur, Vembanad, Kayamkulam, Ashtamudi, Paravoor, Edavanadayare, Anjengo, Kadinamkulam and Veli. At present brackish water fish and shrimp culture is practiced on commercial scale on low lying fields which were once part of the backwaters and have been reclaimed for paddy cultivation by construction of dykes. In these fields, prawn culture and paddy cultivation are being practiced in rotation; prawn from mid November to mid April and paddy cultivation from June to September. This kind of traditional culture is advantageous from the farmers point of view, as it involves only limited investment. It is mainly practiced in Southern Kerala coast while Northern coast has only few farms.

Environmental Issues and Impact of Farming

Commercial shrimp culture has gained global attention not only due to its role in strengthening the economy of a country but also due to sudden collapse of industries in some of the countries. Two basic issues related to aquaculture are the impact of aquaculture on environment and the impact of environment on aquaculture. Pillay (1992) and Alagarswami (1994) have discussed these and various other issues related to aquaculture. These and some other studies (Lee and Wickins, 1992; Macintosh and Phillips, 1992) have concluded that, although aquaculture had both positive and negative impacts but the negative impacts have received more attention and wide publicity. These negative impacts are mainly conversion of mangroves and agricultural areas for aquaculture, salination of surface water resources and agricultural lands besides causing pollution and diseases. This study presents a scientific method to select brackish water aquaculture sites using remote sensing satellite data and GIS to reduce the impact of aquaculture on environment on the Kerala coast.

The Cannanore coast, a part of Malabar coastal region of Kerala was chosen as a study area. It comprises the talukas of Taliparampa, Cannanore and Tellicherry of Cannanore district. It is bounded by Kavayi river in the north, Mahi river in the south and the Arabian sea in the west. The area covered is about 428 sq. km and lies between 11° 40' –12° 10' North latitude and 75° 10'- 75° 35' East longitude.

Results and Discussion

Preparation of Landuse Map

Land use map of the study area was prepared by visually interpreting IRS LISS-II geocoded imagery of Feb. 3, 1991. The major land use categories include agriculture land, fallow land, barren land, wetland areas such as mangroves, mudflats etc. and are described below. A composite land use map generated using GIS is shown in Fig. 1.

The study area has a vast coastal agriculture land which includes the major croping area of paddy, vegetables, arecanut, banana and coconut etc. Though there were distinct differences in the signatures of some of the crops, no distinction has been made between them while preparing land use map for brackish water aquaculture development. Almost 74 per cent area is devoted

for agriculture which covers around 320 sq. km. Fallow lands are uncultivated lands during that period and covers an area of about 24 sq. km. Barren lands occur around the hilly region and as laterite cappings and are generally free from vegetation. Significant patches of barren lands are seen in the north of the study area around Andur, Morazha, Taliparmba and Madayi. The area under barren land is about 12 sq. km. These areas can be used for aquaculture related activities. Mangroves are very diverse and complex eco-system where flora and fauna thrive in a balanced state. These are productive areas and grow only where they can come into permanent contact with sea water/ brackish water. Cannanore coastal track is one of the major mangrove area in Kerala. It covers an area of about 9.5 sq. km. Major patches of mangroves are found in Pazhayangadi area in Kuppem Valapattanam river estuary, Chankuri Chal area and in Darmadom region. These areas are to be avoided for aquaculture ponds. The mudflats are wide expanses of fine grained soft mud along the shore under tidal influences. These areas are the prime focus areas included in the present study for evaluation of brackish water aquaculture. Vast mud/tidal flats along the Kerala coast have been converted into filtration ponds or reclaimed mudflats. They generally consists of clay, silt, ooze etc. These areas are associated with estuary and lagoons. The area covered under mudflats is around 16.90 sq. km. Mudflats devoted to agriculture practices are not included in this category. The major stretches of mudflats are along Kuppam, Dharmadon and Eranholi river, and are suitable for constructing ponds. Vegetation like grass and marsh vegetation normally found associated with the mudflats in the coastal areas, covers an area approximately 14.66 sq. km. These areas may be avoided for any use. Sandy areas are delineated as bright, smooth and linear exposures bordering open coast on the land water boundary and as discontinuous patches in the coastal plain trending parallel to the open coast generally with sparse vegetation. The discontinuous patches are found in the Mattool area. The total sandy area is about 5 sq. km. These regions can be used for hatcheries.

Drainage Map

Rivers and creeks fetch the brackish water for aquaculture development. The water is to be taken (or pumped) in the storage tank/ aquaculture ponds during high tides. In the ponds, some percentage of water is to be exchanged daily depending upon the intensity of culture. The waste water is to be drained out properly via creeks etc. into the sea during low tides so as to avoid the mixing of this water into the nearby ponds. Nearness of the creek or river water is one of the important and controlling factor for the suitability of the site for aquaculture development. Major rivers and creeks in the study area are shown in Fig. 1.

Transportation Map

Transportation map of the study area includes national highways, metalled roads, unmetalled roads, broad gauge railway line connecting Mangalore - Cochin. The other linear features such as low water line and high water lines are also mapped (Fig. 1).

Habitation Map

Important villages and their locations are taken from Census Atlas as shown in Fig. 1.

Identification and Collection of Non-Spatial Data

Selection of brackish water aquaculture sites requires careful consideration of many aspects to make it more efficient and economically viable. It requires both spatial and non-spatial information to assess the suitability of sites for aquaculture development. A mathematical model has already been developed by Gupta *et al.* (1993) in consultation with Gujarat state Fisheries Department, Brackish Water Fish Farmer Development Agency (BFDA), and the Marine Products Export Development Authority (MPEDA). This model takes into account almost all necessary parameters required for site selection along with their importance and

weightages for aquaculture development. The weightages of parameters are assigned in two ways according to i) the relative importance of the parameters and ii) sensitivity within the individual parameters. The model includes engineering, ecological, infrastructure, demographic and meteorological parameters having overall maximum weightages as 18, 31, 27, 12 and 12%, respectively. The spatial and non-spatial parameters used in the present study are assessed using geographical information system (GIS) and the thematic maps described in the previous section.

Database Creation Through GIS and Evaluation of Sites

A database was created through GIS by digitizing point features, line features and polygon features coverages. Various non-spatial parameters (Engineering, Ecological, Infrastructure, Demographic and Meteorological) were collected from state fisheries department, stored in the database and were assigned weightages as per their importance using the mathematical model described above. The parameters such as brackish water supply (i.e. proximity to sea), soil and water properties, seeds and palletized feeds availability etc (Gupta and Sreshty, 1993) are the major deciding parameters for acquaculture site selection. All these parameters were available for the present sites. The priorities or ranking of different sites of brackish water acquaculture development were determined using and validating the software package developed around ARC/INFO (Gupta, 1994). The software is user friendly and is developed using Simple Macro Language (SML), support popup menu, the user response for the choice of sites, distance of transport network, brackish water supply from the site and the location of villages around the site. The package generates a table listing all the selected sites with their ranking in the descending order of priority along with their percent weightages.

In the study area, a total of 39 mudflats sites were taken for evaluation and in all 23 parameters out of 29 parameters were available for most of the sites. Land elevation, land cost, drainage facility, processing facility, population below object poverty and evaporation rate were not available. The contribution of these parameters will not appreciably affect the priority because the per cent weightages of the sites were grouped into different priority levels such as excellent (First), very good (Second), good (Third) and so on. These priority levels along with percent of total available area for brackish water aquaculture development is shown in Table 1. The prioritization map delineating the ranking of the sites in descending order of their priority is shown in Fig. 2.

Table 1: Priority and area available for brackish water aquaculture

AREA (ha)	AREA (%)	WEIGHTAGES (%)	PRIORITY	REMARKS
544	32.14	82 – 85	FIRST	EXCELLENT
311	18.42	80 - 82	SECOND	VERY GOOD
376	22.22	78 - 80	THIRD	GOOD
248	14.69	76 - 78	FOURTH	FAIR
118	07.00	74 - 76	FIFTH	MODERATE
093	05.53	70 - 74	SIXTH	POOR

Fig. 1. Landuse map for brackish water aquaculture site selection in coastal track of Cannanore (Kerala)

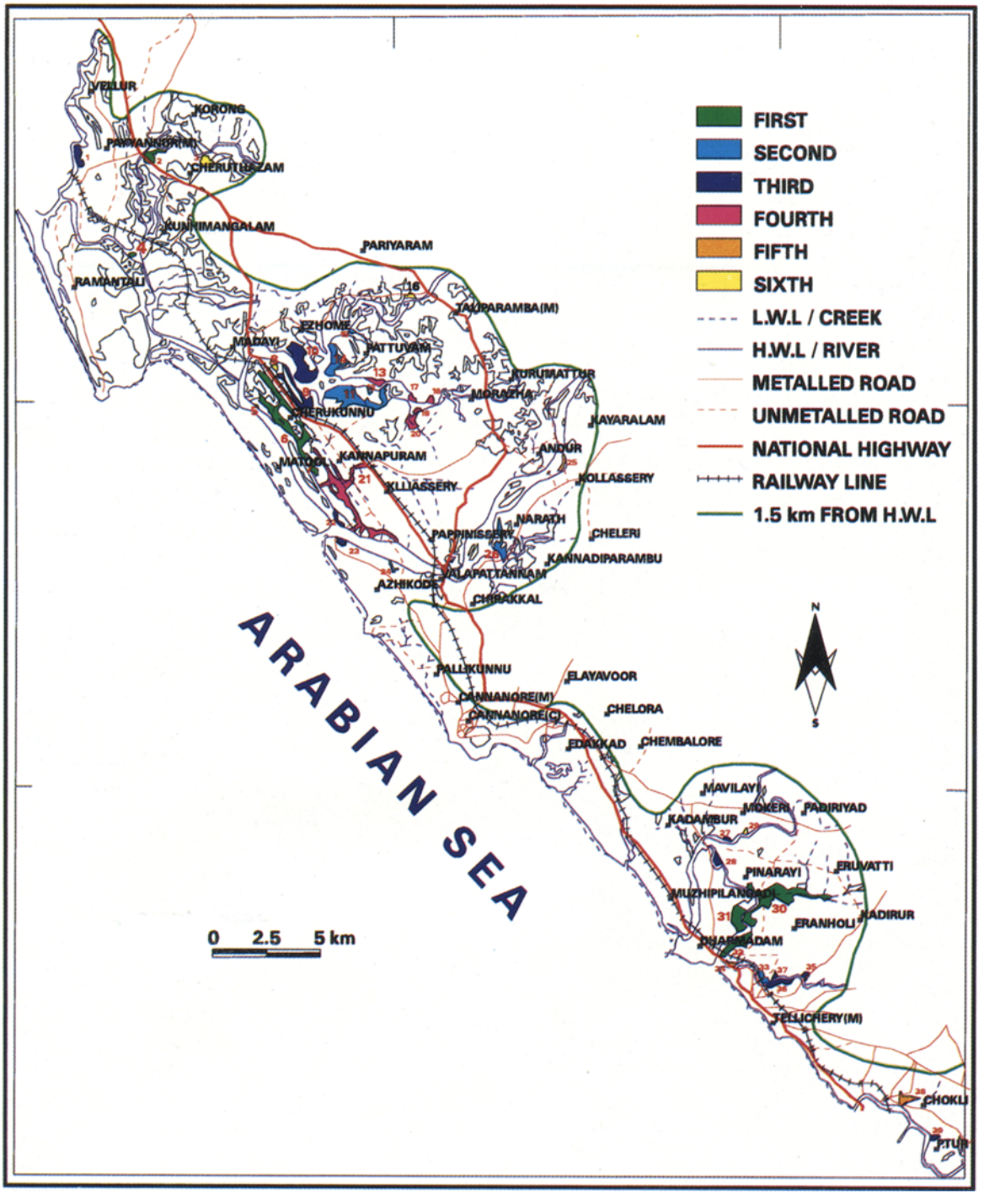

Fig. 2. Prioritization map for brackish water aquaculture site selection in coastal track of Cannanore (Kerala)

Conclusions

All the sites in the study area have per cent weightages greater than 70. This indicates that the study area is quite good for aquaculture development. The total mudflat area is about 1690 ha of which 544 ha falls under excellent category. This includes the sites near Payyanur, Cherukunnu, Dharmadom and Eranholi. The sites near Kannapuram, Narath, Pattuvam and Cavumbagam comprises an area about 311 ha and fall under very good category while the sites near Ezhome, Madakkare, Kavumbbhagam and Andur villages have 376 ha area and are in good category. Thus a total of about 73% mudflat area have a weightage greater than 78 percent. The sites having second and third priorities will need additional investment in infrastructure development. While sites with fourth, fifth and sixth priorities are relatively unsuitable from ecological and engineering point of view.

In the present study, for some of the parameters specially water salinity, only one time data was used due to limited time and rainy season. This may cause little change in the per cent weightage but may not affect drastically the overall priority due to taking ranges of weightages. Barren lands are not taken for evaluation due to non-availability of parameters. Mangroves and other socio-economically significant areas like agriculture land etc. should not be allowed for aquaculture. This has been taken into consideration by the software while prioritising sites. It is advisable to go up to semi-intensive farming. Moreover, Stocking density, use of supplementary feeds, application of chemicals, fertilizers and disinfectants etc. should be within a limit for sustainable development. A buffer zone of suitable width should be created between prime agriculture lands and the aquaculture sites to avoid any negative influence of aquaculture on agricultural lands.

Acknowledgements

Authors are grateful to Dr. R.R. Navalgund, the then Dy. Director, Remote Sensing Applications Area (RESA) and Dr. A. Narain, Sr. Scientist RESA for their encouragement. The support and help provided by Mr. N.P. Kurian, Centre for Earth Science Studies, Trivendram and Mr. S. Aruchamy, School of Earth Sciences, Bharathidasan University, Tiruchirappalli, Tamil Nadu are greatly acknowledged.

References

Alagarswami, K. (1994). Environmental Assessment and Management of Aquaculture Development. Country Report, FAO/NACA Regional Study and workshop on the Environmental Assessment and Management of Aquaculture Development.

Durairaj S (1996). Current Status of Coastal Aquaculture in Tamil Nadu, Proceeding of National Conference on Sustainable Aquaculture, held at Centre for Water Resources & Ocean Management, Anna University, Madras from April 5-6, 1995, pp. 24-28.

Gupta, M. C. and Sreshty, I. V. G. (1993). Development of a Model for Brackish Water Aquaculture Site Selection in India. Technical Note, SAC/RSA/RSAG-MWRD/TN/02/93.

Gupta, M. C. (1994). A User Friendly Software around ARC/INFO GIS for Brackish Water Aquaculture Site Selection in India. Proc. 15th Asian Conf. Remote Sensing, held at Bangalore from Nov. 17-23, 1994.

Lee, D'OC and Wickins, J. F. (1992). Crustacean Farming, Blackwell Scientific Publication, Oxford, 392 p.

Macintosh, D. J. and Phillips, M. J. (1992). Environmental issues in Shrimp Farming. In: H. de Saram and T. Singh (Eds.) Shrimp 92, Hongkong. Proc. of the 3rd Global Conference on 'The Shrimp Industry', Hongkong, September 14-16, 1992. INFOFISH, Kuala Lumpur, Malaysia.

Pillay, T. V. R. (1992). Aquaculture and Environmental assessment and Management. Fishing News Books, Oxford, 576 p.