

REMOTE SENSING AND GIS APPLICATION FOR ASSESSMENT OF ENVIRONMENTAL FACTORS AND PEARL OYSTER CULTURE AREAS IN MINICOY ISLAND, LAKSHADWEEP

Rahul K. Pandey*, **A.K. Mishra** and **Anirban Mukhopadhyay**
Indian Institute of Remote Sensing (NRSA), Dept. of Space, Govt. of India,
4, Kalidas Road, Dehradun-248 001, India - * rahulk_p@iirs.gov.in

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ABSTRACT:

Commercial pearl oyster culture has been a common feature in the oceanic islands around the globe. The islands containing lagoons and reef flats normally support natural population of pearls oysters and exhibit many advantages for farming of pearl oyster and production of cultured pearls particularly from the environment point of view. Suitable site selection is a major key factor for development of pearl culture industry affecting both success and sustainability. In this study remote sensing and GIS were used to build a spatial database to understand the important factors, which are considered to have any major or minor influence on pearl culture development in Minicoy island, Lakshadweep. The main selection criteria used to identify the suitable sites for pearl culture development in Minicoy island were: topography, environmental parameters and social restriction due to fishing and other reef related activities. These selection criteria (factors) were standardized to a common numeric range, and then combined by means of a weighted average to delineate the suitable sites into three major categories as highly suitable, suitable and less suitable. The highly suitable and suitable area was further classified into two sub-categories indicating proper rearing method i.e. rack/raft culture for pearl oysters farming.

1. INTRODUCTION

In recent years, Pearl trade has become the world's most lucrative industry, as there is great demand for quality pearls in domestic and international markets. In the year 2000, the global export trade was valued at US\$ 479 million in which Tahiti, Australia, Indonesia and Japan were the major players. India is recognized as one of the last producers and handlers of naturally occurring pearls and imports pearls worth US\$ 4 million annually (Silas, 2003). This trade imbalance may be due to loss of natural pearl stocks, conflicts between different

coastal activities and poor management practices. Therefore, the first step for scientific and sustainable development of pearl culture industry is suitable site selection followed by improved culture management. Remote sensing and GIS application in regional site selection for oyster culture carried out successfully by (Chenon et al., 1992; Durand et al., 1994; Populus et al., 1997; Scott et al., 1998). In India, work on aquaculture site selection using remote sensing and GIS has been carried out by Ramesh and Rajkumar (1996), Karthik et al., (2005). In the present study, an attempt has been made to demonstrate application of

remote sensing, GIS and GPS for the assessment of environmental factors, bio-resource dependencies, site assessment and industry liaison for pearl oyster culture in Minicoy.

1.1. Study area and it's environment:

Minicoy is an atoll island and lies between 8° 15' - 8° 20' N and 73° 01' - 73° 05' E with an area of 4.4 km² including the attached islet of Viringli also known as small pox island. It rests on an underwater platform of about 100 fathoms deep. Minicoy island has favorable conditions for pearl farming because of its unpolluted and well-oxygenated (3.77-7.09 ml/l) waters, optimum temperatures for growth (27–30°C), stable oceanic salinity (32–35%), and steady pH (7.5-8.47). The growth of (*Pinctada fucata*) was faster in the Minicoy lagoon (>4mm/month) compare to mainland and the mortality was not a serious problem in the grow out systems. The confirmation of the availability of precious, hardy, bigger and more expensive black lip pearl oyster (*Pinctada margaritifera*) and pearl producing abalone (*Haliotis ovina*) indicates that this island has tremendous potential in the protected lagoon and needs urgent consideration for the development of pearl oyster farming at commercial scale (Koya et al., 2003). Therefore, at present, strategically placed pearl oyster cage culture seems like the most viable system for ongrowing pearl oysters in Minicoy.

2. MATERIAL AND METHODS

Extensive fieldwork of the study was carried out during November 2005. The steps involved in this study are given in (Figure 1). Coastal landforms and

bioresource classification of Minicoy island was carried out using satellite data (IRS P6 LISS – IV MX), published map and survey report along with ground truth with the help of global positioning system (GPS). During field survey signature sites (Plate – A, B & C) were observed for the image interpretation. Total no of 18 sampling stations were identified to cover the entire lagoon area. The data collected for different sampling sites were grouped into three major classes namely bathymetry, water quality parameters and social restriction due to fishing and other reef related activities to identify the suitable sites for marine pearl culture in Minicoy.

In this study the ERDAS IMAGINE 8.7 software used for digital image processing of satellite data and other quantitative analysis, SURFER 8.0 for the interpolation. Several interpolation methods were tested and best suited method has been selected for the generation of thematic layers of different parameters. Assignments of weights (Table 1) to different parameters were assigned subjectively with their relative scores (Table 2). The total weight was obtained by adding all the weighted thematic layers to delineate the suitable sites into three major categories as highly suitable, suitable and less or moderately suitable (Figure 2) in Arc GIS map 8.3.

3. RESULTS AND DISCUSSION

Bathymetry is one of the most important factors, particularly for site suitability for pearl oyster farming; the depth preferred is usually 15-20 meter as the growth of oyster is good at such depth.

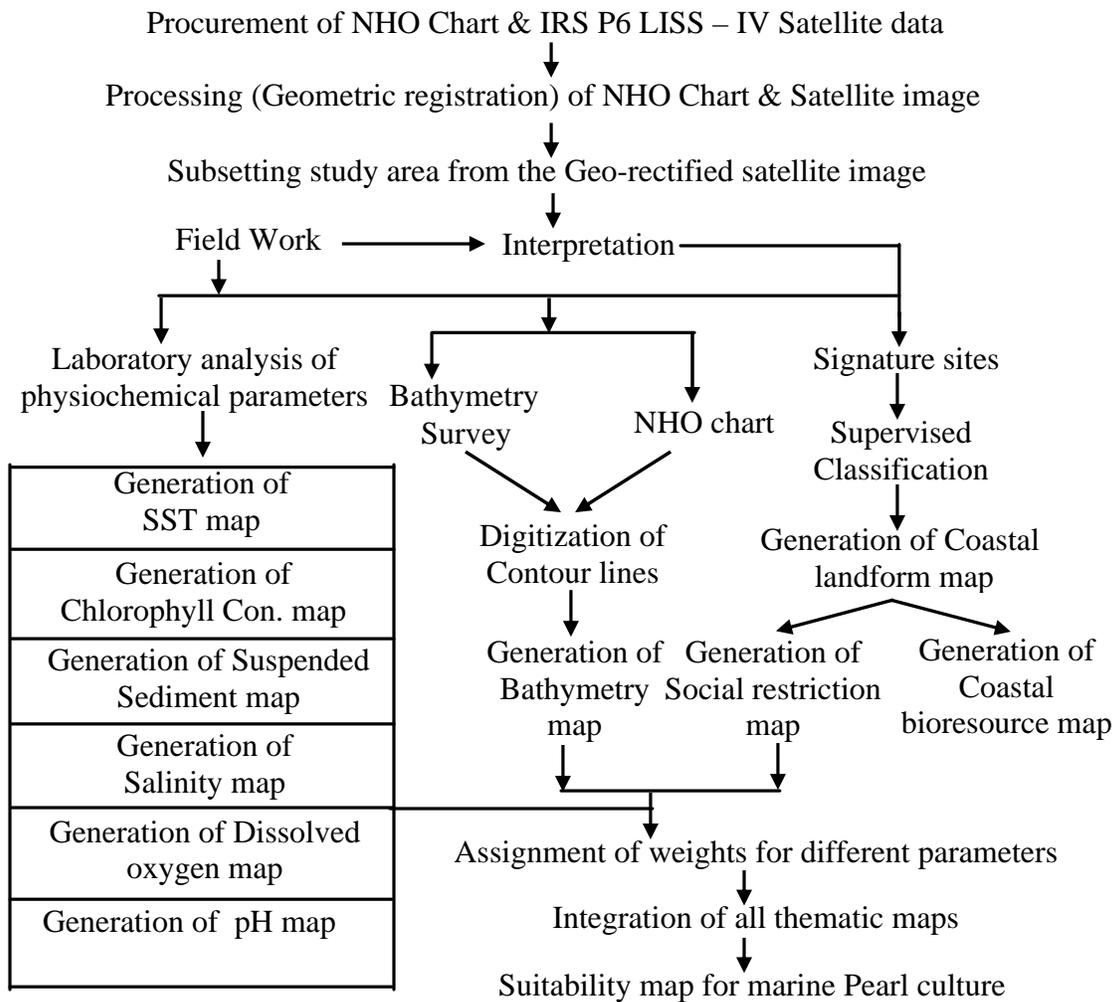


Figure1. The steps followed in generation of the suitability map.

Minicoy lagoon has a depth range of (1-23 meter). Most of the shallower depth (0.001-2 meter) lies in the west and the south-west region of island. The deepest region is having a range of (18-23 meter) in the North-eastern part of the lagoon. The average depth is (4-6 meter). Social restriction such as live bait fishing areas, sea grass etc. which act as a constraint for the establishment of pearl culture farm was delineated using point data collected during field survey, published map and survey report. In the attribute table of this layer, all the polygons belonging to above classes were assigned a value 1 to consider as unsuitable and for other classes as 3 for

highly suitable. Coastal landforms and bioresource classification of Minicoy island has been based on IRS-P6 LISS-IV satellite image of June 2005. The satellite image has been interpreted in the form of false color composite (FCC, 4[R] 3[G] 2[B]) using standard interpretation key (Nayak, 1991). A detailed analysis of the spectral signatures of terrain associated with important elements like geometric, tonal

Table 1. Scores for different parameters.

No	Parameters	Highly suitable	Suitable	Less suitable
A	Topography			
1	Bathymetry (Depth in meters)	10 - 15	6 - 10	<5
B	Social restriction			
1	Due to fishing & other reef related activities	-	-	-
C	Water quality parameters			
1	Water temperature (0°)	28 - 29	30 - 31	>31
2	Salinity (PPT)	31 - 33	33 - 34	>34
3	Dissolved oxygen (mg/lit)	4 - 6	3 - 4	<3
4	pH	8- 8.2	7- 8	<7 & > 8.2
5	Chlorophyll concentration (mg/m ³)	3- 6	1 - 3	<1
6	Suspended sediments load (gm/lit)	0.001- 0.02	0.02- 0.03	>0.03

Table 2. Assignment of weights for different parameters.

No	Parameters	Relative weight (R _w)	R _w *3	R _w *2	R _w *1
1	Bathymetry (Depth in meters)	20	60	40	20
2	Social restriction	20	60	40	20
3	Chlorophyll Concentration. (mg/m ³)	15	45	30	15
4	Suspended sediments load (gm/lit)	15	45	30	15
5	Water temperature (0°)	10	30	20	10
6	Salinity (PPT)	10	30	20	10
7	Dissolved oxygen (mg/lit)	7	21	14	7
8	pH	3	9	6	3
Total weights (T)		100	300	200	100

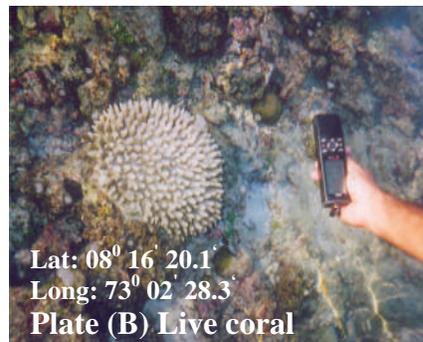


Plate (A, B & C). Signature sites observed during field survey.

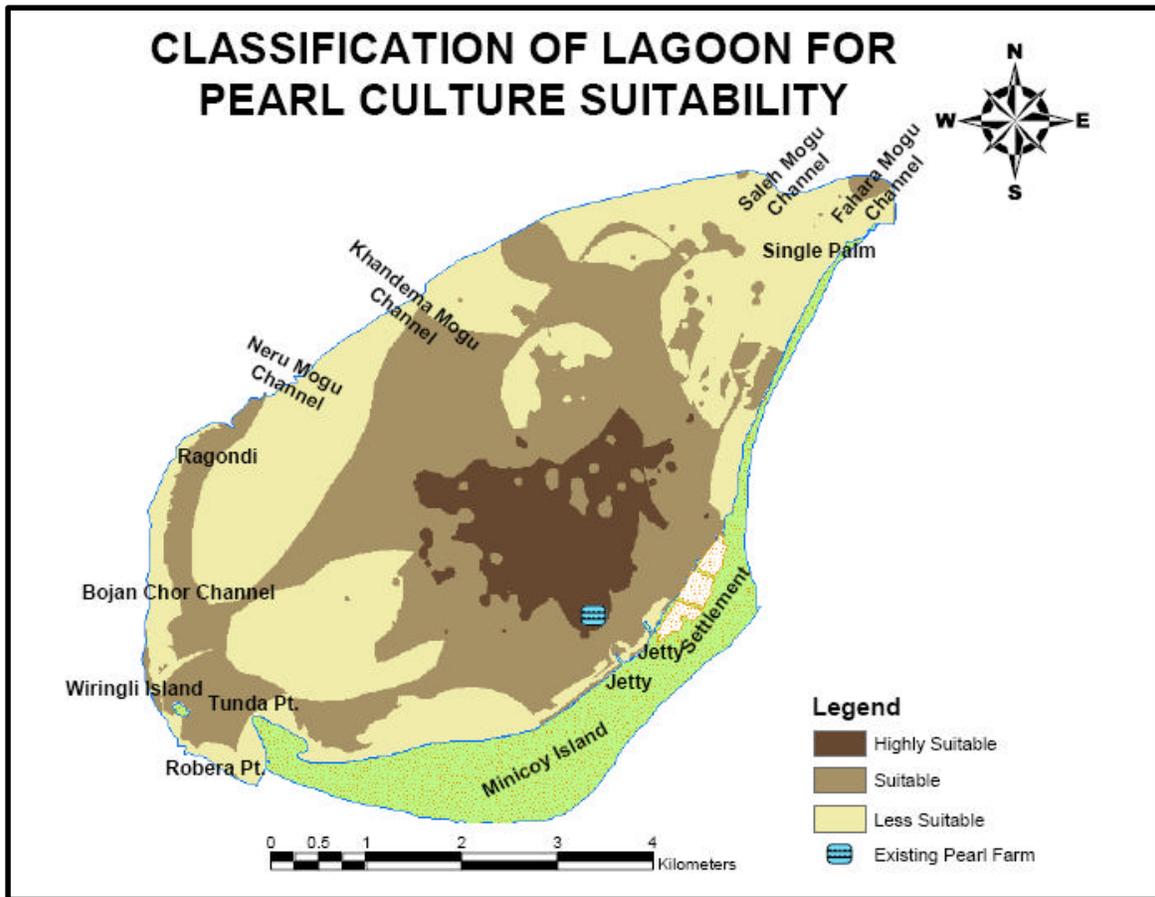


Figure 2. Classification of lagoon for pearl culture suitability.

and textural characteristics of the coastal landforms, helped to identify different geomorphologic units. The coastal bio resources include reef flat (4.61 km²), sea grass (0.10 km²), exposed coral (1.6 km²) and submersed or deep water coral patches (8.568 km²). Tables 1-2 show the value of each parameter for the eight different thematic layers. The total weighting of all the thematic layers was calculated on a 100–300 scale. After overlaying all the eight thematic layers an integrated map was obtained with - total weightage ranging from 123 to 300 of the total lagoon area of 29.23 km², 11% was found to be highly suitable, 45% suitable, and 44% less or

moderately suitable. The highly suitable and suitable area was further classified into two sub-categories indicating proper rearing method i.e. rack/raft culture for pearl oysters farming under which 12.6 km² (77%) to be found suitable for rack culture and 3.8 km² (23%) for raft culture. In this study, the parameters were considered mainly for (*P. fucata*) species but for the other species the same parameters can be used selecting different ranges, as per their body physiology. Meteorological parameters are not considered in the model, as it is homogenous through out the study area. The results of this study were confirmed by the fact that one pearl culture farm

already exist in those areas, which were classified as highly suitable for pearl farming. At this point it is apt to mention that further development of these areas must be done with caution. In general, GIS analysis shows that the major constraints are due to social restrictions. While from environmental point of view Minicoy lagoon has tremendous potential for mariculture activities particularly for marine pearl culture.

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