

## FM04

# Suitable Site Selection of Shrimp Farming in the Coastal Areas of Bangladesh using Remote Sensing Techniques (4 S Model)

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**Abstract** - Two sites in Bangladesh were selected for this study, viz. Cox's Bazar and Khulna-Satkhira. In the study various types of data have been used. It includes different satellite data, thematic maps, field-measured data and other relevant published information etc. Detailed and updated land-use maps have been generated for the two study sites. The whole work has been performed in six major parts. Using this model it is found that, Khulna- Satkhira area are more suitable than Cox's Bazar area for shrimp farming. Fishery resources have been successfully analyzed in the two study areas using GIS modeling of suitable site selection for shrimp farming. Tropical countries can use this model for allocating suitable site for shrimp farming by their Government for allocating shrimp farms in the coastal areas.

### INTRODUCTION

Bangladesh has a great potential for expansion of brackish water shrimp farming aquaculture as or posses a high international demand vis-à-vis a sources of foreign currency improvement of technology from the extensive/traditional pattern to semi-intensive patterns, availability of land area for further expansion etc. The total area of shrimp under production is estimated to be 528,390 ha and the total production is around 1005542 tons which is the 39.23% total production of the country (DFO-2008). Gradually shrimp production is increasing through horizontal expansion of the farming area, not by the desired vertical expansion. However, a limited area under shrimp culture has created some environmental problems, which may lead to ecological disasters, as well as socio-economic problems of greater magnitude if proper measures are not taken. Therefore, careful planning is necessary to develop an environment friendly integrated coastal aquaculture program as a sustainable technique, so that, coastal aquaculture would develop as a good source of animal protein for the growing population, a foreign currency earner and as well as maintainer of ecological balances in the brackish-water region.

There is therefore an urgent need for sustainable development of the coastal resources, both for aquaculture and agriculture. Monitoring of the changes and selection of suitable sustainable sites for aquaculture development is important in order to save the coastal ecosystems. This requires i) detailed survey and monitoring of the present situation, and, ii) exhaustive database creation, and, iii) modelling for sustainable development for brackish water aquaculture, agriculture, etc.

By using remote sensing technique and GIS, the advantage is not only in time and cost effectiveness but also in achieving a more comprehensive and integrated treatment of aquaculture development criteria, which is difficult through conventional techniques alone (Kapetsky

et al. 1987). Satellite remote sensing technique is being used as a tool to know location, extent and spatial and temporal changes of coastal fisheries; especially coastal shrimp farming area (Populas and Lanteri, 1991) Krishnamurthy et al. (1996) explained it for Tamilnadu Coast and Nayak et al. (1995) explained it for West Bengal and Gujarat coast. Shahid et al. (1996) explained it for Bangladesh coast. Considering this entire works, an attempt is therefore made here to use advanced remote sensing and GIS technique to identify suitable site for shrimp farming in the study areas of this project with much more accuracy and precision using latest technology. Studies have also been carried out at SPARRSO on various other aspects of coastal zone environment using remote sensing technique (Quader, 1986). Whole paper is about 14 pages and it is summarized into 4-6 Pages for this conference.

### OBJECTIVE

It is apart of the study on 'Coastal zone development and fishery environment analysis using remote sensing techniques' in Bangladesh which was implemented by the Bangladesh Space Research and Remote Sensing Organization (SPARRSO) and Space Applications Center (SAC) of Indian Space Research Organization (ISRO). This project is funded by UN/ESCAP and executed under UNDP Regional Cooperative Project on Integrated Application of GIS and Remote Sensing for Sustainable Natural Resources and Environmental Management (GIS-RSRP). The aim of this project is to develop space technology based suitable methodology using remote sensing and GIS for coastal zone development and fisheries environment analysis in Bangladesh. Two sites in Bangladesh were selected for the pilot study, viz. Cox's Bazar and Khulna-Satkhira. In the present study various types of data have been used. It includes different satellite data, thematic maps, field-measured data and other relevant published information etc. Coastal wetland and landform maps on 1:50,000 scale using SPOT and IRS-1C/1D LISS III satellite data for the two study areas have been prepared. Detailed and updated landuse maps have been generated for the two study sites.

### METHODOLOGY

The whole work has been performed in six major parts: *Construction of GIS based fisheries environmental database (GISFED)*: This step includes collection, compilation and digitization of spatial information from topo sheets, thematic maps, field and other sources. A simultaneous approach has been launched to update,

improve this information through the application of remote sensing techniques. As such, a significant portion of the project period has been devoted to device a suitable method to improve the quality of the extracted information from remotely sensed data. In this step, a data fusion technique based on IRS LISS and PAN data has been devised. The merged product obtained through such technique provides improved boundary delineation of coastal landforms. Both macro-structured and micro-structured features are well distinguishable in the merged product. In addition, a classification scheme based on merged IRS LISS and PAN product has been developed for the two study sites. Ultimately, a GIS database has been created. It includes point, line and polygon features for the two study sites. *Selection, adaptation and test of GIS based Suitable Shrimp Farming Site Selection Model (shortly, 4S model):* A number of existing models have been investigated. The suitable one has been identified and taken as our reference model due to its applicability to an area similar to that of the present sites situated in Bangladesh. The implementation strategies for this model have been devised in the present context and data availability. *Practical Implementation of 4S Model:* This part of the work includes the steps as defined in the strategy just mentioned above. The suitability layers have been generated from the individual parameters of the GISFED. The scale of representative of each parameter has been taken into consideration. Arrangements have been made to combine each of these parameter based suitability layers in a GIS environment. Finally, they are combined according to the relation as defined in the 4S Model and thereby; a suitability category is obtained for each of the considered points over the study sites. *Application of the shrimp suitability model and analysis of model generated out put:* This part includes the application of the 4S Model for the shrimp farming area suitability analysis over the two study sites using the parameter based suitability layers. The model-generated outputs are then analyzed in respect of site condition. In addition, an evaluation of the present status of the existing shrimp farm area has been made with respect to model-generated outputs. *Socioeconomic characterization of the study sites and analysis of the trend of shrimp culture development:* This part of the work deals with the socioeconomic study of the two study sites with analysis on the present trend of expansion of shrimp cultivation over the study areas. Various socioeconomic data have been used for a considerably long time period. *Analysis of environmental impacts of shrimp culture expansion and risk due to climatic events:* Shrimp farming has certain impacts on the environmental condition of the study area. Some of these effects have been studied with measured field data. The issues related to cyclonic storm surge and climate change have also been taken into consideration. GPS-based field works have been carried out extensively over the two study sites in support of the satellite-derived information for their correction and validation. The infrastructure information is also been updated by such survey. In addition, the model-derived outputs are verified in some specific points over the study sites.

The suitable shrimp farming site selection model (4S Model) has been executed in a GIS environment to analyze the suitability of the two study sites. Such an operation results in maps of two study sites indicating the suitability values. A significant variation is observed in different places over the study sites. A total of 24 parameters have been considered in the calculation of suitability of the area.

## RESULTS

The results from the application of the model are comprehensive for some specific recommendations regarding the present state of the shrimp farming, as well as, its future extension. Wide variation of suitability exists in both the Khulna-Sathkhira (77.8% - 54.3%) and Cox's Bazar (67.9% - 45.1%) study areas. Considering the percentage of weightage, Khulna-Sathkhira area is more suitable for shrimp farming than Cox's Bazar area. Within the attained suitability classes, majorities of the Khulna-Sathkhira areas are placed to the highly suitable categories, whereas, Cox's Bazar areas are placed to the moderately suitable categories. These findings are in good agreement with the present performance of shrimp productivity in the two study sites. The average productions of *P. monodon* have been reported to be about 129 kg/ha in the Cox's Bazar, about 132kg/ha in Sathkhira and 192kg/ha in Khulna districts (this figure is much higher than that for the Cox's Bazar district) in 1997. Total suitable areas in Cox's Bazar and Khulna-Sathkhira study areas are 29,020 hectares and 1,29,452 hectares respectively. These areas included existing shrimp area, as well as, other land use classes considered for evaluation of suitability of shrimp farming. However, in both the study areas, high potential of extension of shrimp farming exists. Considering the higher suitability classes, 9,495 hectares in Cox's Bazar area and 53,612 hectares in Khulna-Sathkhira area can be extended for shrimp farming.

## CONCLUSION

The study reveals that, recent expansion of shrimp farm areas caused depletion of forest cover over the Chakoria-Sunderbans areas and associates certain losses of biodiversity of both fish and forest species. It is also evident that, the rapid expansion and intensification of shrimp culture over the two study sites associate a gradual decrease in agricultural productivity that may be due to increased salinity causing low productivity and transformation of agricultural land into shrimp farm. The present way of intensification of shrimp farm areas also associates certain socioeconomic and environmental problems over the study sites. The study provides evidences of increase of salinity level over the shrimp farm adjacent areas. Considering certain difficulties from the point of view ecological, environmental and socioeconomic, some specific recommendations have been made for future expansion of shrimp farming and subsequent development of coastal zone. The work carried out under the project ultimately fulfilled the main objectives of the project. Firstly, technique-based capacity has been built in data generation and GIS

modeling. Secondly, comprehensive GIS databases have been created for the two study areas and finally, fishery resources have been successfully analyzed in the two study areas using GIS modeling of suitable site selection for shrimp farming. Tropical countries can use this model for allocating suitable site for shrimp farming by their Government for allocating shrimp farms in the coastal areas.

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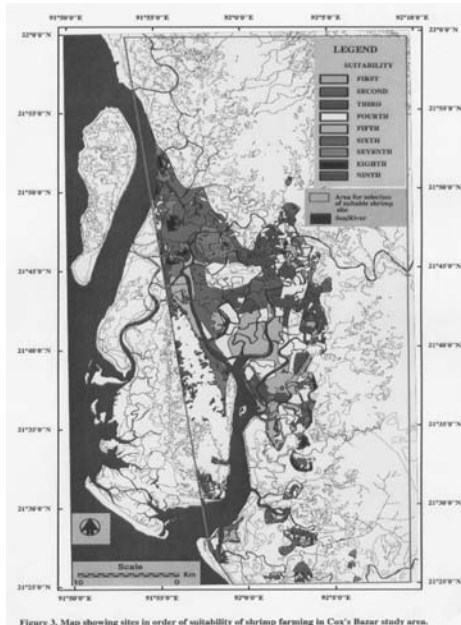


Figure 3. Map showing sites in order of suitability of shrimp farming in Cox's Bazar study area.

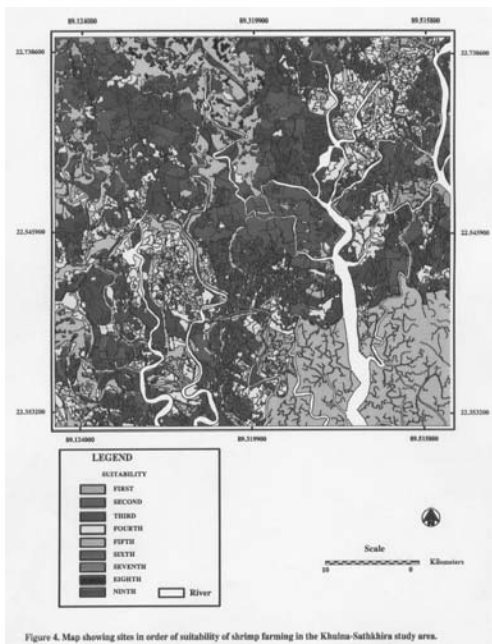


Figure 4. Map showing sites in order of suitability of shrimp farming in the Khulna-Sathkhira study area.

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