Studies on the present status and future potential of molluscs, dry fish and crab in Bangladesh coast: A GIS methodological perspective

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Executive Summary

The present status and future potential of molluscs, dry fish and crab in Bangladesh coast was carried out during June-December, 2005 using PRA and GIS techniques with a view to improve the livelihood of coastal communities in Bangladesh coast. Different PRA tools namely questionnaire interview, focus group discussion (FGD), market visit and case studies have been employed in the coastal areas of Cox's Bazar, Chittagong, Khulna, Satkhira and Bagherhat. Field observation and consultation with the stakeholders were undertaken in consultation with the related BFRF researchers for assessing the present status and marketing channel with value addition of shrimp, crab, mollusc and dry fish.

The study identified different land use types in the coastal region viz. mangrove, molluscs, crab and dry fish area, landings and river transportation systems. Molluks of commercial importance were clam, green mussel, oyster, cockle, karotal, laza, kostura, kata shamuk and kori. The mollusc shells were found to be used for different purposes like making poultry and fish feed, lime, ornament, paint etc. Rakhain and some other tribes of the coast were found to harvest green mussel, clam and oyster for their household consumption. In addition, mollusc meat was used in the coastal shrimp and prawn hatcheries as feed for mother shrimp/prawn. Most of the crab and crab seeds were collected from the coastal rivers, canals and mangroves. Harvesters were found to sell the collected crabs to the near by deport where they are sorted and sent to Dhaka for export. On the other hand, rejected male and female crabs were hardened and fatten by the coastal landless and poor to the marketable size for their livelihood. People from different districts were found to set tent at remote islands like Dubla island in the Sundarbans, Sonadia island, Kutubdia island, St. Martin island and its near by islands for a few months to dry fish to earn their bread.

Visual interpretation and unsupervised land use classification was performed on ASTER image which produced adequate results for the present study. In most of the cases, the spectral categories as defined by the CLUSTER module, correspond fairly with the information classes. However, mangrove separated well than the other land use classes in unsupervised land use classification. Among the parallelepiped and maximum likelihood supervised land use classification strategy, maximum likelihood classification was found to be the most useful tool for discriminating various land classes, although some misclassification of pixels were observed in the fringe of land and water and bare land and urban land use.

During site selection for molluscs, crab and dry fish a number of factors were carefully analyzed. GIS modelling discriminated the most suitable place for molluscs in southern part and moderately suitable in western part in the coastal region considering water and road transport system, market facilities, water transparency and salinity gradients. The out comes of crab modelling dominated in the western and southern part in the coast might be due to good transport system, presence of mangrove forest and more salinity gradients in the region. Analyzing all the factors like water and road transport system, market facilities and presence of alternative preservation system, the most suitable sites for dry fish were the most remote places where only water transport is available and

alternative preservation system was absent. The highest weight was applied to transportation facilities follows by market, salinity and transparency during modelling face.

Background of the Research

The geographical position and climatic condition of Bangladesh have made her coastal areas one of the highly productive areas of the world (Islam, 2003). One of the unique features of the coastal areas of Bangladesh is the influence of the mangrove forests, which support a high number of fishes and other commercially important aquatic organisms. The coastal and marine fisheries have been playing considerable roles not only in the social and economic development of the country but also in the regional ecological balance.

About 20 million people live in the coastal region of Bangladesh; some are from the poorest and most marginalized groups in the country, 20 percent of them directly depend on the coastal and marine resources for their livelihood. They live exclusively on fishing, either as boat owners or as labourers, and in the processing and marketing of aquatic products. The market for several of these products are promising, but the people involved early in the production chain, in fishing, primary processing and local trading, add little value and therefore can make a little profit. The low returns experienced by these groups are partly related to poor product quality and partly to lack of bargaining power in the marketing networks.

About 700 tons of oyster are being collected from the Sundarbans in Satkhira region but all of them are dump to spoil the meat and only the shells only are sold to the *Aratders* (deport owners) for making poultry meal (Salam and Hasan, 2004; and Wahab and Amin, 2004)). Moreover, quite a few families from Patuakhali, Barguna and Bagerhat districts were found to collect live clams and shells of clams from the Sundarbans and surrounding forests for lime making. None of them has used them as meat for household consumption or as poultry/fish feed. On the other hand, the Rakhain community harvests oyster, green mussels and clams for their household consumption and sold the shells to prepare poultry meal. Potential local markets have been identified for these molluscs by Ghose (2004) Prospective export markets also exist in Thailand, Cambodia and China where these species are commonly eaten.

A great variety of mollusc species are of commercial importance throughout the world. Apart from molluscs harvested from nature, a large number is cultured. Total world landings, both capture and culture has increased from 3,603,426 mt in 1980 to 4,524,929 mt in1986 with an average annual growth rate of about 3.95% (FAO, 1988). In the mollusc fishery sector the landings from aquaculture activities are high. Over 2.8 million metric tons of molluscs were cultured in 1985 which accounted for over 65.5% of the year's total production obviously indicating the importance of aquaculture activities with regard to this resource group.

Assessment of the present stock and potential sites for sustainable production is fundamental for planning for aquaculture expansion. Applying appropriate criteria, both environmental and socio-economic, can identify potential sites for various types of aquaculture developments. Earlier, site selection was aimed at ensuring economic profit and increasing production, but in the proposed study, environmental factors will be used to ensure sustainable development. Appropriate socio-

economic factors will ensure the profitability of the industry, while environmental factors will maximise production and prevent adverse impacts on the environment (Jarayabhand, 1997). Apart from aquaculture development, satellite imagery can be used to prepare an inventory and monitor the aquaculture activities, fishery resources like crab, molluscs and land parcel for drying fish (Kapetsky, 1989; Rao *et al.* 1998; and Shahid *et al*. 1992). Thus, used in the combination with other information in a GIS, satellite data can be a tool for aquaculture development as well as management.

Objectives of the Research

The main objectives of the study was to review the current socio-economic and livelihood situation of a range of coastal communities involved in exploitation, production, processing and marketing of molluscs and crab having potential for international trade.

Specific objectives

- To sketch the current socio-economic and livelihood situation of coastal communities.
- To portrait the present production and harvest level of molluscs, crab and fish drying and their sites.
- To do an inventory of present land use types in the coast using satellite image.
- To develop a database of the Bangladesh coast and find the best place to culture molluscs, crab and fish drying.

Materials and Methods

The study area

The study area is located in the southeast and southwest part of Bangaldesh from the mouth of the Naf river in the southeast, to the mouth of the Raimangal river in the southwest, and approximately one million ha of territorial waters extending 19 km seawards. (Fig. 1).

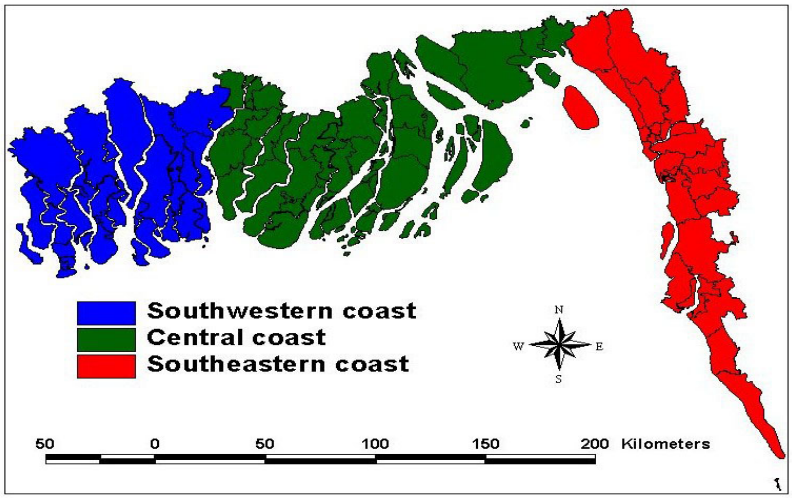

Fig. 1. The study area along the Bay of Bengal

Although one of the most densely populated countries of the world, it has abundant natural resources such as the Sundarbans, the world's largest single compact mangrove forest; an intricate network of rivers with rich fish habitats, a vast communications network and ample fertile lands to grow crops. An area of about 166,000 km^2 is now under the economic jurisdiction of the country for exploration, exploitation, conservation and management of its living and non-living resources. The area gets inundated by tidal water increases and due to increasing maritime influence, the salinity of river water also reaches a maximum during the post-monsoon season because of its characteristic south-western winds, high temperature and higher evaporation rates with occasional heavy thunderstorms. The monsoon brings high rainfall and cloudy cover resulting in rise in water levels and increased sediment loads in upper catchments areas. During the monsoon and post-monsoon season, the estuarine hydrology is characterized by a prolonged low-saline regime. A semi-diurnal tide is typical of the coastal waters. Very low or no tidal inundation resulting in a dry, exposed period is characteristic of the winter season. As a result the area is endowed with a vast area of marine, brackish and inland waters having great fisheries potential

Materials used

The research team was composed of three remote sensing and GIS expert cum coastal resource management specialist, and aquaculturist. A marketing expert, a fisheries expert, a sociologist and a conservation biologist were regularly consulted during the research work. The thematic maps were generated using topographic maps at 1:10,000 scales, published by the Survey of Bangladesh, and land type maps at 1:50,000 scales, published by the Soil Resources Development Institute (SRDI). These and other relevant spatial data were collected from various government departments. ASTER satellite images of February 2004 were applied in this study. The topographic maps, satellite data and land use maps were used to develop various thematic maps. The image processor ENVI was used for data analysis. Arc View GIS software was also used to digitize the maps. The attribute tables were simultaneously created from the analysis.

Satellite image interpretation

The ASTER satellite images of the study area were analyzed to identify the geographical features. The images were first spatially geo-rectified selecting 225 Ground Control Points (GCPs) from the UTM map projection, using a first order polynomial and then re-sampled with bilinear algorithm. All the selected GCP's were easily identifiable and permanent in nature for measuring accurate results. Then, map to image registration was used to create image data covering the whole area. All the data such as satellite images, topographic maps and other ancillary data were used for digital image processing and visual interpretation. Digital image processing was applied for two purposes: firstly to enhance image quality and extract more information through image enhancement functions; and secondly, to classify images to separate different resource base, which were combined with other data sources, for example visual interpretation for creating final thematic maps.

ISODATA unsupervised classification was performed considering the minimum and the maximum classes of 5-10, 10-15 and 15-20, where 10-15 classes turned out to be useful. Subsequently, principal component analyses (PCA) were carried out on the raw data but the approach did not prove to be useful. Supervised classifications were carried out on the basis of region of interest (ROIs), where the ground truth or so-called training areas (collected during field investigation) were regions of terrain with known properties or characteristics. Parallelepiped and maximum likelihood classification strategy were applied after Lillesand and Kiefer (2000). Maximum likelihood classification was found to be most useful tool for discriminating classes.

Ground truthing

The acquisition of field data is required to be supplement and verified with the features from digital image processing and visual interpretation of ASTER satellite images to compare the actual conditions. After finishing the image processing, the reference points in the study area were chosen for ground verification. The reference points were surveyed for collecting data and comparing the preliminary map to the real world. A preliminary map of the different natural resources were thus corrected and revised. The resource map was finalized by using Arc View GIS software.

Data collection method

Participatory approach

Participatory appraisal involves a series of qualitative multidisciplinary approaches to learning about local-level conditions and local peoples' perspectives. Rapid Participatory Rural Appraisal was carried out using field observations and community level group meetings with different stakeholder groups from July to December 2005 to gather primary information. Prior information was sent to the stakeholders through the community leaders to introduce and to explain the objectives of the research to them. Observations were recorded through transects across the area defined by using maps and satellite images. Photographs were taken as evidence of certain facts before interpretation. To produce useable outputs, observations were recorded as drawings and notes. Stakeholder selection and analysis were required to find out the appropriate groups for collecting information and to reveal the relationship between their activities. A checklist of topics was used to aid the memory.

Target people

Molluscs, crab harvester/collector and fish dryers

Harvesters were those who were involved in collecting different types of molluscs and crabs from sea water and tributaries in the coastal waters and mangroves. The function of the harvester was to procure supplies and display them in forms, and at times convenient for consumers and businessmen. Most of mollusc collectors were found to collect molluscs in traditional method i.e. by hand and sometimes they collected those by diving in the water. On the other hand, crab collectors used bamboo made traps, hooks and baited net traps to catch the crab.

Wholesalers

Wholesalers were the professional traders. They usually bought molluscs, crab and dry fish from the collectors/harvestors/dryers to sell in the wholesale market. They got profit margin through buying and selling.

Consumers

Consumers were those who used Mollusc, crab and dry fish as food like soup, curry, etc as a delicacy. They bought them from the bazars, collectors or harvesters.

Lime producer

Line producer were those who used to produce lime from mollusc shells. They collected shells of molluscs from the wholesalers.

Feed processors

Feed processors were those who were found to produce fish, shrimp and poultry feed by crushing mollusc shells in crushing mills and mixed it with dry fishes.

Ornament makers

The ornament makers were those who were found to be involved in making different types of ornaments, bangle, showpieces etc from the shells of molluscs to earn their bread.

Spatial manipulation of factors

In order to prepare data for spatial modelling, depending on the origin of the data, the primary data layers could be manipulated in different ways: Spatial evaluation in IDRISI environment, all the factors needed must be scored positively with respect to suitability, meaning appropriateness according to predetermined conditions and requirements or circumstances. This is a common term in decision-making or allocation situations where tracts of land are to be allocated according to their suitability for one or more purposes. Suitability for a purpose was determined by whether or not certain criteria are met by the piece of land under consideration. The results of such assessment were presented in the form of a suitability map.

Criteria selected for molluscs, crab and dry fish suitability modelling

The selection of factors involved in a GIS modeling is very important since they are the basis of the evaluation of potential sites for fish culture in the area. These factors are sometimes called production function (Kapetsky, 1989). These criteria are of two kinds: factors and constraints, factors are also known as decision variables or structural variables. On the other hand, a constraint serves to limit the alternatives under consideration. In most cases constraints are expressed in the form of a Boolean map, for example areas excluded (water bodies, settlement, roads etc.) from consideration being coded with 0 and those open as consideration with 1 (Table 1).

Table 1 Criteria selected for molluscs, crab and dry fish modelling

Criteria	Criteria for molluscs, crab and dry fish modelling
Water transport	Molluscs culture sites
Road transport	
Market for molluscs	
Water transparency	
Salinity gradients	
Water transport	Crab culture sites
Road transport	
Market for molluscs	
Salinity gradients	
Water transport	Fish Drying sites
Alternative preservation facilities	
Road transport	
Marketing facilities	

Transportation facilities

Transportation facilities are important criteria for the development of mollusc and crab aquaculture and fish drying in any particular area. In the present study, the major transportation facilities were considered to be:

- Highways, all weather motorable roads and railways
- Available rivers for water transportation

Road networks

Roads required to transport products to processor and markets and to receive the goods and supplies necessary for culture and fish drying operation. Proximities are important in two ways: site development costs and culture operation costs. Close proximity to a road or river or landing center indicates that transportation costs will be less than for a more distant site. Likewise, close proximity to a facility for processing and marketing aquaculture products, to a large town or to a feed mill mean that transport costs will be less than from a distant place. For this study, highways, railways and all weather motorable roads were considered. The classification procedure undertaken in this study is shown in Table 2 and road and water transport systems are shown in Figs. 2 and 3.

Table 2 Classification scheme for different factors for crab and mollusk aquaculture and fish drying

Criteria	Very suitable	Moderately suitable	Marginally suitable	Currently unsuitable
For crab culture	Land, water and air transport	Land, water	Water or land	Far from water or land
	Near landing station	Landing station far	landing station very far	Absence
	Fattening sites present	-	-	Fattening sites absent
For mollusc culture	Water salinity 28-32 in dry season	Water salinity 18-22 in dry season	Water salinity 12 in dry season	Water salinity <12 in dry season
	Water salinity 20-22 in wet season	Water salinity 10-12 in wet season	Water salinity 8 in wet season	Water salinity <8 in wet season
	Transparency >50	Transparency 30-40	Transparency 25-30	Transparency <25
Fish drying	Land, water and air transport	Land, water	Water or land	Far from Water or land
	Near deport	deport far	deport very far	Absence
	Alternative preservation absent	-	Alternative preservation present	-

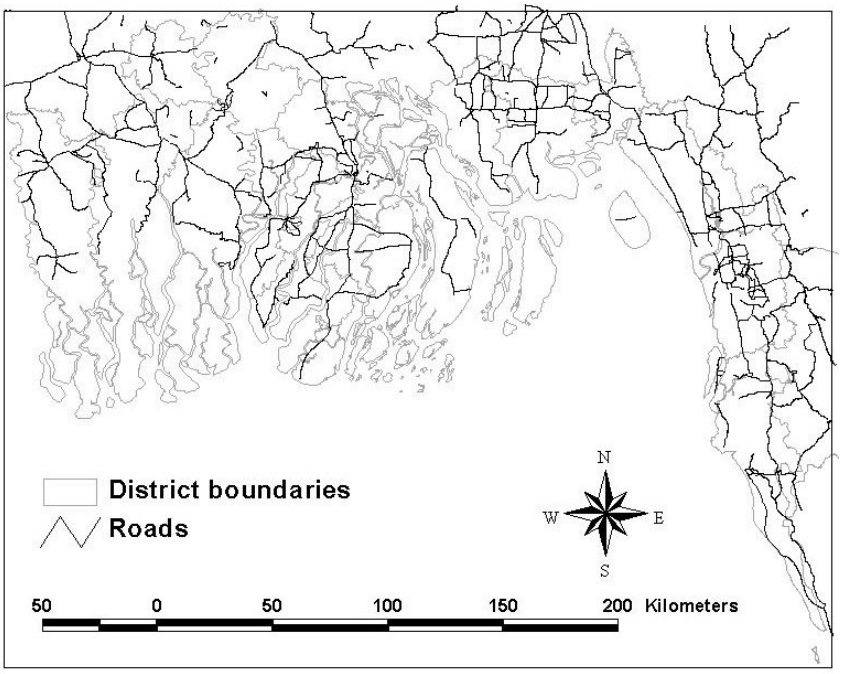

Fig. 2. Road transport system in coastal region of Bangladesh.

Relative importance of criteria

In order to determine potential sites for molluscs and crab aquaculture and fish drying sites development in the study area, several criteria were developed. After criteria development, it was necessary to establish the relative importance of the criteria (Table 3).

Table 3 Relative importance factors for crab and mollusc aquaculture and fish drying activities

Criteria	Very suitable	Moderately suitable	Marginally suitable	Currently unsuitable
For crab culture	Total weight >139	Total weight 120-139	Total weight >66	Total weight <66
For molluscs culture	Total weight >139	Total weight 120-139	Total weight >66	Total weight <66
Fish drying	Total weight >135	Total weight 120-131	Total weight >66	Total weight <66

After calculating the factors weight, they were combined in the form of a weighted linear combination in ArcView GIS environment. The basis of this calculation is shown in the following equation.

Suitability (S) = $\sum (W_i X_i)$

Where, S = Suitability, W_i = Weight of factor i, and X_i = Criterion score of factor i.

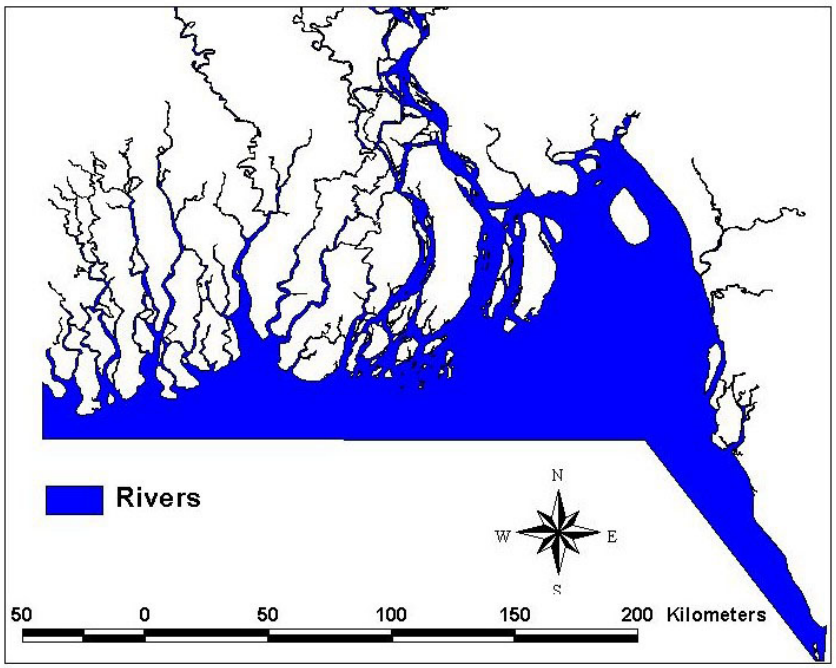

Fig. 3. Water transport systems in Bangladesh coast.

Results and Discussion

Present status of molluscs in Bangladesh coast

A total of 30 mollusc species were found during the present study, of which 24 species were very common. Among the available species, 6 species viz. green mussel, clams, oyster, laza and dant jhinuk were consumed by the coastal Rakhain people. The usages of different molluscs are given in Table 4 and Fig. 4 shows the location of molluscs availability in Bangladesh coast.

Some minority communities in the coastal belt of Bangladesh were found to choose mollussc collection as their main profession like Rakahain in Cox's Bazar and Rajbanshi in Satkhira, while numerous coastal communities earn their livelihood from the mollusc sector. In addition, around one thousand households in Cox's Bazar coast mainly Muslims were found to be involved in ornament making and related business. In Chandkhali, Khulna, Sarankhola and Bagerhat, around 100 families were found involved in lime making from mollusc shells.

Around 10,000 households both tribal and non-tribal living in the coastal belt from Satkhira to Teknaf were found to be involved in mollusc marketing chain either as collectors or wholesalers, ornament makers, meat suppliers for human consumption and for the shrimp hatcheries, lime makers, shell suppliers to the coastal districts and distant places for the preparation poultry and fish feed and paint.

Table 4 Major uses of different mollusc species by the coastal people

Name of the species	Human consumption and meat used in shrimp gher	Shell use in fish, shrimp and poultry feed	Shell for lime preparation	Shell as Ornament and home decoration
Green mussel	√	√	√	
Oyster	√	√	√	
Clam	√	√	√	
Taltela jhinuk	√	√	√	
Laza	√	√	√	
Dant jhinuk	√	√	√	√
Kortal				√
Kata shamuk				√
Ful Kori				√
Angti kori				√
Bang Kori				√
Kala kori				√
Boro Lal Shamuk				√
Bhua Shamuk				√
Kalo buk chira shamuk				√

Name of the species	Human consumption and meat used in shrimp gher	Shell use in fish, shrimp and poultry feed	Shell for lime preparation	Shell as Ornament and home decoration
Sada net				√
Taj jhinuk				√
Bhuttar dana				√
Sabuj Shamuk			√	√
Jinjira Jhinuk				√
Mutra Laza			√	√
Kura			√	√
Lal boro laza			√	√
Sada kori				√

Note: After Hossain and Faruk, BFRF funded molluscs research Project

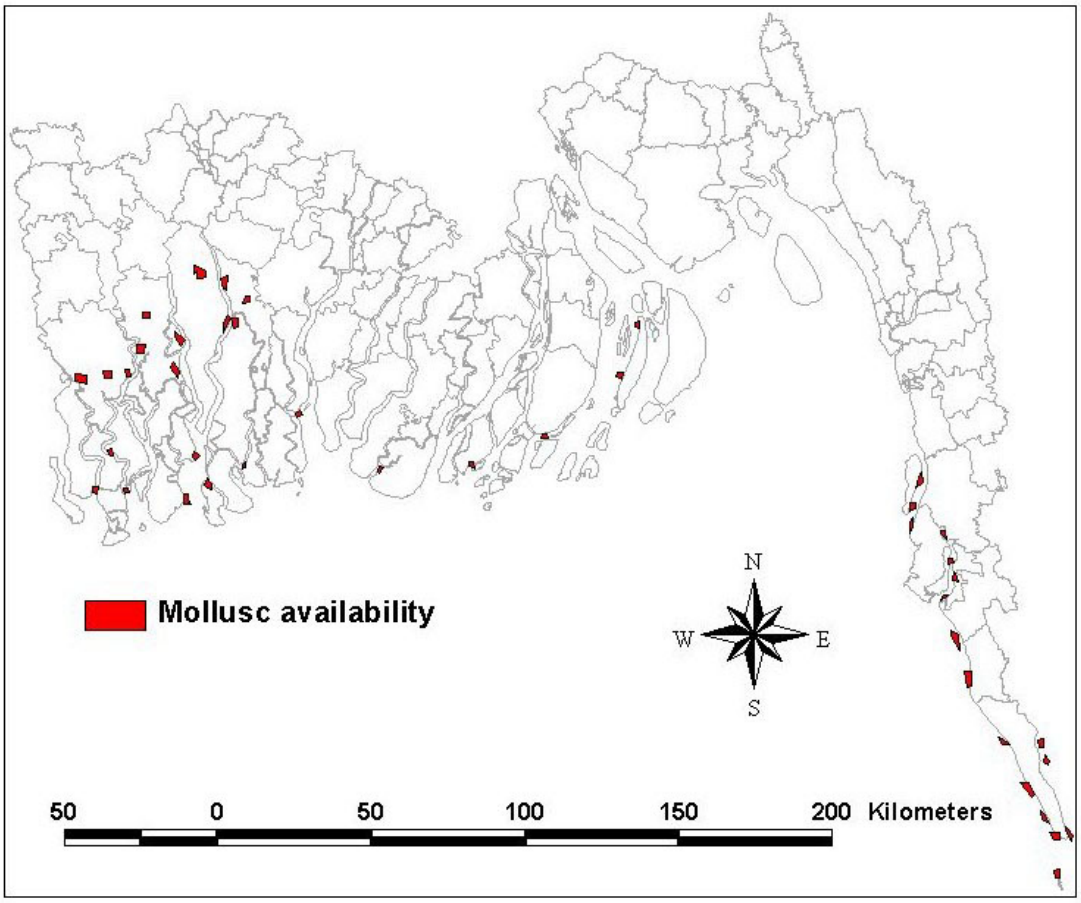

Fig. 4. Mollusc available areas in the Bangladesh coast Satkhira to Teknaf.

Present status of crab in Bangladesh Coast

As many as 50 species of crabs have so far been recorded from the coastal and marine habitats of the Bay of Bengal (Quader, 1994) of which 11 are purely marine. Only three species, namely *Scylla serrata* (mud crab or mangrove crab), *Portunus pelagicus*, and *P. sanguinolentus* are reported to be commercially important (Quddus and Shafi, 1983; Sarker, 1993; and Quader, 1994). The mud crab, *Scylla serrata* is abundantly available and is reported to be suitable for coastal aquaculture. The seeds of this species are also available throughout the coastal belt (Kamal, 2000). However, no report is available on the standing stock of the crab resources. Fig. 5 shows the crab available areas in the Bangladesh coast.

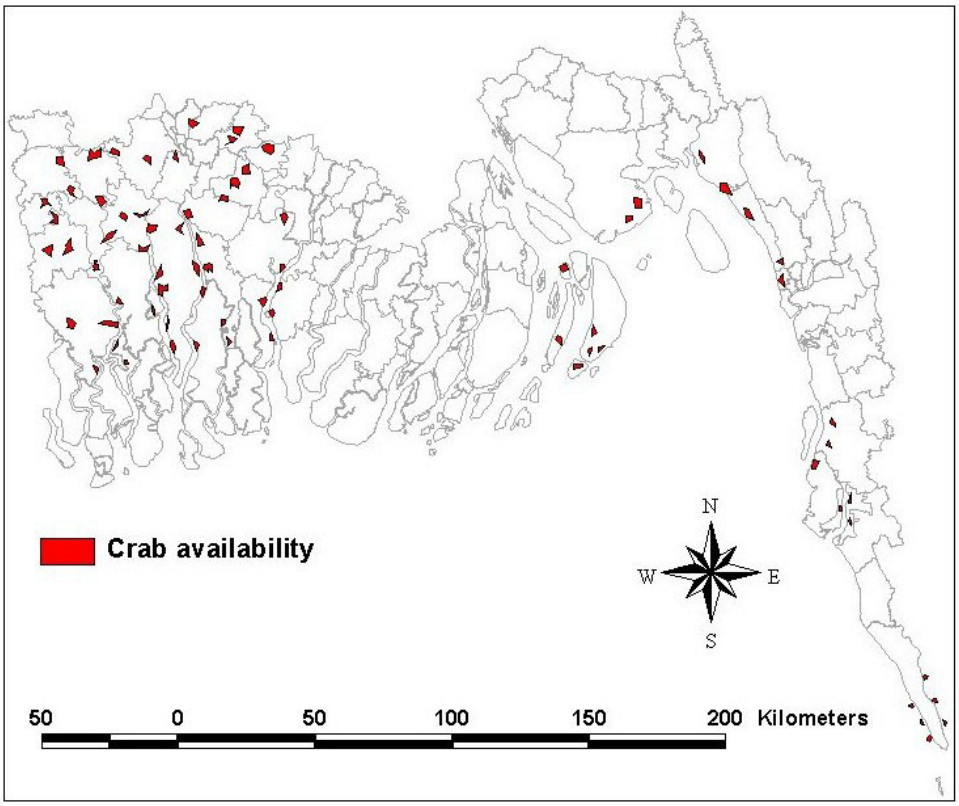

Fig. 5. Crab available areas in the Bangladesh coast.

Present status of dry fish in Bangladesh coast

Thousands of people were found to be engaged in fish dry activities in the coastal belt of Bangladesh. Most of the people engaged in fish drying were migrated labour from different near by districts as well as from northern part of the country. The main fish drying activities were observed in Dubla island in the Sunderbans and its near by islands.

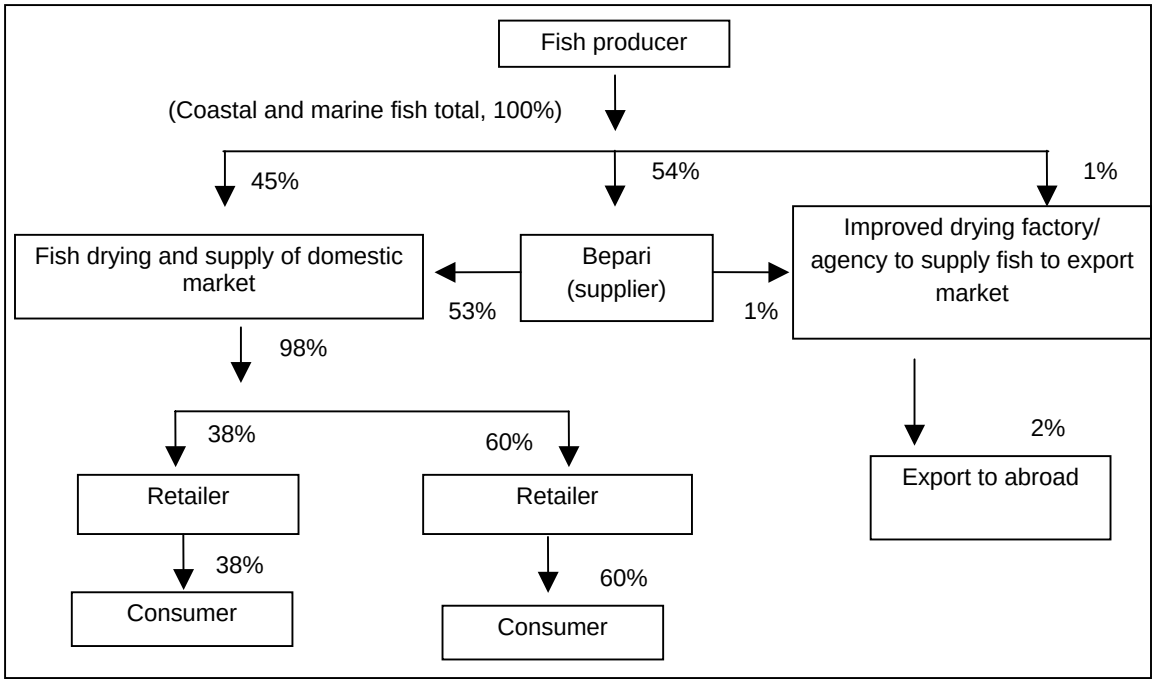

Fig. 6. Domestic market and export marketing chain of dry fish (After Islam's BFRF funded molluscs research Project).

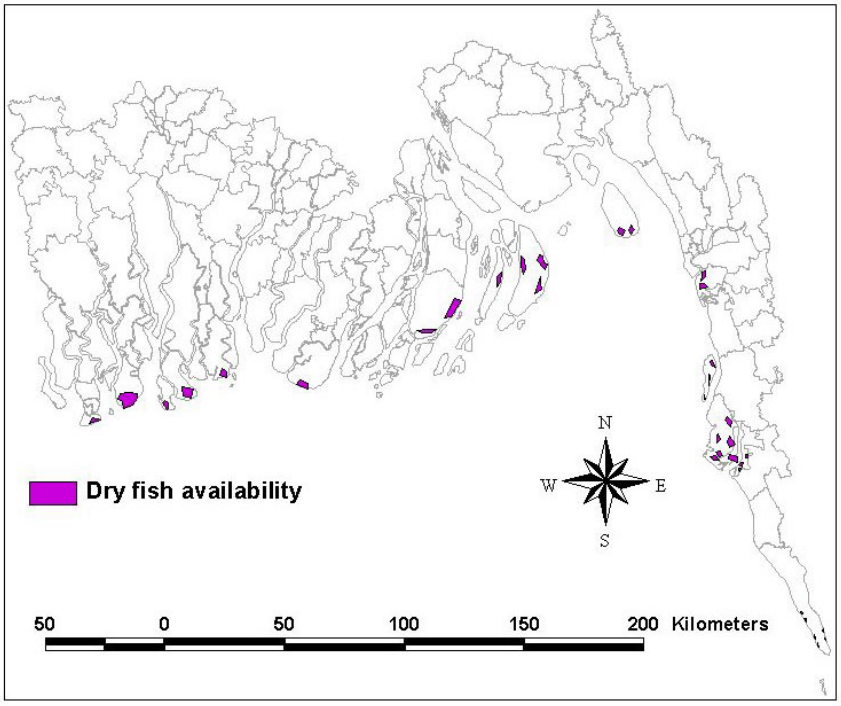

Fig. 7. Exhibits the location of fish drying areas in the Bangladesh coast.

On the other hand, Chittagong was the largest wholesale market for dry fish business. Few highly sophisticated export oriented geo-fish drying industries were found in Nuniarchar and in Cox's Bazar. Chewa fish drying was mainly found in Hatya, Noakhali which was reported to be an important raw material for fish feed and poultry feed industries. St.Martin's Island, Kutubdia Island, Moheshkhali Island, Swandip island, Sonadia Island etc. are famous for fish drying activities in the coastal belt of Bangladesh. Seven point three million coastal fishing villagers were reported to be dependent on fishing for their livelihoods. Twenty percent of total marine catch was reported to be dried round the year. These marine dried products were marketed both in the domestic and in the international markets. Figs. 6 and 7 shows the marketing chain and fish drying areas in the Bangladesh coast.

Outcome of unsupervised and supervised land use classification

Visual interpretation and unsupervised land use classification was performed using the CLUSTER module on ASTER image. The minimum and the maximum classes of 5-10, 10-15 and 15-20, were used where 10-15 classes turned out to be useful. The technique produced adequate results for the purposes of the study. Most of the cases, the spectral categories as defined by the CLUSTER module, correspond fairly with the information classes. In land unsupervised classification, mangrove separated better than the other land use classes.

Supervised land use classification was applied as for coastal land use. Parallelepiped and maximum likelihood classification strategy were applied for supervised land use classification (Lillesand and Kiefer, 2000). Among the techniques maximum likelihood classification was found to be the most useful for discriminating various land classes. However, the image exhibited systematic misclassification of pixels where land met water and bare land pixels misclassified with the urban (Figs. 8 and 9).

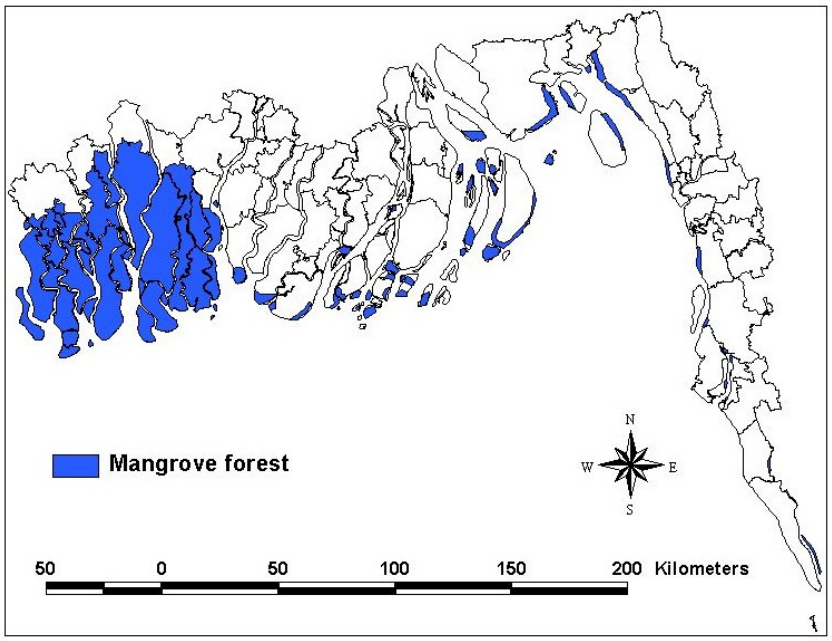

Fig. 8. Available mangrove forest identified from image classification.

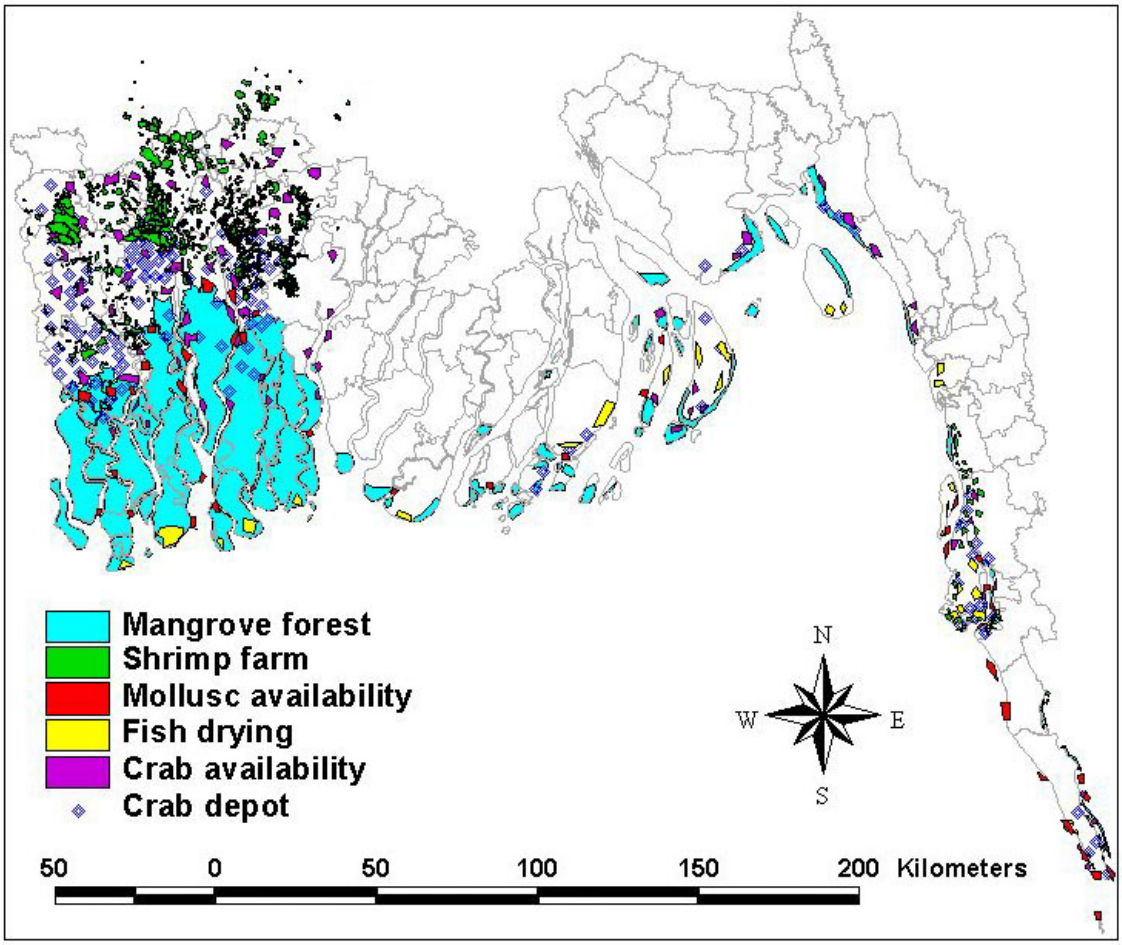

Fig. 9. Major coastal land use types identified through image classification.

Suitability modelling out comes for molluscs

Considering water and road transport, market facilities, water transparency and water salinity gradients, the most suitable place for molluscs was mainly found to be in the coastal region of the southern part while that of the western part was moderately suitable due to high water transparency, presence of mangrove forest and more salinity gradients. On the other hand, middle part of the coast is not suitable for molluscs culture due to high freshwater content, less salinity gradients and muddy substrates (Fig.10).

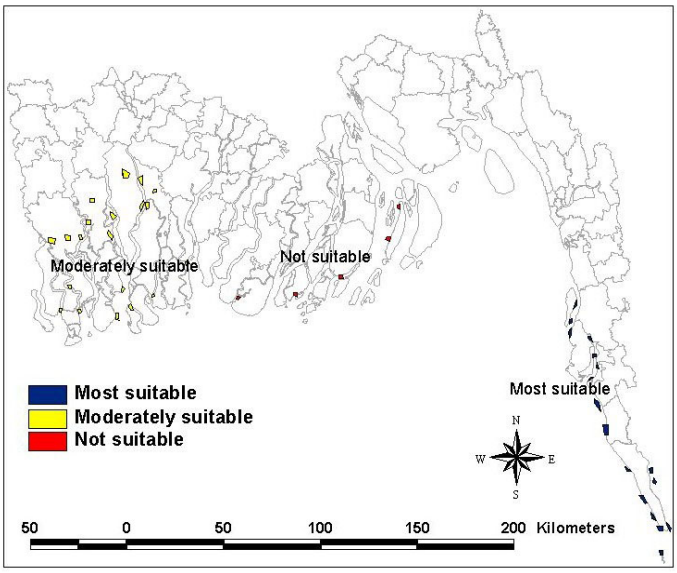

Fig.10. GIS out comes for suitable areas for molluscs in the Bangladesh coast

Modelling out comes for suitable areas for crab

Crab model included water and road transport, market facilities and salinity gradients. The highest weight was given to transportation facilities followed by market and salinity. The out comes were in favour of the western and southern part in the coast might be due to good transport system, presence of mangrove forest and more salinity gradients. In contrast, middle part of the coast was evaluated to be less suitable for crab culture due to less salinity gradients and lack of transport facilities and turbid water (Fig. 11).

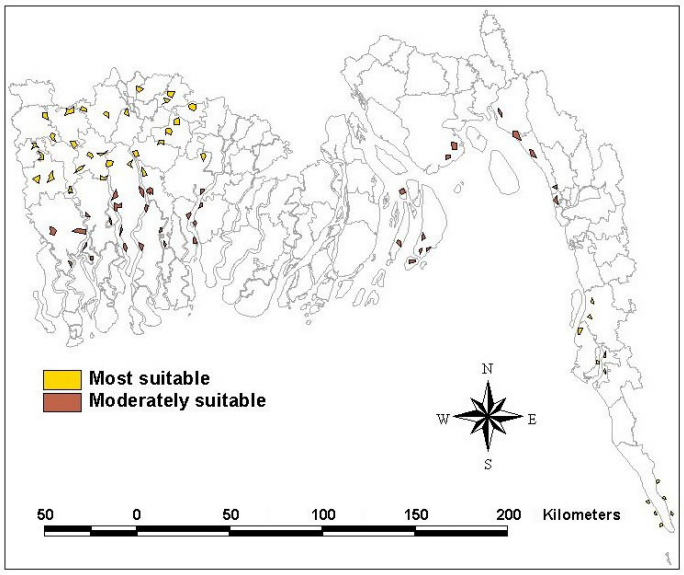

Fig. 11. GIS out comes for suitable areas for crab in the Bangladesh coast.

Modelling out comes for dry fish

Dry fish model included water and road transport, market facilities and presence of alternative preservation systems. Analyzing all these factors the most suitable sites for dry fish production were the remotest places where only water transport was available and alternative preservation system was absent (Fig. 12). The reason behind this type of out come was that the artisanal fishermen could not travel far distances to market their catch and were compelled to sell their catch to the near by islands for drying or they themselves landed the catch in the near by islands and dried the same and store for sell.

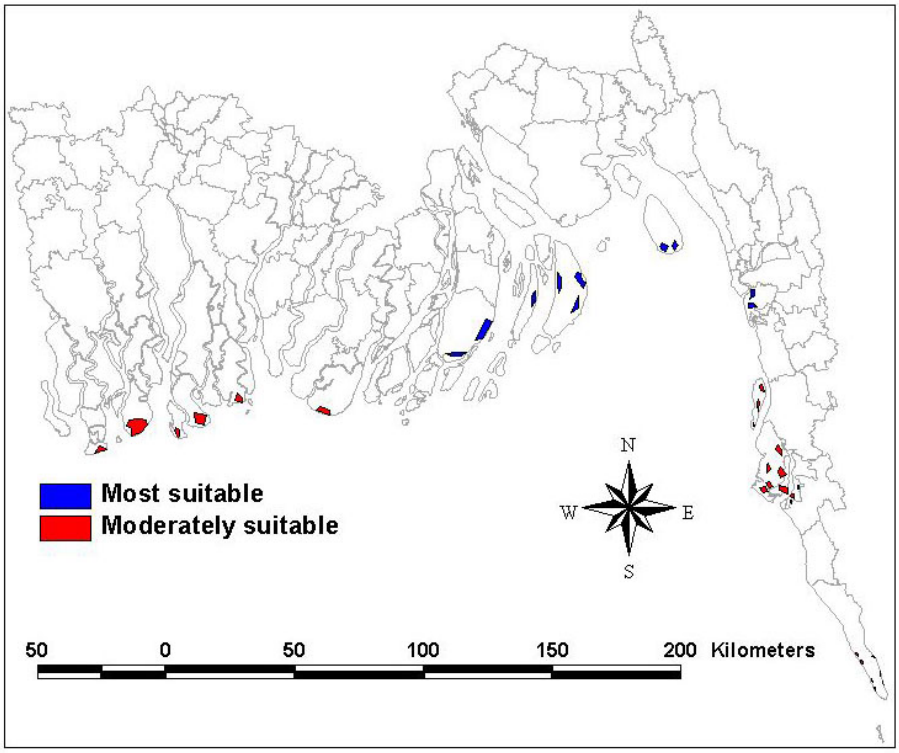

Fig. 12. GIS out comes for dry fish production areas in the Bangladesh coast.

General Discussion

The major constraints in the development of coastal aquaculture for molluscs and crab are lack of domestic market and processing plant (Pollnac, 1992). Moreover, conflicts that arise from land and water uses for various activities also hindered the activities. Aquaculture has been involved in land-use conflict issues in several parts of the tropics, particularly in highly urbanized and overcrowded areas (Beveridge and Philips, 1993). The Bangladesh National Conservation Strategy has identified six important areas of conflicting land use in coastal areas as a) agriculture vs. shrimp and capture fisheries; b) forest land vs. shrimp and capture fisheries; c) agriculture vs. livestock; d) agriculture vs. settlements; e) agriculture vs. brickfields; and f)

agriculture vs. newly accreted char lands. Another problem is lack of appropriate data for modelling the Bangladesh coast. Moreover, unplanned disposal of wastes, oil spillage, and industrial effluents damaging the aquatic environment, such as destroying the breeding ground, feeding ground, substrates and obstructing fish migration. Cropping on fragile char lands before it stabilized causes rapid erosion in the coastal land. Flood control and drainage structures have altered the land and water use patterns, and led to the decline of fish stocks and production by more than 25% in recent years.

Fish drying has more prospect than the other two components. Dry fish has a constant domestic market. The by-catch or a bulk catch in the sea is difficult to transport into the landing centre for fresh consumption. However, the only alternative is to dry them up in hygienic condition without adding harmful chemicals. These dry fish has a good export market as well in Europe, America and other Asian countries.

Cost-benefit analysis of a particular bivalve culture system (eg. bottom, raft, long-line, etc.) should also be considered when a given culture site is selected. Culturists interested in commercially growing oysters, as the selected bivalve species, will be confronted with the initial capital investment required to set up the operation. The various culture systems which may be set up to culture the oysters, require different levels of investments depending on the complexity of the system itself. The materials necessary to construct an oyster raft or long-line unit are numerous and certainly more capital intensive if compared to the materials required to establish a pole culture plot. Potential culturists with adequate financial resources may well consider to invest in a more capital intensive system such as the long-line method. If the financial needs do not pose any major problem, the investor will direct his efforts in selecting sites suitable for establishing long-line facilities, therefore, excluding all other sites unsuitable for this culture method.

Site selection for any sea farming/ coastal aquaculture system is a process by which a number of factors should be carefully analyzed prior to the investment itself. The factors can be arbitrarily divided into two groups: primary and secondary. The factors which are of prime importance are all those biological and ecological factors which will determine whether a particular species will adequately grow in a given site, while secondary factors concentrate on the socio-economic feasibility of the proposed enterprise. The suitability of a site for a particular marine organism will be dependent on the right balance and satisfaction of all major primary and secondary factors.

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