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Assessment Of Impact On Aquaculture Using Remote Sensing Data And GIS In Tiruchendur

T.Subramani[1], K.K.Venkatachala Moorthy[2], S.Priyanka[3]

[1]Professor & Dean, Department of Civil Engineering, VMKV Engineering College, Vinayaka Missions University, Salem, India

[2]PG Student Of Irrigation, Water Management & Resources Engineering, Department of Civil Engineering, VMKV Engg. College, Vinayaka Missions University, Salem, India

[3]UG Student, , Department of Civil Engineering, VMKV Engineering College, Vinayaka Missions University, Salem, India

Abstract
GIS and remote-sensing provides better options for managing resources and enhancing the productivity.Our study is carried out to access the optimum Aqua farming or Aquaculture sites in Tiruchendur area.Using the different essential parameters for selecting sites provides the optimum sites in the project area that will help Aqua farmers and results in overall progress in Business. The project review the current state of the science with respect to remote sensing applications for aquaculture, including site location, aquaculture facility mapping, market proximity analysis and associated roadway infrastructure, epizootic mitigation, meteorological event and flood early warning, environmental pollution monitoring, and aquatic ecosystem impact, primarily for catfish and tilapia, inter alia. The potential of technology transfer from the controlled environment at Tiruchendur in tirunelveli district. The potential for multi-sensor remote sensing deployment to support sustainable fish production in these environments and subsequently in other Tiruchendur area is evaluated.

Keywords: Assessment, Impact, Aquaculture, Remote Sensing, GIS, Tiruchendur.

1.INTRODUCTION
GIS and Remote-Sensing is such a technology that caters the solutions systematically and gives optimum solution scientifically considering time, quality and risk factors. The increasing population requires much food today to sustain. Hence Aquaculture will provide add on to the increasing food demand. Aquaculture means the farming of aquatic organisms like fish, aquatic plants etc. It includes cultivation of fresh and salt water populations under controlled conditions. Mostly the aquaculture producers also farms ornamental fish for the aquarium trade, and growing plant species used in a range of food, pharmaceutical, nutritional, and biotechnology products. Aqua farming or Aquaculture has a potential to create huge job opportunities, and food. There are mainly two types of aquaculture i.e. Marine aquaculture and Fresh water aquaculture. Marine aquaculture includes farming of species especially lives in the ocean while Fresh water aquaculture includes farming of species which is found in rivers, channels, lakes especially on land water bodies or man-made aquaculture structures. GIS and Remote-Sensing technology will give the proper solution for the site suitability for aquaculture. It includes the parameters containing road network, rivers, channels, streams etc. Aquaculture depends upon the market availability for selling fish and other essential conditions for survival of aquatic organisms. The analysis of the proper site will result in better productivity and also good for business. India is a large producer of inland fish, ranking next only to Japan.

1.1 Aquaculture In Tuticorin
Fish has always been an important part of the diet ofIndians; but until recently, fish has been largely harvested from the wild. This has been encouraged by expansions of NGO developmental activities in aquaculture, improved aquaculture production technologies, recognition of over exploitation of natural fisheries, decline in natural and environmental resources, and increased nutritional requirements of rapidly growing populations. These factors combine to make aquaculture an economically attractive agricultural production alternative in Tuticorin. Aquaculture provides economic opportunities, which include contribution to food security and poverty alleviation through employment and income generation.

1.2 Remote Sensing
Remote Sensing (RS) refers to the branch of science which derives information about objects from measurements made from a distance i.e. without actually coming into contact with them. Conventionally remote sensing deals with the use of light i.e. electromagnetic radiation as the medium of interaction. RS refers to the identification of earth features by detecting the characteristics electromagnetic radiation that is reflected by the earth surface. Every object reflects a portion of electromagnetic radiation incident on it depending upon its physical properties. In addition, objects also emit electromagnetic radiation depending upon their temperature & emmisivity. Reflectance pattern at different wave lengths for each object is different. Such a set of characteristics is known as spectral signature of the object. This unables identification & discrimination of objects. Visual perception of objects is the best example of remote sensing.

1.3 Stages In Remote Sensing

- Requirement of an energy source (Sun is the main source of energy during day time.)
- Energy interaction with the atmosphere
- Interaction with the target
- Recording of energy by sensor
- Data transmission & processing
- Image processing & analysis
- Application

1.4 Geographical Information System (GIS)

GIS may be defined as the integration of computer hard & software with spatially referred digital data so that storage, retrieval, manipulation, analysis and display all forms of geographically referenced information.GIS is a computer assisted system that can input, store, retrieve, analyse & display geographically referenced information useful for decision making.

- The definition of GIS is not that important but it must encompass
- Data & concepts concepts concerned with spatial distribution (Geographical).
- Notion of conveying data, ideas or analysis (Information).
- Sequence of inputs, processes & outputs (System).

1.5 Objective Of The Study

- To establish a trend in water quality changes along the River using GIS approach
- To create a database of water quality parameters at specific points along the Volta for depicting trends
- To facilitate future updates to the database.

2.METHODOLOGY

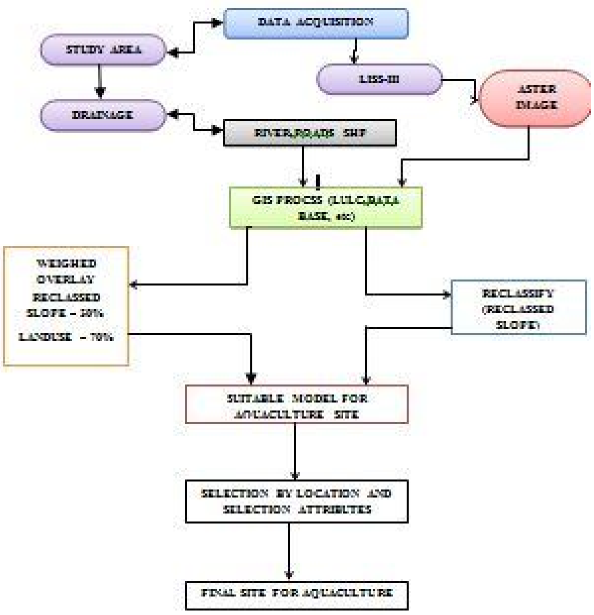

Figure 1: Methodology

Methodology adopted in this study shown in Figure.1

3.STUDY AREA

Tamil Nadu has a coast length of 1076 km 13 coastal districts. Tuticorin is located in the south east coast of Gulf of Mannar. The coast of Tuticorin is part of Gulf of Mannar Biosphere Reserve, is situated in between the latitude of 8°45'36"N and 9°02'31" N and the longitude of.78°07'17" E and 78°19'18" E. Figure. 1 shows Location map of the Study Area.

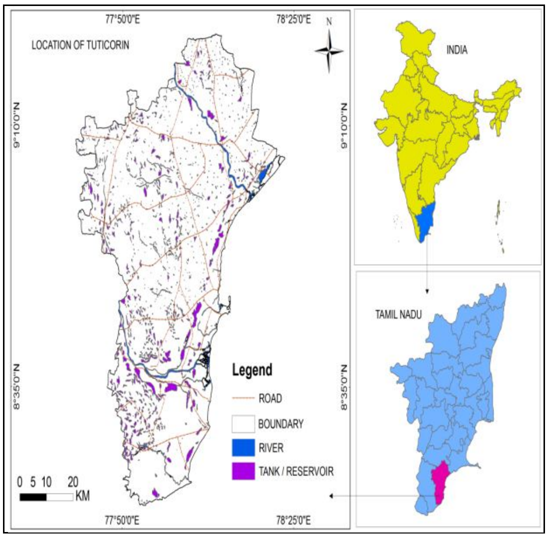

Figure 1: Location map of the Study Area

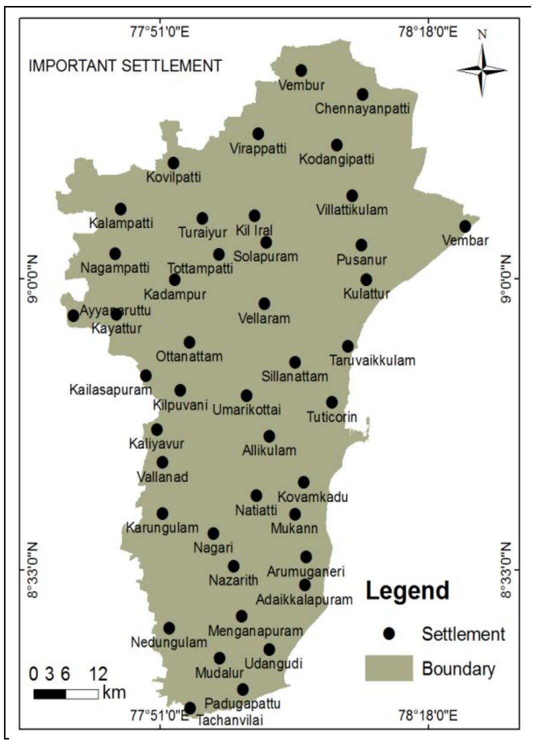

Figure 2: Layout Map with Sample Station Location in Tuticorin District

This geographical area runs from the mouth of Vembar to Manappad. The area is endowed with a combination of ecosystem including mangroves, sand dune, scrub, riparian ecosystem etc.The study areacovers geographical area of 154 sq.km. Thewatershed is drained by a stream network oriented in the NW–SE direction and is of ephemeral in nature. The topographic elevation varies from 26.22 m amsl to a few meters amsl near Tuticorin town and slopes from west to east. The slope is gentle in the western and the central part and nearly flat in the eastern part of the watershed. The area receives rainfall during the northeast monsoon season, which is active during the months of October–December. The long-term average annual rainfall of Tuticorin town is 568 mm (IMD data). The land is utilized for cultivation of cotton, maize and some medicinal plants. Some of the land is fallow and some barren with vegetation such as thorny shrubs with a thin cover of dry grass and palms. Figure 2 shows Layout Map with Sample Station Location in Tuticorin District.

Table 1 Water Quality Parameters For The Study Area

Sample Collection	Latitude	Longitude	ph	Ec	Tds	Mg	Ca	Hco_3	Cl
Pudukottai	8.752	77.844	8.5	11000	9568	2405.2	497	146	19273
Thoothukudi	8.798	78.12	7.6	1265	1346	89	120	179	569
Kurukusalai	8.928	78.096	7.1	450	312	24.3	68	207	89
Kadambur	8.992	77.853	7.3	230	196	22	46	146	56
Ettayapuram	9.153	77.986	8.5	3563	4562	189	332	656	5698

Table.1 shows the Water Quality Parameters For The Study Area.

3.1 Geology And Hydrology

About 90 % of the study area is made up ofsedimentary rocks of Tertiary to Recent age comprising of Shell limestone and Sand, Tuffaceous Kankar, Sand (Aeolian deposits) etc., and the remaining area is covered by mixed and composite Genesis of Proterozoic age of crystalline rocks. The general Tuticorin district stratigraphic succession is presented below. The Archaean groups of formations are crystalline and metamorphic, and finely foliated with a general NW– SE trend described by Balasubramanaian et al. (1993). The area is covered with black soils in the western part (Sankarapari area), red soil (sandy loam to sandy soil) in the central part and alluvial Sandy soils (Coastal area) in the eastern part. The maximum soil thickness is about 3 m. The sandy soils originated from sandstones and these have low soil moisture retentivity. The alluvium soils are windblown sands and shells constitute beach sand and coastal dunes, which have very low soil moisture retentivity. The important aquifer systems in the district are constituted by i) unconsolidated & semi consolidated formations and ii) weathered and fractured crystalline rocks. The porous formations in the district include sandstones and clays of Recent to subrecent (Quaternary) and Tertiary age. The Recent formations comprising mainly sands, clays and gravels are confined to major drainage courses in the district.

Table 2 Geology of the Study Area

PERIOD	FORMATION	LITHOLOGY
Quaternary	Alluvium Colluvium	Red soil, Coastal sand Clay, River Alluvium, Laterite, Red Teri Kankar, Tuffaceous Kankar, Shell limestone,Calcareous Sandstone
Tertiary	Panamparai Sandstone	Hard, compact, Calcareous sandstone, Shell Limestone
Proterozoic	Crystalline complex	Charnockite, Mixed and c.omposite Genesis Peliticgneiss Calc-granulite, Quartzite

The maximum thickness of alluvium is 45.0 m bgl, whereas the average thickness is about 25.0 m. Ground water occurs under water table and confined conditions in these formations and is being developed by means of dug wells and filter points.The productive zones are encountered in the depth range of 29.5 to 62 m bgl. Alluvium, which forms a good aquifer system along the Vaippar and Gundar river bed which is one of the major sources of water supply to the villages.

3.2 Integration Of Spatial And Attribute Database

The groundwater samples were collected from wells and tested for physico-chemical parameters are compared with the permissible limits. The major water quality parameters of the samples were analyzed. The layout map with sample station location in Tuticorin district is shown in Figure. The base map of the Tuticorin district is derived from the thematic map collected from Institute of Remote Sensing, Anna University on 1:50,000 scale. The base map was geo referenced and digitized by using MapInfo software and exported to Arc View software for spatial analysis. Spatial interpolation technique through Inverse Distance Weighted (IDW) approach has been used in the present study to delineate the distribution of water pollutants. This method uses a defined or selected set of sample points for estimating the output grid cell value.

3.3 Vegetation

Satellite remote sensing techniques with reasonably high spatial and temporal resolution could be used as potential tools for monitoring changes in different vegetation types in features on spatial and temporal The change in vegetation structure is brought about by a number of factors biotic and a biotic resulting in characteristic response of its surroundings a biotic environment, which includes physical factors such as temperature, light, soil, topography etc. Studies on the varied biotic factors in relation to biodiversity and their ecological relationship with each other help in the systematic assessment of the status of vegetation. During the field survey the ground control points of the vegetation types and other land cover classes were collected using GPS. The images were classified digitally manually using visual interpretation keys such as colour, tone, texture, pattern, size and shape. A thematic map of vegetation types and land cover was generated for the two corresponding images. The classes for vegetation types are mangroves, scrub jungles, sand dune vegetation, riparian vegetation, Teri vegetation, and open vegetation. Ground truth analysis was performed to assess the accuracy of the map prepared and the corrections were carried out to produce the final output maps. Change deduction analysis was performed on the corresponding images to assess the changes in vegetation type.

4. AQUACULTURE

Aquaculture, also known as **aquafarming**, is the farming of fish, crustaceans, molluscs, aquatic plants, algae, and other aquatic organisms. Aquaculture involves cultivating freshwater and saltwater populations under controlled conditions, and can be contrasted with commercial fishing, which is the harvesting of wild fish. Mariculture refers to aquaculture practiced in marine environments and in underwater habitats. According to the FAO, aquaculture "Farming implies some form of intervention in the rearing process to enhance production, such as regular stocking, feeding, protection from predators, etc. Farming also implies individual or corporate ownership of the stock being cultivated." The reported output from global aquaculture operations in 2014 supplied over one half of the fish and shellfish that is directly consumed by humans; however, there are issues about the reliability of the reported figures.[6] Further, in current aquaculture practice, products from several pounds of wild fish are used to produce one pound of a piscivorous fish like salmon. Particular kinds of aquaculture include fish farming, shrimp farming, oyster farming, mariculture, algaculture (such as seaweed farming), and the cultivation of ornamental fish. Particular methods include aquaponics and integrated multi-trophic aquaculture, both of which integrate fish farming and plant farming.

5.ABOUT SOFTWARE

5.1 GIS

GIS is as a collection of computer hardware & software tools used to enter, edit, store, manipulate, and display spatial (geographically referenced) data (Hunter, 2012). RS is the art, science and technology of obtaining reliable information about physical objects and the environment, through the process of recording, measuring and interpreting imagery and digital representations of energy patterns derived from non from non-contact sensor systems (Colwell 1997).What GIS and RS does together, is that it takes data (facts without any meaning) and turns it into information (knowledge derived from data). It takes collected data from sensor systems (satellites, planes) and manipulates that data from people using various hardware and software technologies; the data does not become information though until it is applied to specific procedures. The eventual goal of using GIS/RS is to create information for specific problems in the aquaculture industry and to develop them into sustainable systems. The use of GIS has become of increased significance for environmental planning and assessment mainly because of the need to compare a great number of spatially related data, and because it can be used to couple these spatial data with their attributes and overlay them. Indicators include the types, breadth and numbers of spatial issues addressed, the numbers of spatial applications in aquaculture, the ecosystems at which or in which aquaculture spatial applications have been carried out, and the scales of the applications. The term "geographic information systems" may be identical or closely related to a number of other terms, such as "geographical information systems", "geospatial systems" and "geographical information science"; collectively, these terms may be thought of as forming part of "spatial science" or "geoscience" or "geotechnology". However, "GIS" as the acronym for geographic information systems successfully encapsulates what this technical paper is concerned with. There are many definitions of GIS and the precise definition may depend on who is giving it, the context in which it is being used, when the definition was made, and the degree of detail being provided. However, it is generally agreed that GIS are computer-based systems whose incorporated software are capable of using geo referenced data for a range of spatial analyses and outputs. "In short, GIS add value to spatial data.From this brief definition, it may be clear that GIS can be divided into a number of essential components:

People GIS cannot operate in isolation from the organizational context and there must be people to plan, implement and operate the system, as well as to make decisions based on the output.

Data For most GIS operatives, data have now become the most important element to GIS, a fact largely based on their high costs relative to other operating costs. Today, a vast array of data is available from varied and diffuse sources. The requisite data for any specific project must be carefully identified and acquired, and the quality of these data will determine the usefulness of the final GIS output.

Hardware A range of hardware exists for transforming data into digital formats, which must be stored, manipulated and processed by computers before output can be obtained via plotters, printers and screens.

Software GIS has the potential to utilize a range of software for carrying out
a variety of tasks, most of which provide the essential instructions and other linkages between the data and the hardware.

Procedures Analysis requires well-defined, consistent methods to produce accurate, reproducible results.

5.2 Remote Sensing

Remote Sensing (RS) refers to the branch of science which derives information about objects from measurements made from a distance i.e. without actually coming into contact with them. Conventionally remote sensing deals with the use of light i.e. electromagnetic radiation as the medium of interaction. RS refers to the identification of earth features by detecting the characteristics electromagnetic radiation that is reflected by the earth surface. Every object reflects a portion of electromagnetic radiation incident on it depending upon its physical properties. In addition, objects also emit electromagnetic radiation depending upon their temperature & emmisivity. Reflectance pattern at different wave lengths for each object is different. Such a set of characteristics is known as spectral signature of the object. This unables identification & discrimination of objects. Visual perception of objects is the best example of remote sensing.

5.2.1 Stages In Remote Sensing

- Requirement of an energy source (Sun is the main source of energy during day time)
- Energy interaction with the atmosphere
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- Recording of energy by sensor
- Data transmission & processing
- Image processing & analysis Application

6. AQUACULTURE MANAGEMENT

Any aquaculture system, management of cage culture to optimizing production at a minimum cost rests on the competency and experience of the farm operator or farm manager. He plays a vital role in ensuring the cultured fish grow at an expected rate through suitable regulatory measures on their feeding and stocking, minimizing losses due to diseases and predators, monitoring of environmental parameters and maintaining the efficiency of the technical facilities.

6.1 Biofouling

Almost all marine cages are faced with the serious problem of biofouling. In tropical waters, the rate of fouling is very much faster than in subtropical or temperate regions. The net walls as well as the firm structures such as the floats can be covered with biofoulers which serve as excellent habitats formed by the sedimentation of silt particles, for smaller organisms such as amphipods, shrimps, isopods, polychoates, etc. Such biofouling may eventually clog the mesh of the net walls, hence reducing the exchange of water. This may cause unnecessary stress on the cultured fish due to deprived oxygen and accumulated wastes. A fouled net may increase drag and attain heavy weight; in serious conditions this may result in the loss of the net and fish.The rate of fouling depends on the mesh size of the nets, temperature of the water and productivity of the site. Smaller mesh (0.64–1.27 cm) can be easily fouled within 7–14 days whilst large mesh (2.54–3.81 cm) is fouled in about 1–2 months (Cheah & Chua, 1979). In tropical waters, the net-cage has to be replaced at least once a month. In designing the cages, it is therefore important to take into consideration the rate of biofouling and the species composition.

6.2 Regulation Of Growth And Production

The growth and consequently the net-production can be regulated through proper management and manipulation of the operational functions such as stocking density and feeding. It is sometimes necessary to regulate fish growth in the cage so as to attain the desired size for the targeted seasons. It was shown in estuary grouper that at water temperature between 29–30°C and feeding to satiation daily, a fingerling of 15–16g will attain marketable size of 500g in about 7–8 months at stocking densities of 15 fish/m^3, 8–9 months at stocking densities of 30–60 fish/m^3 and 11–12 months at stocking densities of 90–120 fish/m^3.Optimal stocking rate varies with species, feeding, behavior and environmental characteristics. Sound management to regulate these characteristics will help to maximize production. In many studies, maximum production of fish was attained by optimal stocking rate.The optimal stocking rate in marine cages can be further increased through proper understanding of the behavior characteristics. Teng and Chua (1979) have shown that by providing artificial hides in the form of used car tires, the optimal stocking density of estuary grouper, Epinephelus salmoides, can be increased from 60 fish/m^3 to 156 fish/m^3 and the production of fish could be increased by 230% over that of the stocking rate without artificial hides.

6.3 Harvesting

Harvesting in a cage culture system is a simple process. For flexible cages the net can be lifted and the cultured fish collected by means of a simple scoop net. For rigid cages, the cage has to be lifted to facilitate harvesting. No sophisticated harvesting technology is required. In most marine cage culture practices, the harvested fish are kept alive such as yellowtail, breams, snappers and groupers and transported immediately to the markets or restaurants. Preservation and processing of cultured fish will be an essential part of the culture industry when aquaculture is further developed.

6.4 Transportation

Transportation of both fish fry and the harvested products is an important aspect of all aquaculture systems. Transportation of young fish or fry from the wild or hatcheries to the culture site could encounter severe mortality due to bad handling and packing techniques. In the transportation of fry, the fish are usually kept in oxygenated water in polythene bags and packed in paper boxes. For long duration, such packing technique may cause severe stress in the fish if the surrounding environmental conditions become unfavorable such as high temperature and excessive shaking. Sytrofoam boxes are now increasingly used for fry transportation in which the water temperature could be decreased and maintained low by ice.

6.5 Problems And Constraints

One of the main problems in marine cage culture is the uncertainties in seed supply. Many commercial farmings such as milkfish in Philippines, Taiwan and Indonesia, the yellowtail in Japan and groupers and sea perch in Malaysia, Thailand, Hong Kong and Singapore, are largely dependent on wild stocks for seed supply. However, the fish farmers are often confronted with shortage of seeds. Undoubtedly, it is essential to maintain a dependable source of seeds. Hatchery developments are only intensified recently and it is envisaged that not for another decade or so can fish seeds be easily available at a reasonable price. However, the advantage of controlled breeding and genetical selection and hybridization should receive increased interest in scientists and governments.

Marine cage culture is a high risk farming venture and in spite of scientific innovation, there is no way to control the onset of natural environmental hazards such as typhoons, monsoonal storms, hurricane, or the occurrence of red-tides. Marine cage culturists must be prepared to face such environmental hazards although a good farm operator will be able to avoid most of these through careful site selection and proper cage design to cope with the expected extreme environmental conditions.

6.6 Potential For Development

Although aquaculture is not new, marine cage culture systems are relatively new to many countries. The potential for development is large although the problems and constraints outlined above have yet to be resolved and overcome. Compared with many other aquaculture systems, marine cage culture has added an advantage in using the natural environment as the medium for fish growth. The continuous movement of water through the cage generated by tides or coastal currents ensure high productivity of the culture system provided the food supply is adequate. Although there are risks encountered in such culture systems, they can be minimized through careful site selection, skillful operation and management. The rapid development of such culture techniques in many countries of the world today since this method was successfully implemented in Japan in the early 60's clearly demonstrates its technical and economic potential as an effective aquaculture system for fish production.

Apart from the technical and economic significance, cage culture system can play an important sociological role in providing alternative employment to the inshore fishermen of many countries who are facing serious overfishing problems and low economic returns. Like the cage farmers in Cambodia, Vietnam and Indonesia who operate few cages on a family level , marine cages can be operated by small fish farmers in estuaries, lagoons, bays and protected coast. Although the initial capital input in marine cage culture is higher than fresh-water cages, the economic returns from marine cages are also higher. Many small cage farmers in Singapore, Hong Kong, Thailand and Malaysia have contributed significantly not only in fish production but also have generated employment. In Malaysia, cage culture is being developed at family, cooperative as well as company levels. With the subsidy from the government, many inshore fishermen in Malaysia are gradually turned into full-time small cage farmers operating few marine cages or part-time cage farmers using the surplus manpower from the family (children, wife, unemployed members) to maintain and manage the farm whilst the trash fish from the catch is converted into fish feeds. This family unit system of cage farming is being encouraged in Malaysia (Chua & Teng, 1978a). Whilst there is an increased activity in incorporating cage farming in improving the rural economy, the impact of cage farming on the socio-economics of the rural community has yet to be investigated.

7. ANALYSIS DATA

7.1 Satellite Data

The digital satellite images from Landsat – TM of 1987, IRS 1B - LISS II of 1994, IRS 1C - LISS III data of 1998 and IRS 1D - LISS III data were used to delineate and monitor changes in the spatial extent and distribution pattern of aquaculture farms. The details of date of acquisition, path and row are given The topographic map of 58 M/15 from Survey of India was used for the delineation of basic geographic features like rivers, reserve forest boundary, railway and road network, that serve as ground control points in georeferencing the satellite data. Figure. 3 shows Boundries Of Study Area

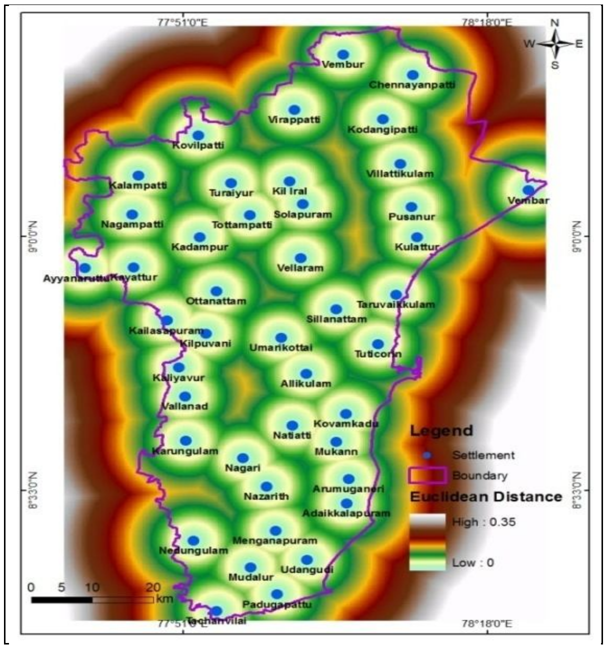

Figure. 3 Boundries Of Study Area

7.2 Georeferencing Satellite Images

The digital satellite images were geo referenced by co registering the selected ground control points (40 no.) that are identifiable both from the image as well as from the topographic maps at 1:50,000 scale. The projection applied was geographic latitude/longitude with spheroid and datum WGS 84. The georeferenced image was enhanced to produce a clear image using different.

7.2.1GIS Analysis

The visual interpretation approach has been used for extracting the land use information using image characteristic keys developed by Space Application Centre. Figure. 4 shows DEM Data.

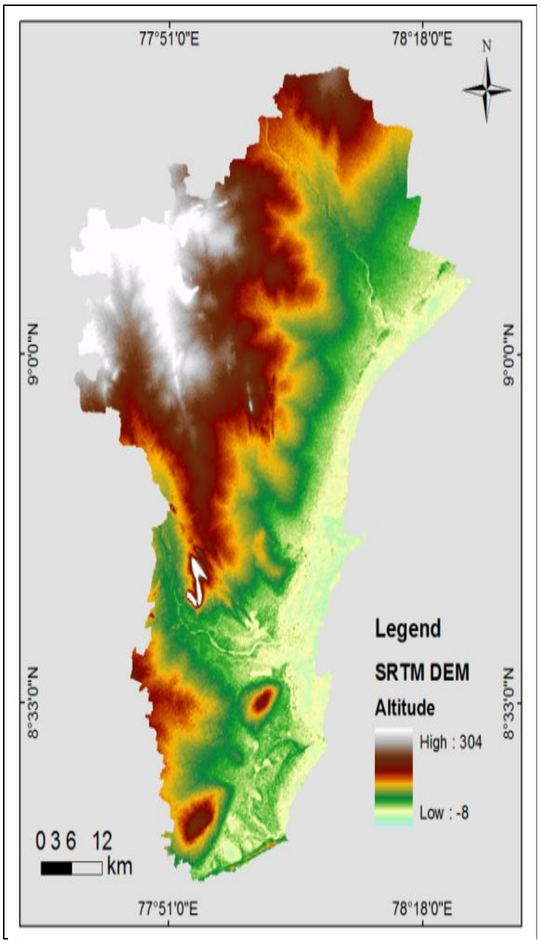

Figure. 4 DEM Data

As aquaculture farms were associated with other creeks and estuaries, to eliminate the classification errors by the supervised classification, manual digitisation was found appropriate to delineate aquaculture farms. Aquaculture ponds, agricultural fields, creeks, reserve forest boundaries and fallow lands were manually digitised using Arc GIS 9.0 and cleaned to remove nodes and dangles and also to get exact shape. Aquaculture farms with their associated features were mapped using Arc Map. The areal extent and spatial distribution for each dataset were estimated using 'Arc Map' attributes.

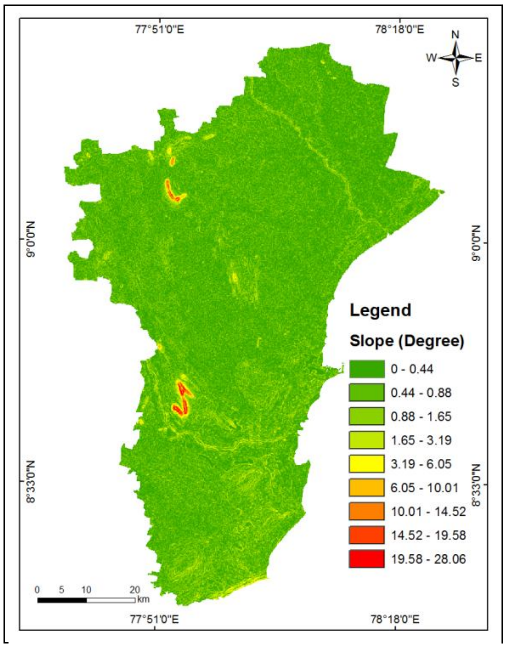

Figure. 5 Sloping Data

Figure. 5 shows Sloping Data and Figure. 6 shows Slope Aspect

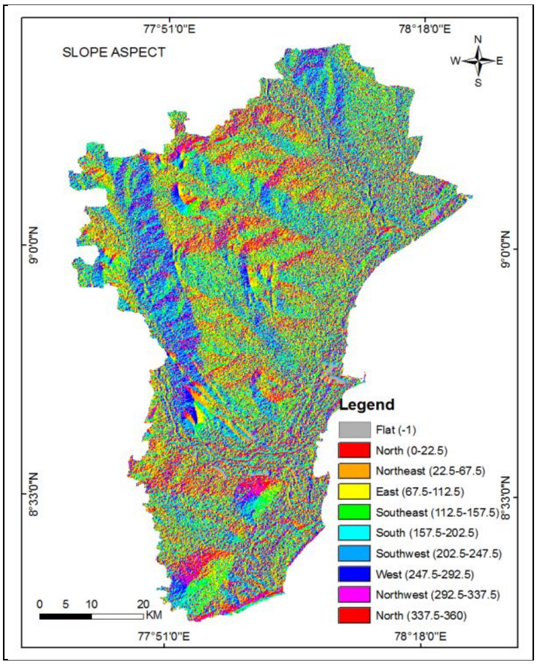

Figure. 6 Slope Aspect

Land use/Land Cover (LULC) defines landscape patterns. Land use is typically defined as human modifications land as agriculture land, infrastructural development etc. While land cover is natural like forest, hills etc. Land use is constrained by environmental factors like climate, topography, soil characteristics etc. Supervised classification is used in the study based on prior knowledge.

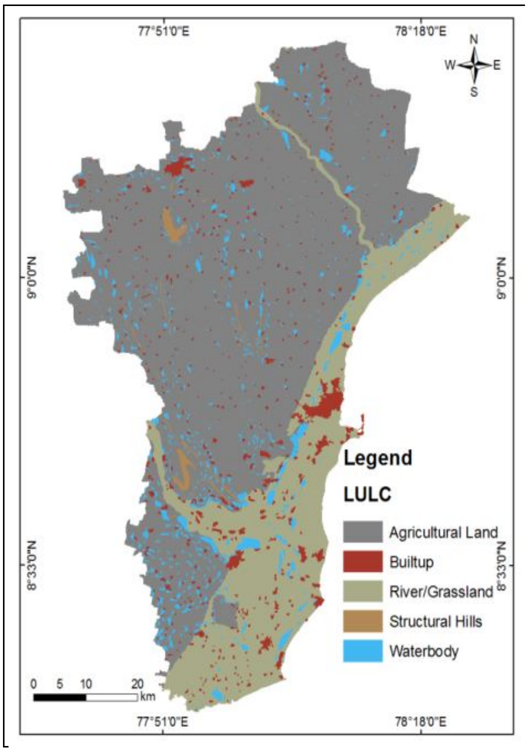

Figure. 7 Land Use And Land Cover.

Figure. 7 shows Land Use And Land Cover. Figure. 8 shows Land Classification. Figure 9 shows Land Classification Based On Slope Figure. 10 shows Aquaculture Suitability For Tuticorin.

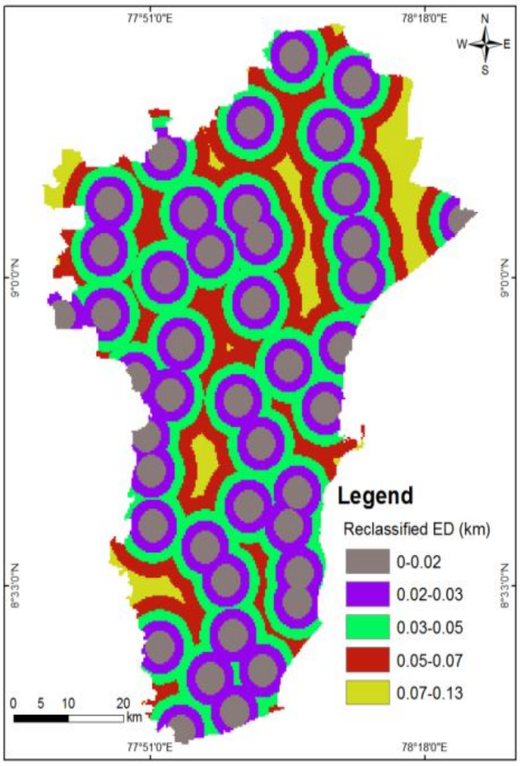

Figure. 8 Land Classification

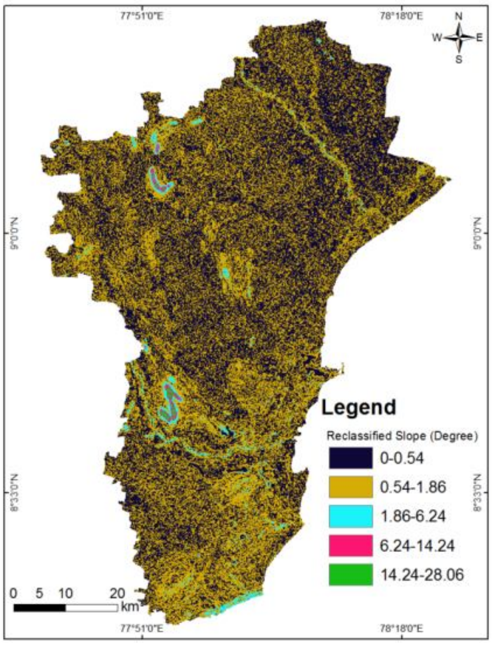

Figure 9 Land Classification Based On Slope

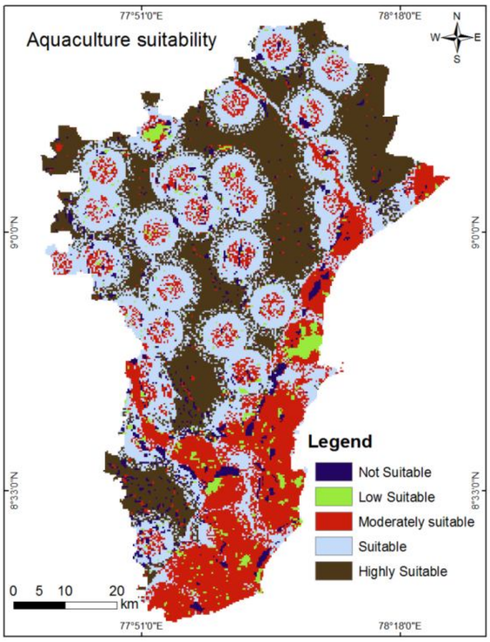

Figure. 10 Aquaculture Suitability For Tuticorin

8.CONCLUSION

Latest GIS and remote sensing technique allows users to integrate spatial as well as non-spatial information to model the current scenario of the study concerned. So, it is expected that during the aquaculture development process the near water body area is much suitable for the aquaculture result to optimum production in fish marked which helps farmers for net benefits. The present study also focuses on the different parameters for a suitable aquaculture site with the ease of routing patterns based on network analysis. If model will be implemented than it is sure that one can achieve good result in terms of production and market. As satellite images provide information on the spatial distribution of different land classes and their associated features, it is possible to develop comprehensive scientific database with accurate, up–to-date information on habitats, protected areas and carry out periodic assessment on the resource use pattern of coastal ecosystems. With the analytical capability of GIS, it is possible to quantify the utilisation of various resources with their availability for alternative developments.

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AUTHOR

Prof. Dr.T.Subramani Working as a Professor and Dean of Civil Engineering in VMKV Engineering College, Vinayaka Missions University, Salem, TamilNadu, India. Having more than 27 years of Teaching experience in Various Engineering Colleges. He is a Chartered Civil Engineer and Approved Valuer for many banks. Chairman and Member in Board of Studies of Civil Engineering branch. Question paper setter and Valuer for UG and PG Courses of Civil Engineering in number of Universities. Life Fellow in Institution of Engineers (India) and Institution of Valuers. Life member in number of Technical Societies and Educational bodies. Guided more than 400 students in UG projects and 300 students in PG projects. He is a reviewer for number of International Journals and published 174 International Journal Publications and presented more than 25 papers in International Conferences.

K.K.Venkatachalamoorthy received his BE Degree in the branch of civil Engineering in Kongu Engineering College, Perundurai in Anna University. Now, he is working as an Assistant Engineer in PWD WRD., Erode Currently he is doing his ME Degree in the branch of Irrigation water Management and Resources Engineering in the division of Civil Engineering in VMKV Engineering college, Salem.

S.Priyanka is persuing B.E. Degree in the branch of Civil Engineering in V.M.K.V. Engineering College , Vinayaka Missions University, Salem. She has illustrious career in her intermediate and matriculation exams, her hobby is cooking and surfing internet.