Selection and Monitoring of Aquaculture Farm Sites using Remote Sensing and Geographic Information System

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It is axiomatic that, land and water being the primary base for economic development, there has to be an account of these resources, so as to determine such of the areas as assessed to be amenable for fisheries development.

Commercial aquaculture has been attracting heavy investment in the recent past and its rapid growth has resulted in the conversion of important ecosystems and land utilized for other purposes into brackishwater aquaculture farms. Its fast growth has invited some of the environmental issues arising out of conversion of agricultural lands and mangroves into brackishwater farms, salinisation of agricultural lands and drinking water resources because of resulting adverse impacts of aquaculture on environment. Problems have arisen, not because of production technology problems, but because of a lack of understanding of the aquatic environment and the resultant use of unreliable means for resource assessment. Most of the places are inadequately mapped and our planners rarely incorporate current and accurate information on environmental factors in the planning process. Thus, it is necessary to accurately assess the land and water resources available before planning any related developmental activity.

In India, Public Interest Litigation was filed for formulating coastal management plans and for identifying coastal regulation areas to protect environment. Supreme court in its judgment delivered in December 1996 stated that shrimp culture industries should not be permitted in Coastal Regulation Zone (CRZ) as defined in CRZ notification and that the agricultural lands, salt pans, mangroves, wet lands and forest lands shall not be used for construction of aquaculture ponds. Identifying areas for aquaculture and monitoring existing aquaculture farms adhering to CRZ will be helpful for future planning and promoting sustainable environment. The conventional way of manual surveying and preparation of maps is costly, low in accuracy and presents a picture of only a small area. So, there is a necessity for an advanced technology to get the real time data on a repetitive basis.

Site selection, layout of the farm, water availability, species selected for aquaculture, culture method, operational procedures, production levels, skills, technology standards, legal status, economic viability and general conditions in overall management are some of the factors we have to take into account for sustainable aquaculture. Proper site selection for setting up aquafarms and monitoring them are important management measures, which can mitigate negative impacts. An earlier estimate identified about 1.2 million ha of coastal land as suitable for brackishwater aquaculture but this should be rechecked, based on the recommendations of Aquaculture Authority, Govt. of India. The availability of potential area needs to be reassessed and proper sites for brackishwater should be identified for sustainable shrimp farming. To monitor the coastal environment, remote sensing data have become an essential component as the aerial extent, type, condition and other parameters of land and water features can be studied effectively using remote sensing.

Remote sensing technology emerged as an efficient and powerful tool in providing reliable information on various natural resources of a region in spatial format. This is so essential because of its capability of synoptic viewing and repetitive coverage which provides useful information on land use dynamics (Sharma *et al.*, 1989). The data we receive from satellite are those recorded in selected wavelength bands depending on the variations in the amount of electro magnetic energy being reflected by objects on the surface of earth. Inspection of a satellite image reveals information on the colour, shape, tone, texture and pattern of different areas, which are in some way related to the underlying habitats. We can interpret the spatial features in the data based on aforesaid parameters. To identify the features of earth, Space Application Centre, Ahmedabad has developed image interpretation keys (SAC, 1992).

Image interpretation keys for the different integral entities like creek, agricultural land, wasteland, aquaculture farms etc. were fixed based on the tone, texture, pattern and its location. For example, Aquaculture sites will be in dark blue to light blue and in square or rectangle shape with smooth texture and with slightly rough pattern. Accuracy in interpretation of satellite data will be assessed based on the ground truth verification. Once the features are identified, the data can be processed using Geographic Information System (GIS). GIS provides a well structured approach to the analysis of geographic data important for any activity and can be used to spatially link and to conceptually integrate the complex data needed for aquaculture development, management and for monitoring aquaculture environment. Satellite data can be obtained from Space Application Center, Ahmedabad or National Remote Sensing Agency, Hyderabad on a payment basis by giving path and row, date of the pass of the satellite with latitude and longitude of the area.

Thematic Maps from Remote Sensing Data

Thematic maps are the maps prepared from the satellite data for various themes like land use, soil, slope etc. To prepare the thematic map, the base map is necessary as it gives the idea about land and water boundary, low and high tide line, location of coastal villages and major towns, transport network, important cultural features, major rivers, waterspread areas, reserve forest boundary and coastal bathymetry contours. The base map can be prepared from the Survey of India toposheets received from Soil Survey and Land Use Organization. This serves as the basis for the preparation of thematic maps. The various wetland categories like beach, mudflat, agricultural land, mangroves, degraded mangroves, wastelands, agricultural plantation and aquaculture sites can be identified from the remote sensing data either by visual interpretation or digital techniques. These categories play a main role in identifying the potential areas for aquaculture development, management and monitoring aquaculture environment as required, to conform with CRZ notification. Presence of important ecosystems, extent of agricultural lands, industries, topography of the area, soil and water quality, distance from shoreline, existing aquaculture sites etc can be mapped from satellite imagery.

Ground truth verification is one of the important components in the field of remote sensing applications. The validation of the information derived from remote sensing data should be checked by ground truth information. Field checks should be made in doubtful areas and the necessary corrections should be made in the interpreted maps. Many of the coastal mapping projects in India follow the classification accuracy based on a sample basis, assuming a binomial distribution for the probability of success/ failure of sample tests (SAC, 1992).

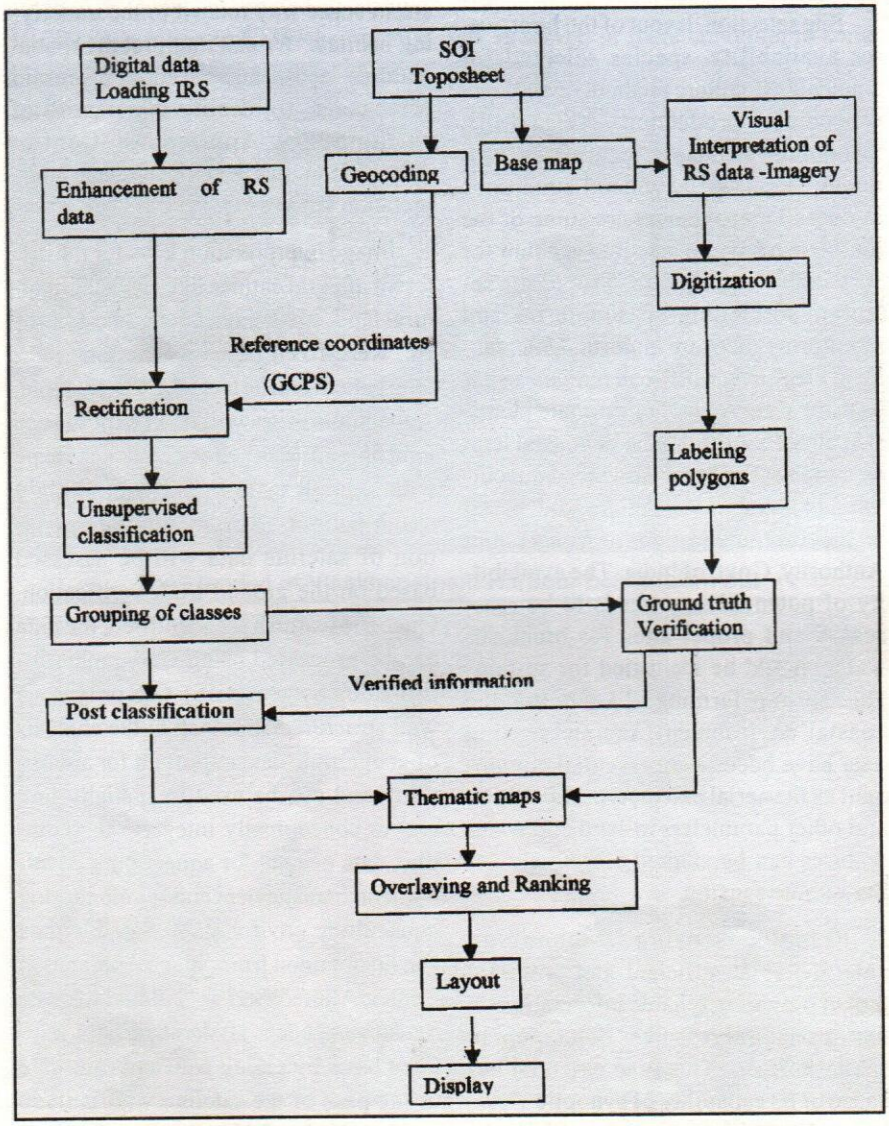

Fig 1. Methodology for using remote sensing data and GIS

Geographic Information System (GIS)

GIS is a 'computer system for capturing, managing, integrating, manipulating, analysing and displaying data which are spatially referenced by earth' (McDonnell and Kemp, 1995) and it could be an integral part of the successful management of aquaculture because it has the facility for regular updating with newly available information. Some of the PC based GIS softwares are ERDAS Imagine, ArcINFO, ArcVIEW, Geo media professional, IDRISI, SPAN, CGIS etc. The thematic maps can be prepared from the satellite data using GIS and projected to geographic coordinates to make use of the map for analysis. The accuracy of geometrically corrected image is usually checked by overlaying the rectified toposheet on the digital imager. The vector layer can be created with false colour composite (FCC) as the background image by digitizing various features available on the imagery. The labels like water, aquaculture, agriculture etc can be assigned to each polygon for a specific land use class. The final spatial information in the form of a layout with the corrected and completed maps can be created in Arc VIEW. The flow chart given in Fig 1 describes methodology for preparation of thematic maps and GIS analysis.

These maps can be overlaid using GIS to identify sites for aquaculture or for monitoring the sites under aquaculture. Seasonal changes under major land use and land cover types can be derived by spatial intersection of land use maps. The

changes that occurred from one class to other class like agriculture, mangroves etc., to aquaculture can be identified with area statistics and these changes will be useful in policy decision-making process. GIS and remote sensing technology can be combined to provide an accurate information which will be useful for development, monitoring, and management of aquaculture environment. The timely inputs of natural resources distribution from satellite data analysis will help decision makers for better management of resources.

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