Chapter 27

Application of Remote Sensing and GIS in Fisheries

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1.0 Introduction

Satellite remote sensing due to its synoptic view and ability to cover large geographical areas on a repetitive mode alongwith the coupled use of Geographical Information System (GIS) can play a very important role in research and management of fisheries. It is increasingly being understood that management of fisheries should encompass all the factors that affect the productivity of waters and is well managed with an ecosystem perspective.The ocean physical conditions influence productivity and hence the fluctuation in catches and the understanding of these physical factors that influence the productivity is useful for managing fisheries in a holistic manner.

2.0 Background

Conventional approaches of sampling the oceans using representative samples either from research vessels or ships of opportunity were limited in terms of global coverage and temporal resolutions. With the advent of remote sensing techniques, especially with the determination of changes in the ocean colour and sea surface temperature, in global scale, the determination of areas with specific characteristics, or ecological niches could be determined and the spatial and temporal variations in the boundaries could be easily identified. Since the changes happening to these spatial boundaries are mostly due to physical forcing, the relationship between the physics and biology of the oceans could be better related and predicted with a high degree of accuracy. Studying these relationships could be

very useful to relate variations in the biological structure of the stock like recruitment, distribution patterns, survival etc. and the variation in the physical forcing in the oceans.

There are a large number of potential applications in which remote sensing could be of immense help in fisheries, some of them include identification of potential areas of fish aggregation, identifying and predicting areas with harmful algal blooms (HAB), identifying suitable locations for cage base aquaculture, identifying areas suitable for marine protected areas (MPA), determination of areas suitable for aquaculture, determining threats to coral reefs, stock assessment in fisheries, predict large scale inter-annual events like ENSO mid-latitude warming events etc.

3.0 Operational monitoring programs

The first operational fisheries program started in Japan in 1930s for forecasting fish availability based on the relationship between ocean temperature and fish behaviour. The NOAA produced Sea Surface Temperature (SST) front analyses on a regular basis, to provide fisheries-aid charts, especially for tuna and like species. The charts included information like optimal SST range for selected fish species, coastal SST, mixed layer depths, ocean thermal boundaries, ocean colour boundaries, sea surface winds and direction, wave heights and direction and location of high and low pressure centres. Many other coastal countries like Australia, India, Chile, France, Norway, Portugal and Russia, have also started operational forecasting systems.

Application of remote sensing and GIS technologies for identification, planning and management of aquaculture activities involves extracting useful data regarding temperature and water quality. However the uses of remote sensing data for management of aquaculture facilities largely remain experimental in nature.

Remote sensing analysis can provide real time data for process-oriented experiments, data needed for numerical modelling and stock assessment, and also databases for retrospective analysis of biological phenomenon that would have influenced long-term trends and changes in the fishery which forms the basis for research applications.Operational research includes real-time data acquisition, archiving and distribution of datasets to support fishing activity, and implementation of Decision Support Systems (DSS).

Remote sensing can be an important information provider for the strategic and tactical aspects of fisheries management like providing information on the environmental conditions and other biological data with the help of models which will be immensely helpful for strategic management issues like mesh size regulations, estimation of optimum stock size, optimal fishing mortality, recruitment etc. and also can cater to tactical management issues like mortality and recruitment indices, oceanic circulation predictions, environmental variations etc. and by catering this it provides better scientific basis for use and management of an operational fishery and develop a snap shot of the existing biological and other conditions of the complex oceanic system.

An off-shoot of the application research using RS and GIS would be to make order out of the complex fisheries management process by processing fisheries and environment monitoring data to meaningful information like species geo-distribution maps, and an integrated output to fisheries managers.

4.0 Worldwide fisheries GIS tools and initiatives

GIS with combined use of RS is used in lot of fisheries management tools in the marine, inland and aquaculture sectors. The Fisheries Global Information System (FIGIS) is an Internet-based interactive system on the web that provides the policy makers with strategic information on fishery status and trends on a global scale. GIS Fish depends on Geographic Information Systems (GIS), Remote Sensing and Mapping and applied to Aquaculture and Inland fisheries. GIS Fish deals with the issues in aquaculture and inland fisheries, and demonstrates the benefits of using GIS, remote sensing and mapping to resolve them.

Global initiatives such as Global Coral Reef Monitoring Network (GCRMN), Global Coral Reef Alliance (GCRA), and International Coral Reef Initiative (ICRI) play an important role in monitoring the reef zones and raising awareness in the public.

Knowledge on the spatiotemporal distribution of fish populations and their habitats as well as on how fish populations interact on seasonal changes in the marine environment is important for modelling their population dynamics and managing fishery resources. The strong spatial component of GIS will help in areas related to catch and effort data, the establishment and monitoring of essential fish habitat (EFH) and marine reserves, the management and monitoring of stock assessment programs, development of habitat impact assessment, finding locations suitable for mariculture, aquaculture and monitoring and modelling of fish stocks and fishery quotas.

RS and GIS technologies are excellent tools for mapping population migrations (spawning and feeding) the direction and the scale of these movements help in mapping species migration corridors. This information coupled and incorporated in GIS will be a valuable tool to study the environmental biology of species and variations in the life cycle strategies.

4.1 Indian scenario

To meet the growing demand of ocean related remote sensing needs, the IRS-P4 satellite was launched in 1999. This satellite had two sensors specifically for ocean observations one was the Ocean Colour Monitor (OCM) with eight spectral bands and the second was Multi-frequency Scanning Micrometer Radiometer (MCMR), operating in four frequencies with global coverage capability. The repetivity of these sensors was every two days. The launching of the OCM2 in 2008 was another milestone in the area of ocean research in the Indian scenario and this satellite was designed to provide service continuity for operational users of OCM. The main objectives of the OCM-2 are to study surface winds and ocean surface strata, observations of chlorophyll concentrations, monitoring of phytoplankton blooms, study of atmospheric aerosols and suspended sediments in the water.

Identifying areas suitable for fish aggregation was one of the major developments in the operational remote sensing in India. The integrated potential fishing zones were initially developed using ocean colour data and sea surface temperature and identifying ocean fronts and eddies, that are indicators of local upwelling along the coast. The wind data vector from scaterometer was later used to determine the direction of the wind that could influence the movement of the identified feature. The technology for identifying potential fishing zones (PFZ) was taken up by Indian National Centre for Ocean Information Services (INCOIS) and is now disseminating PFZ advisories every day for fishermen all along the Indian coast, except during the ban period for fishing. Species specific forecast for tuna is also disseminated by INCOIS. The main advantage realized by using the PFZ is reduction in the scouting time, reduced fuel consumption and better benefits to the fishermen.

Indian National Centre for Ocean Information Services (INCOIS) has developed technologies harnessing the combined utility of remote sensing data and GIS. The Coral Bleaching Alert System developed by using SST climatology, bleaching hotspot and degree of heating week generates threat levels for coral bleaching and is intended to generate coral health bulletins along the Indian coast.

The satellite based information service for Detection and Monitoring of Harmful Algal Bloom (HAB) has been implemented at INCOIS .The rolling chlorophyll anomaly (RCA), rolling sea surface temperature anomaly (RSA) and bloom index (BI) are the parameters used for detecting HAB. The information on occurrences of HABs will be provided daily at near real-time (NRT) to regions along the Indian coast.

5.0 Conclusion

The application of remote sensing data in oceanographic and fisheries applications have been developed mostly in the recent years largely due to factors like (1) improved sensors with higher spatial and radiometric resolution, (2) ability to process and disseminate data easily due to the use of computing facilities, (3) easier data access through many dedicated sites and (4) increasing awareness of the use of remote sensing methods for potential users. The combined use of remotely sensed data and Geographical Information System will provide an excellent backdrop for informed decisions on a very complex area of fisheries resources management.

6.0 Further reading:

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