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Satellite chlorophyll image and fish catch data from southwest coast of Kerala, India – A preliminary attempt of correlation

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Abstract

Recognising the ocean features such as water colour, turbidity, seastate, size and direction of waves, wind patterns, temperature variations over sea surface etc. can be efficiently used to formulate fishing strategies, efforts have been made by India to utilise satelllite based remote sensing for identification and exploitation of potential fishing grounds. The Central Institute of Fisheries Technology, Kochi and Space Applications Centre, Ahmedabad as collaborating agencies have attempted to correlate the chlorophyll images taken by IRS P4 OCM with the ground truth data. The attempt was to analyse the catch data collected from the trawling boats operating from Munambam - a fishing village in Kerala. Emphasis was on the correlation of the catch data of the pink prawns and satellite generated chlorophyll image of the area of operation of the boats. It was observed that in all the images where no chlorophyll gradient was seen, catches have been either average or poor. More information is being gathered to study the relationship between the chlorophyll gradient and the fish distribution pattern so as to use chlorophyll gradient as a tool for the prediction of Potential Fishing Zones.

1. Introduction

Both biotic and abiotic factors play a vital role in the distribution and availability of marine organisms in the environment. Sensitivity to environmental issues and the dynamic nature of our natural resources underscore the need for practical and innovative information solutions. The sea surface temperature, chlorophyll, productivity, currents etc. play an important role in the distribution of marine living resources. Until recently sea surface temperature (SST) image generated from NOAA satellite was used as a criterion for predicting the Potential Fishing Zone (PFZ) and forecasting the fishery resources. Chlorophyll gradient is another important parameter that can influence the distribution pattern of fishes. The Indian remote sensing satellite, IRS-P4 (Oceansat–1) is the first in the series of Indian satellites to address the oceanographic applications in a more concerted manner. This satellite carries two payloads, viz., an Ocean Colour Monitor (OCM), and a Multi-frequency Scanning Microwave Radiometer (MSMR) to study both the biological and physical parameters of ocean. The spectral bands of OCM have been specifically chosen to observe the optical properties of phytoplankton pigments, inorganic suspended sediments and yellow substances. Phytoplankton supports almost all marine life. Its growth and subsequent death and sinking transport vast quantities of materials out of the surface waters. This biological pump is essentially responsible for the cycling of many biologically active substances and acts as a significant link for atmospheric carbon dioxide. Estimates ocean phytoplankton levels from space are based on optical properties of seawater caused by changes in the chlorophyll-a, the primary photosynthetic pigment. This information could be used for various scientific and operational applications such as estimation of phytoplankton concentration, assessment of primary productivity, identification of potential fishing zones etc. Ocean features such as water colour, turbidity, sea state, size and direction of waves, wind patterns, temperature variations over the sea surface etc. can be effectively used to formulate the fishing strategies, as fluctuations in any of the existing environmental conditions over the oceans affect the distribution, abundance and availability of fishes. While it is not possible to measure the entire spectrum of information needed to assess such changes in the marine environment, basic information on important environmental factors and processes can be gathered using ocean surface measurements from satellite sensors for locating marine fisheries. For this, techniques like ocean colour monitoring (measurements of chlorophyll pigments) and measurements of sea surface temperature (SST) have been used effectively.

2. Material and Methods

The Data for validation of the PFZ was collected off south west coast of India (Lat 08°40' and Long 76°02') from the boats operating off Munambam

during the period February-March 2000. Detailed information and data on the area of fishing operation, depth and the catches landed by the bottom trawlers (mainly the 'pink prawns') were collected. The grading of the catches for the analysis was done on the basis of the number of stations covered on a particular day. The chlorophyll image was generated from the raw satellite data, processed and geometrically corrected using the IMAGINE image processing software. A total number f 24 CD's covering February to May 2000 were analysed and the images suitable for further analysis were selected based on the image quality and cloud cover in the area of interest. A total of 10 images were finally used for correlation studies. The rest of the days were found to be cloudy.

The fishing stations were plotted geographically on an annotation layer, data wise with the fishing data available. For every image, annotation layers of the same day were superimposed and observations made.

3. Results and Discussion

Efforts were made by the Space Applications Centre, Ahmedabad to utilize satellite based remote sensing for identification and then further exploitation of the catch with minimum wastage of fuel in search of a potential fishing ground. The Central Institute of Fisheries Technology, Kochi attempted validation of the PFZ with the help of the commercial fishermen. The flow of information regarding the potential fishery zones were relayed to get the feedback from the commercial fishermen of Munambam – a fishing village, which is located 30 km from Kochi, has a prominent mechanized fishing fleet, having about 710 small and medium trawlers. These trawlers are owned by professional educated fishermen who are receptive scientific innovations. For this reason Munambam has been chosen for the purpose of transfer of technology and extension activities by various institutions like Central Institute Fisheries Technology, Central Marine Fisheries Research Institute and Marine Products Export Development Authority. The fishermen of the village are very responsive and responsible in adopting new technologies developed for improved mechanized fishing. Here about 70% of the mechanized vessels (Table 1) falling in the size group of 43–52 feet are installed with Geographic Position System (GPS) and echosounders. 15 recently introduced boats in the size group of 60 feet, are also fitted with GPS and echosounder. Some fishermen are known to use mobile phones for communication between the vessels, while at the sea.

Table 1. Fishing fleet of Munambam (Mechanised trawlers)

Size (Feet)	Number	Depth of fishing
28 - 32	120	Upto 70 m.
38	75	150 – 200 m.
40	100	150-200
43 – 52	400	150-300
60	15	400 m and beyond

Presently, the fishermen's organization is equipped with a fax machine which will help in easy reception and dissemination of all fishery prospect charts in real time.

The catch data of the pink prawns were collected from the boats operating from Munambam where they usually undertake a voyages lasting to 6-8 days. The collected data were analysed at the Space Application Centre, Ahmedabad. Details of the chlorophyll image analysis with the ground truth data are furnished in Table 2.

It was observed that in all the images where no chlorophyll gradient was seen, catches have been either average or poor. The image on 21st March showed a chlorophyll gradient at latitute 11°25' longitude 75°19'. The annotation layer of 17th March when superimposed on 21st image, one of the stations fell in the gradient area, but individual catch details for that particular station was not available on that day from the commercial fishermen (Fig. 1).

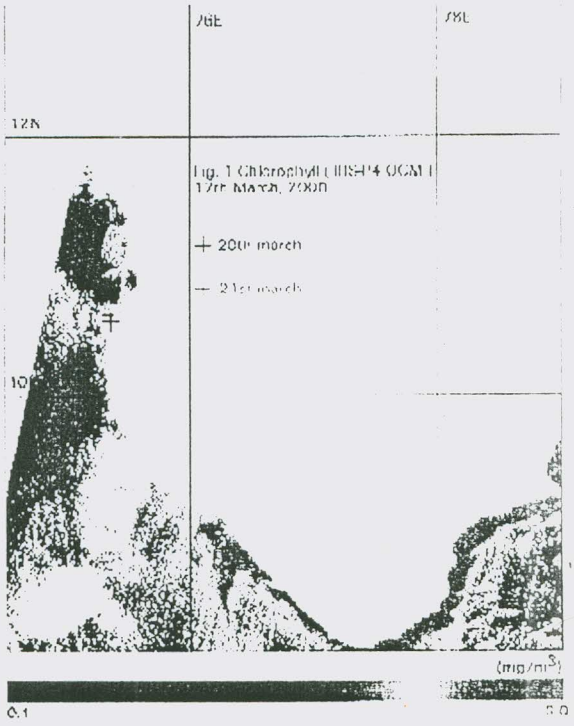

Fig. 1. Chlorophyll (IRS-P4 OCM) on 17th March, 2000.

Table 2. Details of chlorophyll analysis with ground truth.

Date of Image	Date of fishing	Fishing Area		Catch rating	Gradient observed						Whether gradient persists	Comments
					Fishing area			Other area				
		Lat	Long		Lat	Long	Value	Lat	Long	Value		
3.3.00	4.3.00	08°40'	76° 02'	Avg	No	No	0.24	10° 57'	75° 47'	1.22-0.33		
7.3.00	7.3.00	09° 22'- 09° 24'	75°39'- 75° 45'	Avg	No	No	0.24	-	-	-	-	No gradient observed near the fishing ground. Image cloudy.
9.3.00	9.3.00	09° 20'- 09° 24' 08° 42'-	75° 41'- 75° 43' 75° 48'-	Poor	No	No	0.24	09° 28'	77° 44'			
		08° 42	75° 47'	Poor	No	No	0.25	09° 28'	77° 44'	0.47-0.20	Yes	No fishing data from the gradient area.
		08° 11'	76° 34'	Poor	No	No	0.23	09° 28'	77° 44'			
13.3.00	9.3.00	09° 20'- 09 24'	75° 41'- 75° 43'	Poor	No	No	0.24	10° 10'	76°56'	0.83-0.41	Yes More Prominent	No fishing data from the gradient area.
		08° 42'- 08 42'	75° 48'-	Poor	No	No	0.24					
			75° 47'									
		08° 11'	76° 34'	Poor	No	No	0.24					
17.3.00	20.3.00	10° 33'- 10° 36'	75° 21'- 75°20'	Avg	No	No	0.25	8° 43'	76° 23'	0.75-0.32	Yes	No data from the strong gradient seen in the south.
	21.3.00	10° 31'- 10° 32'	75° 10'- 75° 13'	Avg	No	No	0.24					No data from the strong gradient seen in the south.
		10° 36'-	75° 20'-									
		10° 36'	75° 19'	Avg	No	No	0.24					gradient seen in the south.
		11° 25'	75°19'	Avg	Yes*	Yes*	0.21					Weak gradient seen in the fishing area.
21.3.00	21.3.00	10° 31'- 10° 32'	75° 10'- 75° 13'	Avg	No	No	Cloudy	8° 28'- 8° 57'	76°18' 76° 22'	0.13-0.57	Yes	No data for the gradient area.
		10° 36'- 10° 36'	75° 20'- 75° 19'	Avg	No	No	Cloudy					
		11° 25'	75° 19'	Avg	Yes*	Yes*	Cloudy					Weak gradient persisted. Image cloudy.
23.3.00	21.3.00	10° 31'- 10° 32'	75° 10'- 75° 13'	Avg	No	No	0.21	8° 54'	76° 16'	0.49	Yes	The gradient appearing from 9.3.00 started weakling.
		10° 36'- 10° 36'	75° 20'- 75° 19'	Avg	No	No	0.21					
		11° 25'	75° 19'	Avg	Cloudy	Cloudy	Cloudy					The image too cloudy.
8.4.00	8.4.00	09° 04'- 09° 08'	75° 47'- 75° 48'	Poor	No	No	0.16 0.19	10°09' 10°34'	75°38' 75°46'	0.12-0.22	-	Strong gradient seen in March is no more seen.
8.4.00	10.4.00	10° 31'	75° 13'	Good	No	No	0.18	10°09'	75°38'	0.12-0.22	Yes	No gradient seen
		10° 15'- 10° 20'	75° 38'- 75° 39'	Good	Yes	Yes*	0.12- 0.22	10°34'	75° 46'			*Good catch at gradient
		09° 09'- 09° 15'	75° 47'- 75° 48'	Good	No	No	0.14					No gradient seen
12.4.00	12.4.00	10° 04'	75° 36'	Avg	No	No	Cloudy	Cloudy	Cloudy	Cloudy	-	Image cloudy

A gradient was observed on 8th April image. When superimposed with the annotation layer of 10th April, 2 stations fell in the gradient and the individual catch details for these stations were not available. On an average, food catch of prawns was recorded on that particular day (Fig 2). A strong gradient seen on 9th March remained until 23rd March in the areas in and around lat. 09°28' long. 77°44', but none of the fishing stations fell within the gradient range.

During the course of analysis it was felt that more details need to collected with respect to fishing operations in order to make the validation more effective. Supporting data on biological and oceanographic parameters could be of immense use in understanding the relationship between ground truth data and the satellite data. At present, the commercial fishermen are neither equipped to collect such data nor is it possible for a research vessel to cover such a large number of stations at a time. More data will be gathered on the catch during the current season to come out with fruitful correlation between the chlorophyll gradient and the distribution pattern of the bottom fishes. The idea is to examine the use of chlorophyll image as a tool for prediction of the potential fishing areas of bottom resources also. This method is not found to be fully useful for bottom resources. But this study proposes to

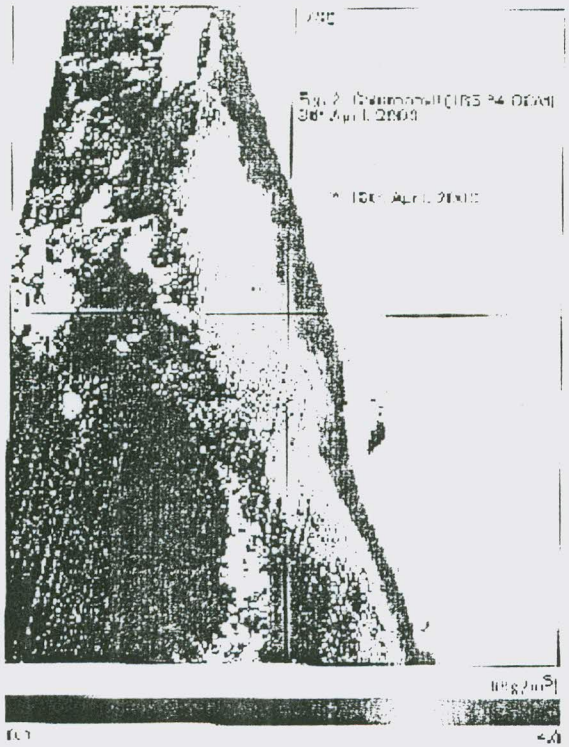

Fig. 2. Chlorophyll (IRS-P4 OCM) 10th April, 2000.

find out methods to overcome this limitation and to come out with correlation using a time lag if found existing. A campaign for increased awareness of these modern facilities like PFZ is planned to be taken up all along our coast. Since India's long coastline has widely varying oceanographic conditions, this study has to be taken up on an all India level.

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