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Short communication

Utilization of IRS P4 ocean colour data for potential fishing zone — A cost benefit analysis

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IRS P4 OCM (Ocean Colour Monitor) derived chlorophyll concentration is being used along with NOAA AVHRR (National Oceanic and Atmospheric Administration – Advanced Very High Resolution Radiometer) derived SST (Sea Surface Temperature) for Potential Fishing Zones (PFZ) forecast in the country. There is a need to compute cost benefit ratio to understand its impact on the fishing industry and to evaluate utilisation of OCM data for benefit of fishermen community. In order to compute cost benefit ratio, cost towards generation of forecast, expenditure towards fishing and profits from increased catch were considered. Actual fishing cost per unit was considered based on the fisheries survey made by different agencies and probable increase in catch was assumed based on PFZ validation experiment. An average receipt was found increased from Rs. 38428/ ($814/) to Rs. 65315/ ($1390/) for trawler and Rs. 1443/ ($31/) to Rs. 2742/ ($ 58) for gill-netter to PFZs users. The benefit cost ratio increased from 1.27 to 2.12 for trawling and 1.3 to 2.14 for gillnetting compared to non-PFZ users to PFZs users, respectively.

[**Key words**: AVHRR, fisheries, cost benefit, OCM, PFZs]

The development of fisheries depends upon availability of natural resources, climate, physical resources, adequate finance, suitable new technology, growth of fishing units, extension of fishing areas, Government policies, the modern technology and flow of the technical information to grass-root level. The marine ecosystem is complex in respect to its species composition as well as the processes occurring within it. With the increase in fishing fleets, there is a tremendous pressure on the traditionally known fishing grounds, which lead to decline in CPUE (catch Per Unit Effort). Hence, there is a need to divert some fishing efforts in other suitable potential fishing areas, which can be explored using remote sensing techniques. The prediction of marine ecosystem structures and functions depends on a thorough understanding of the physical and biological processes which govern the abundance, distribution and productivity of the organisms on a wide range of time and space scales. Arnone[1] used CZCS (Coastal Zone Colour Scanner) and AVHRR data to understand the relationship between chlorophyll and SST. The classification of water mass appears to be associated with different biological and physical processes. Potential Fishing Zones (PFZs) forecast was started during 1989-90 using NOAA AVHRR derived SST in India[2]. Nath *et al*.[3] used SST images to estimate fish catch in the Arabian Sea. An integrated approach was developed using IRS P4 OCM derived chlorophyll concentration and AHVRR derived SST for locating potential fishing zones by Solanki *et al*[4]. The Fishery Survey of India, Central Institute of Fishery Technology and Gujarat State Fisheries Dept carried out the validation exercises. It was observed that 70-90 % forecast yielded 70-100 % increase in the catch. PFZ forecast technique has been transferred to INCOIS (Indian National Centre for Ocean Information Services), Hyderabad for operational applications. INCOIS disseminate the PFZ maps to about 225 nodes for operational use. At present PFZs forecast maps are free of cost available to fisherman. The products may be commercialised in future. This study was taken up to understand the impacts of the satellite based PFZs forecast on economics of fishermen community and fishing industry. The cost of fishing, generation of PFZ charts as well as fish has been considered.

In order to compute cost benefit ratio, cost towards generation of forecast, fishing through trawlers and gill netting and profits from increased catch were considered. The cost of one PFZ forecast bulletin generation was calculated. For this, OCM and AVHRR data cost, computation cost (system), manpower cost, dissemination costs, etc. were considered. Table 1 indicates the cost of satellite data

Table 1 — Cost estimate for PFZ Chart generation using remote sensing

[For 700 × 700 km, per day per forecast]

		Cost	
		Rs.	US $
1	Satellite data (one quadrant of OCM & AVHRR):	17000	362
2.	Data transfer through Spacenet/VSAT / inter-net	1000	21
3.	Use of computer system: (2 hrs data down loading, 3 hrs processing)	7500	160
4.	Cost of outputs (Maps, images printing etc)	500	10
5.	Cost of Manpower for generating forecast * (Operator 8 hrs, scientist 1 hr)	3000	64
6.	Cost for infra structure	1000	21
7.	Forecast dissemination:		
	Telephone/fax etc. (assuming their availability):	500	10
	Manpower at fishing base:	500	10
Total: Per forecast bulletin per quadrant		31000	658
Overhead cost (100%)		31000	658
Total		62000	1316

(Each bulletin may contain information of on an average 5 PFZs)

*Cost for R & D efforts towards development of PFZ identification technique has been considered in estimate.

and value for generating one forecast bulletin. For the economic analysis, two main types of the fishing boats were considered namely trawlers and gill-netters. Both boats have different fish harvesting techniques and thus vary in catch, employment potential, duration, wage- system, type of the nets used and distance/depths of fish catching. The cost benefit analysis has been carried out considering all the factors, which essentially influence costs and earning of the boats.

The year 1999-2000 has been considered as initial investment year for the acquisition of new boat, nets and other fishing equipment. Marketing expenses of fish catch was not considered except unloading the catch up to the auction hall. Under fixed coast, maintenance and repair includes annual overhauling of boat and engine, painting of the boat and replacement of gears (nets). The boat charges related to ports and custom was considered. This includes, registration related, berth charges, creek pass etc[5]. The detail break-up of entire handling, cost of acquisition, etc., are given Table 2.

Two methods for evaluating cost were applied in this study. Based on increase in total catch: (a) In this method, increase in fish catch (in %) was calculated from catch per unit effort (CPUE) of total catch (all species together) in PFZ area. The increase in fish catch was computed based on monthly mean catch for the vessel. The catch/vessel/trip (for trawler and gill-netter), net gain and expenditure per trip were taken from statistics of Gujarat fisheries (1989-99)[6]. These figures were then converted to the rate of increase in catch to compute benefit to PFZ users (Table 3). (b) Based on the species composition (i.e. % increase in each species). This method takes care of different market rates for different species. For this, species composition of two vessels (i.e. *Matsya Neerikshani* and *Matsya Mohini*) was normalized to calculate mean catch/haul for the month and for the PFZ areas. Species-wise monthly mean catch per unit effort (CPUE kg/haul/vessel) was compared with monthly mean catch in the PFZ area. From this, specieswise % increase in catch was calculated. Market values in Rupees of each species were taken from published Gujarat State Fisheries Department Statistics of 1989-99-2000 and personal communication with Fisheries officials. Specieswise increase in CPUE kg/haul/vessel was multiplied by market value. This value indicates extra benefit in Rupees to PFZ forecast users as compared to normal fishing. This value was multiplied by number of hauls per day, i.e. usually 4 hauls per day. This value indicates net increase in income/profit per vessel per day for trawling.

The results of the first method only have been described in this report. Apart from this, fuel saving and time saving for searching potential fishing areas are important criteria for cost benefit analysis.

The fishing data of pelagic resources received from Gujarat State fisheries were compared with monthly mean catch per operation of gill net in that area. The results indicated increased in fish catch. Solanki *et al*.[7] have discussed details of feedback analysis and

Table 2 — Economics of trawler and OBM gill netters

[*As per report on techno-socio-economic survey for Fishermen community in Gujarat*[5]]

Sr. no.	Particulars	Trawler	OBM gill netter
1.	Cost of acquisition of trawler	1. Rs. 1300000 ($27660/) (Rs. 700000 for boat, Rs. 325000 for engine, Rs. 65000/ for steering gear, Rs. 150000 for nets and other equipments)	Rs. 183000 ($2894/) (Rs. 85000 for boat, Rs. 58000 for engine, Rs. 40000 for nets)
2	Expenditure per trip	Fuel 1000 litre @Rs. 16.5 /lit Wages-one Skipper @ Rs.2500/trip Five Khalasi @ Rs.1125/trip/person Ration Rs. 200/person Water Rs. 50 Ice 30 blocks @Rs. 70 per block Loading/unloading Rs.350/ Boat maintenance Rs. 500/	Fuel: Kerosene –18 lit@Rs.8/lit, petrol 0.5 lit @ Rs.30/, oil 0.5 @ Rs 70/ Wages: Total 5 persons @Rs.125/ Ration Rs.30 per person Maintenance Rs. 50/ per trip
3	Annual Repair and maintenance	2.25% of fixed assets	2.5% of assets
4	Trips:	40 per year (Mid Sep to April, ~30 weeks	Average trip duration 12-15 hours per day, Average 20 days per month i.e. 160 trips per year
5	Average expenditure / trip	Rs. 30116/ ($460/)	Rs. 1074/ ($22/)
6	Average catch Price/ trip	Rs. 38428/ ($818/)	Rs. 1443/ ($31/)
7	Profit/trip	Rs.8312/ ($177)	Rs. 378/ ($8/)
8	Return on investment in %	20.85	26.98%

Table 3 — Benefit to PFZ forecast users based on % increase in total catch in PFZ areas

Fishing boat type	Conventional fishing ground location & fishing (Figures are on an average)*				Benefit to PFZs forecast user @	
	Average catch per trip (kg)	Average receipt per trip (Rs.)	Average cost/expenditure per trip (Rs.)	Av. net gain per trip (Rs.)	Increase in catch per trip (kg.)	Extra benefit to PFZ user/trip (Rs.)
Trawler	2484	38428	30116	8312	1738	26887
Gill netters	50	1443	1074	378	45	1443

*Figures as per report on techno-Socio-Economic survey for Fishermen Community in Gujarat[5]

@ 70% increase for trawler and 90% increase for gill-netters, as per validation results

results. Normalised CPUE of each observation for demersal resources was compared with normalised mean CPUE of vessel for each month. Some observations indicated abrupt increase in catch two to three fold in PFZs. The high CPUE may indicate the most favourable oceanographic environment/condition for resources accumulation and fishing operations. This may be considered as the potentials of satellites to locate most favourable fishing zones. The CPUE also depends on the skill of the skipper, gear specifications, wind direction, sea state and bottom topography. Solanki *et al.*[8] reported about 70% observations were positive in depth zone 30-50m whereas 90% observations were positive in 50-100m-depth zone. On an average 100% and 70% increase in catch at 30-50 m and 50-100 m respectively (Table 4).

The per cent increase in total catch was calculated from CPUE in PFZs as compared with mean CPUE of

Table 4 — Summary of feedback analysis

Feedback: Demersal by FSI, Mumbai, Pelagic by Gujarat State Fisheries Dept. Gandhinagar

	Fishery resource type	Number of PFZ sites validated	Number of positive feedback	Per cent success	Magnitude of increase in catch (%)
Phase III	Demersal	22	20	93	140
Phase II	Pelagic	16	14	88	100-200
	Demersal (30-50m)	48	34	71	102
	Demersal (50-100m)	30	26	87	71
Phase I	Pelagic			100	>100
	Demersal			85	

Table 5 — Summary of benefit/cost analysis for trawler and gill-netters

Sr. no	Boat type	@ Cost of operation (Rs)	* Cost of PFZ bulletin/boat (Rs)	@ Average receipt without PFZ (Rs).	#Average receipt with PFZ (Rs)	Benefit/cost without PFZs	Benefit/ cost with PFZs
1.	Trawler	30116	620	38428	65315	1.27	2.12
2	Gill netter	1074	206	1443	2742	1.3	2.14

@ Figures are per trip and as per report on techno-Socio-Economic survey for Fishermen Community in Gujarat
* Cost of PFZs generation as per table no.1. Assuming that a co-oprative society of 100 fisherman are paying for generating PFZ chart
# Benefit included as per PFZs validation results shown in table no 3 and 4

the month. It was observed from the feedback (Table 4) that about 100 % increase in catch in PFZs located in 30-50 m depth zone and 70 % increases in catch in PFZs located in 50-100 m depth zone. It was observed that cost-benefit ratio increased from 1.2 to 2.12 for trawler and 1.3 to 2.14 gill-netters (Table 5). These ratios were calculated based on the utilisation of forecast bulletin for one long trip in the case of trawlers and three daily trips in the case of gill netters. It was reported by Sinha *et al*.[9] that 29 % fishermen use PFZs forecast in Gujarat State. They stated that the delayed dissemination of PFZs information, short validity period, unawareness of the modern technology are the probable reason for limited users in Gujarat. The number appears small but in the practical sense, it is not as large number of fishing boats are being operated. At present, PFZs forecast is being disseminated to 225 nodes by Indian National Centre for Ocean Information Services (INCOIS), Hyderabad. The majority of active fishermen are using forecast for locating potential fishing grounds. Hence, fishermen are getting substantial benefit who are using PFZ. In this computation, the skill of the skipper, location of proper fishing grounds, efficiency of fishing gear and boat, suitable weather, accommodation of fishing craft in same fishing ground, etc were not considered. Benefit to cost ratio was calculated as 2.12 for trawlers and 2.14 for gill-netters to PFZs users against 1.27 for trawlers and 1.6 for gill-netters to non-PFZs users.

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