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Efficacy of spatial study on catch and effort from fishing vessels for strengthening fisheries management

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Original Article

Abstract

Ever since marine fishery operations were extended beyond territorial waters of respective states, the need was felt for incorporating spatial component of fishing effort and catch for formulating marine fishery policies. The present study is an attempt of spatio-temporal analysis of changing scenario of fishing operations in GIS platform with catch and effort data collected from fishermen, to highlight the need for the change in approach in fisheries management and also for updating the information of fishing along the Indian coast. Marine fishing operations by commercial fishing vessels operated from different states has extended up to 200 m depth since 2000 and duration of fishing, especially trawling extended from single day to 8-13 days per voyage. Present findings were drawn from the analysis of 1,217 days of trawling operations during 2007-2013 by a sampling trawler supplemented by additional fishing operational data support from a group of commercial trawlers. Study reveals that there is an organised and confidential maintenance of log sheets in most of the progressive trawler operators and the information available in spatial platform can be utilized for better fisheries management with fishermen's participation. Spatial analysis of fish catch from the sampling trawler operated from Mangalore showed that more than 70% of the fish landed in Mangalore was brought from the area beyond the territorial waters of Karnataka signifying that majority of fish catch landing to the state is from waters beyond their jurisdiction. Even though the fishery beyond territorial waters of all maritime states is governed by Government of India, so far, there is no comprehensive management plans regarding fishing operations beyond territorial waters of the states. The study further reveals that fishing grounds beyond territorial waters of each state are being intensively fished without any fishing regulations and there were many conflicts being reported from these waters concerning the fishing rights of different sectors and different states. In the light of the findings from the study on fishing operations and fishery, an action plan to regulate the fishery off the territorial waters of each state is felt essential. "Regional fisheries committees" with members constituting the officials from neighbouring states sharing same resources with the aegis of Central Government is recommended as a viable option to take care of the management of the fishery within the Indian EEZ.

Keywords: *Marine fishery policy, territorial waters, fishing pressure, fisheries governance, GIS platform.*

Introduction

Globally, marine fisheries has been highly dynamic in nature with updated technologies over the period of time. In India, by

early eighties onwards mechanised vessels especially trawlers started contributing major part of the total marine fish production (Srinath *et al.*, 2003). Trawlers from most of the maritime states are involved in multi-day trawling practices extending from 9 to 13 days across the territorial boundaries of neighboring states (Dineshbabu *et al.*, 2013). In India, from legislative point of view, "fisheries" is a "subject" under state list as per article 21 of the Indian Constitution, and management and control of coastal fisheries is vested with the maritime states and union territories. Comprehensive Marine Fishing Policy of Ministry of Agriculture, Government of India released in 2004 (DAHD, 2004) reviewed the present status of fishery regulation in coastal waters. It recognises that, though the Marine Fisheries Regulation Acts (MFRAs) of coastal states and Union Territories have adequate provisions for management of resources and fishing operations, it is often found falling short of effective implementation. It also raised concern that "exploitation of living resources within 50 metres depth zone is showing symptoms of depletion and in certain belts in the inshore waters it tends to cross optimum sustainable levels". One of the most promising suggestions in the policy is to introduce the marine spatial planning and ecosystem based fisheries management (DAHD, 2004). Present study investigates, the possibility of introduction of marine spatial planning in Indian marine fisheries, with the help of the data available with fishermen for the effective management of marine ecosystem and also to reduce the conflicts in sea.

In recent years, incidents of conflicts among different stakeholders of the fisheries sector is on the increase, which arise mostly due to the disparities in sharing the limited resources (Vivekanandan *et al.*, 2010). Policy demands demarcation of area for traditional, motorised and small-mechanised fishing vessels and efforts would be made to harmonize the demarcation of reserved areas to the maximum extent possible. Similar demarcation is being carried out in many countries to reduce inter-sectoral conflicts (Caddy and Carocci, 1999). Considering the country's diverse and vast coastline, multi-species multi-gear scenario, it was felt that regional specific management plans are most suitable for Indian peninsula (Vivekanandan *et al.*, 2003). Internationally marine spatial planning (MSP) and ocean zoning has become a crucial step in supporting ecosystem based marine fisheries management (Douvere, 2008). GIS based spatial studies were projected as a management tool in marine fisheries policy development (Maeden, 2013) and stressed upon such studies in those countries, where the data available from the traditional data collection system is inadequate in reaching a sensible compromises between, fishers, scientists and politicians. In the Indian scenario the major problem in spatial planning of fishing is non-availability of spatial data on fishing effort and catch. St. Martin and Hall-Arber (2008) demonstrated the utility of participatory method of data sharing between fishermen and researchers in resource mapping to understand the fishing complexities in multi-species multi-gear scenario. Spatial data analysis is being considered as a basic requirement to formulate policies in fisheries resource conservation and fishing pressure estimation in coastal waters and governmental agencies are encouraging this concept with number of projects (Black *et al.*, 2013; Baird *et al.*, 2011; Baird *et al.*, 2015). In India also the protocols are developed in spatial analysis of fishing effort data (Dineshbabu *et al.*, 2016) and attempt for resource mapping by participatory approach along Karnataka coast was done by Dineshbabu *et al.* (2012). Present study focuses on an important issue flagged in the Comprehensive Marine Fisheries Policy (DAHD, 2004) in terms of fishery governance and fishing pressure. It is an attempt to analyse the changing scenario of fishing operations in space and time, with analysis of catch and effort data from the trawlers in GIS platform and the study also demonstrate the possibilities of incorporating the fishermen data in marine fisheries management and to solve some of the socio-political issues.

Material and methods

Spatio-temporal data on catch and effort collected from 1,217 days of trawl operations for six continuous fishing years (2007-2013) formed the data base for the present study. Crew of sampling trawler identified were given training in spatial data collection and were provided with specially designed logbooks. There was no pre-planned cruise schedule and the fishing boats are allowed to follow their traditional trawling track throughout the period of study along with other commercial trawlers (Graham *et al.*, 2002). This was done to make the data as unbiased as possible and also to follow their traditional knowledge of selection of fishing ground by the fishers (Wiber *et al.*, 2004). On board information collected followed the methodology developed for the spatio temporal data collection and resource mapping in India (Dineshbabu *et al.*, 2016) Geomedia software was used for the mapping of fishing effort and fish catch from different geographical area of fishing with the methodology described by Wood and Baird (2010). Apart from the exhaustive data on fishing, data on fishery, fish biology and fishing operational details were recorded in log book from four commercial trawlers operated during the same period. Additional data points recorded in the log sheet of four commercial trawlers were used as a supplementary data, to fill up the fishing points not recorded in the sampling boat data. However in overall analysis, the pattern of fishing was found to be similar in all trawlers. The period of fishing was classified into fishing years, which generally commenced from August to June next year. Continuous data for six years, except for the period of mechanised fishing ban period were analysed in the study. The mapping of catch and effort for 1,217 days of trawl operations in 135 fishing cruises were carried out with mapping of catch and effort with reference to depth contours of 20 m, 30 m, 50 m, 100 m and beyond. Attempts were made

in identifying the depth zones of high intensity fishing pressure in the light of concerns in the Comprehensive Marine Fishery Policy document (DAHD, 2004) regarding over-exploitation of resources within 50 m depth zone.

Results

Area of operation

During the period 2007-2013, multiday trawlers from Mangalore were operated from Ratnagiri coast of Maharashtra in north and Calicut coast of Kerala in the south with depth of operation extending from 150 to 200 m. It was understood that a systematic pattern of fishing operation was followed from the trawlers operated from Mangalore with a season specific path and depth of operation. From the fishing operational data available from sampling boat and the commercial boats it was found that immediately after "monsoon trawl ban", the trawlers from Mangalore concentrated in fishing beyond 50 m depth. It was reported that during this period the trawling grounds within 50 m depth have very low in fish assemblage due to monsoon related bottom disturbance. In August and September, the fishers generally target thread fin breams, groupers and cephalopods. Good catch of ribbonfishes were observed in the catch during this period in some years. Off late, pufferfish and *Lagocephalus* also formed a good portion of the catch, which is also becoming a targeted fishery since it found commercial market in Mangalore Fisheries harbour from 2010. It was observed that invariably in all the years, by the end of October, fishing operation shifted to the fishing ground within 50 m depth zone and till the end of the fishing seasons trawlers invariably conduct trawling operation within 50 m depth zone. Low operational cost and good market demand for juveniles from fish meal plants are said to be a major reasons for intensive combing of trawlers in the lower depth zone.

Distribution of fishing effort in different depths

Spatial analysis of 1,217 days of fishing operations were carried out to understand the areas of high fishing pressure during long time series study (six years). Of 1,217 days of trawl fishing (average 240 days per year), 1,045 days of fishing was carried out within 100 m depth zone of which 730 days of trawling (60% of the total fishing days) were within 50 m depth zone (Fig.1). The additional data collected from the commercial trawler operators also showed the similar trend. Highest percentage of fishing operation was found to be within and around 50 m depth zone. A regular trawling pattern observed in all the trawler studied was that, even though fishing depth was extended up to 200 m, the fishing operation beyond 50 m depth zone was occurring mainly during, August-September and March-April. From October onwards the trawlers concentrate within 100 m depth zone. While calculating the fishing pressure or distribution of fishing operation, with reference to the territorial waters of

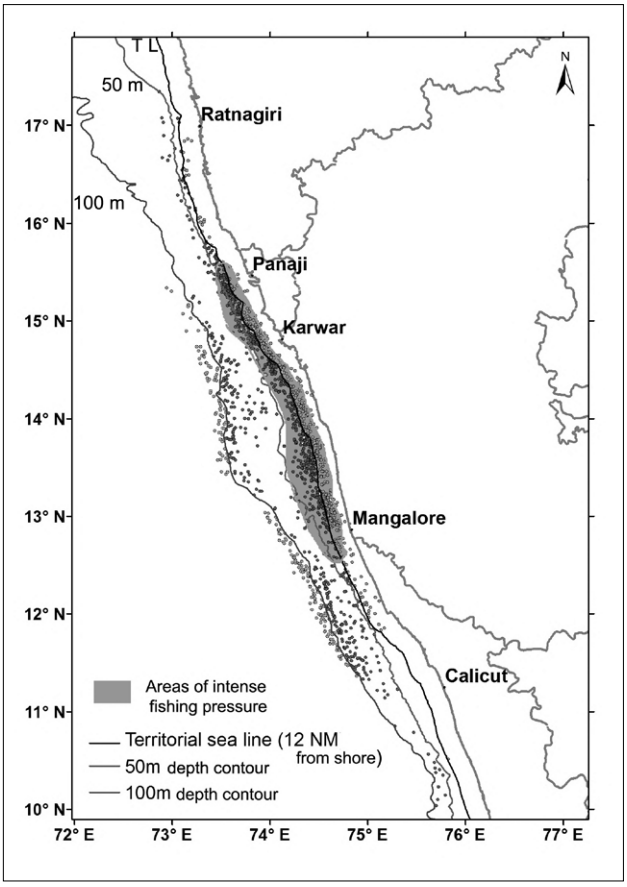

Fig.1. Distribution of fishing effort mapped off Karnataka during 2007-2013

Karnataka, it was found that only 28% of the cruises are falling within the territorial waters of 12 nautical miles and 72% of the operations are beyond territorial waters of Karnataka. It is to be mentioned that average depth range of territorial waters of Mangalore falls within 30 m depth.

Spatial distribution of fish catch in relation to territorial waters

To understand the contribution of fishes brought by trawlers, operating from Mangalore fisheries harbour, the fishes caught by the sampling trawler were subjected to spatial analysis. The catches brought from territorial waters and beyond territorial waters of Karnataka were analysed separately (Fig. 2). It was found that 70% of the catch by trawlers operating from Mangalore was brought from the waters beyond 12 nautical miles (Table 1). The analysis was carried out to point out that the fishery management from each state should take care of the resources beyond their territorial waters, since most of their fishery income is coming from the water beyond their fishery jurisdiction and to sustain the state fishery production, care should be taken to manage the fishery beyond their territorial waters too.

Discussion

The result from the long term spatial analysis of catch and effort from the trawlers operated from Mangalore brings out very important points which need the attention in future marine fishery policy development. Ever since the advancement of mechanisation adopted in the fishery sector, the fishery extended beyond territorial waters (Dineshbabu *et al*., 2013). This extension of fishing ground demands inclusion of spatial dimension in the fishery data analysis to come out with present sea truth information. Since India is not having a compulsory log book keeping system, spatial studies of marine fisheries has been a difficult task, but study showed that there is an organised log data maintenance in most of the progressive trawler operators, which are being used as the record of area of high catch and low catch with species information. These data base is generally kept confidential with limited access to group members. Such an organised log sheet maintenance opens up very promising future for involvement of fishermen in deriving fishery management policies. Involvement of local fishermen in spatial data collection process for GIS analysis are proved to be a very handy and useful input for developing management tools (Hutching and Ferguson, 2000; Maurstad, 2000). The team lead by Graham *et al.* (2002) could succeed in preparing "Atlas on ground fish spawning in Bay of Fundy" with participatory research program involving commercial fishermen and similar methodology is adopted in the present study also. Resource mapping along Karnataka coast with fishermen's participation was done by Dineshbabu *et al.* (2012). Present study revealed that the marine fishing scenario have undergone significant changes in terms of operational depth and area. These changes should be reflected in future fishery management plans for better regulation of the fishery and for sustaining many of the fishery resources. It was understood that trawl fishing is being carried out in very organised manner with most of the trawler operating groups keeping very elaborative log sheet, which is kept in high confidentiality, which is shared only with their own group members. Prevalence of this practices, can be considered as promising opportunity for bringing in spatio-temporal suggestions to sustain the production.

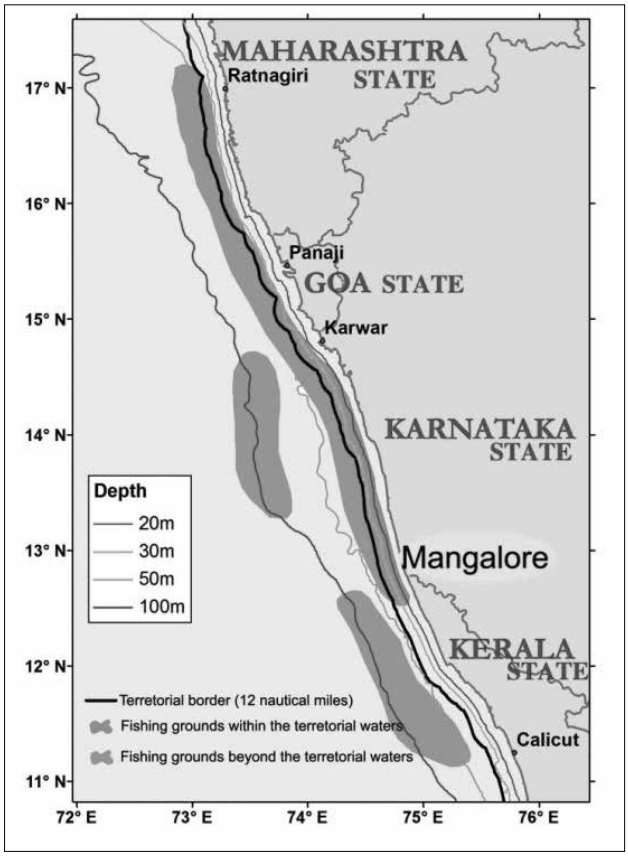

Fig.2. Mapping of fishing grounds and catch to find out the contribution of fish catch from territorial waters and beyond

The issue of cross border fishing is raised as a serious concern in the comprehensive Marine fishery policy (DAHD, 2004). Since the space sharing and resource sharing among different states is a reality, there is a need for more spatial analysis of catch and effort data from different states, to reduce the conflicts in the sea. Since fishery beyond territorial waters is governed by Government of India, "regional fisheries committees" with members constituting the officials from neighbouring states sharing same resources with the support of Central Government is a necessity. Even with analysis of trawl fishery alone, present study also endorses the concern raised in the Comprehensive Marine fishery policy document that highest fishing pressure is within 50 m depth

Table 1. Spatial analysis of catch from sampling trawlers operated from Mangalore

Year	Number of operations	Number of days	Catch (kg)	within 12 NM	percentage	Outside 12 NM	Percentage
2007-2008	20	175	124968	45238	36.2	79730	63.8
2008-2009	23	221	185692	62021	33.4	123671	66.6
2009-2010	22	195	187164	57646	30.8	129517	69.2
2010-2011	22	203	227451	60047	26.4	167404	73.6
2011-2012	23	204	219707	61957	28.2	157750	71.8
2012-2013	25	219	263010	66805	25.4	196205	74.6
Total		1217	1207991	353715	29.3	854276	70.72

zone. The concern shown in policy document (2004) is highly relevant when the study include more craft groups like traditional crafts, motorised crafts and other mechanised crafts. The finding also give the policy makers an opportunity for re-thinking on the options and claims made by different states that, the introduction of trawlers with capability of fishing in deeper waters can reduce the fishing pressure in the nearby fishing grounds. Spatial reallocation of fishing pressure can be a method for attaining sustainability and also for avoiding conflicts in the sea (Douvere, 2008). Involving fishermen in the Marine spatial planning proved to be very efficient method in decision making on fishing area sharing and resource sharing in multi -species, multi-gear scenarios (St. Martin and Hall Arber, 2008). Similar marine spatial planning involving the contributions of all stake holders in marine fishing may be a very good option in Indian fisheries policy development, which can reduce the conflicts in the sea and can also ensure sustainability of marine fisheries resources.

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