

Use of Geospatial Technology for Sustainable Development of Small Scale Fisheries in India: Challenges and Way Forward

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Abstract

The total fish production in India is estimated to be 13.42 million metric tons (Mt) of which nearly 3.71 Mt are contributed by marine fisheries. The fisheries sector provides direct livelihood support to approximately 16 million people, of which marine fishers constitute a dominant subset and almost double the number along the value chain. In the past, the fisheries community in India had relied on traditional indicators of fish abundance such as the congregation of birds, colour of sea water, bubble breaking in the sea water and muddy/oily water on the sea surface in their traditionally known fishing grounds. The increased frequency of extreme weather events observed in recent times, have been related to major losses in marine ecosystem services. Further, the livelihoods of Small Scale Fisheries (SSF) communities are endangered not only by their limited understanding of the magnitude of the risks associated with natural hazards but also by the diminishing returns of relying on traditional knowledge for accurate prediction of the fishing stock at their usual locations. Therefore, the Government of India has launched several programs to use geospatial technologies for the benefit of marine pelagic fisheries in India for the sustainable development of the SSF communities. However, the lives of SSF communities are also challenged by complex, inter-linked socio-economic factors. In this paper, we focus on the maritime state of Odisha which is affected by several extreme weather events (cyclones) in the Bay of Bengal. We describe the socio-economic and technological factors which determine the degree of assimilation of the Potential Fishing Zone (PFZ) and Ocean State Forecast (OSF) advisories provided by the Indian National Centre for Ocean Information Services (INCOIS) with a focus on the threads linking natural and anthropocentric factors that produce significant changes in the Catch Per Unit Effort (CPUE) and net profit for pelagic fisheries of Odisha. More importantly, we identify the research and implementation gaps that must be addressed so that science, technology, and societal interactions can be used to enhance the sustainable development of the SSF communities. Keywords: Potential fishing zone, Catch per unit effort, Ocean state forecast, Geospatial technology.

INTRODUCTION

The framework of the 2030 Agenda for Sustainable Development, United Nations (UN) included 17 Sustainable Development Goals (SDGs) along with 169 targets and 230 indicators in 2015, while the Food and Agriculture Organization of the United Nations (FAO) acts as a custodian agency for fulfilling the several SDGs target (FAO, 2018). The SDG target of 14.b/14.b.1 under SDG 14 “Life Below Water” deals with the Small Scale Fisheries (SSFs) where UN set the goal to provide the access in marine resources and markets for the SSF community by 2030 (Ritchie et al., 2018).

Predominantly, SSFs or Artisanal Fisheries indicate the traditional fisheries where a small amount of capital and small crafts are being involved for fishing and usually use for the local consumptions (Matthew, 2015; Jena & George, 2018). In general, small-scale fishers make short fishing trips near to the shore (Matthew, 2015), however, SSFs constitute more than half contribution in the marine fishery globally in terms of both value and quantity while it employs 90% of the total fishers in developing countries (Jena & George, 2018; United Nations, 2019). SSFs not only provide the food security at the local level but also very crucial for the livelihoods of the millions of small-scale fishers through poverty reduction across generations (Matthew, 2015; Jena & George, 2018). SSFs are also less harmful to the marine habitats and henceforth, environment friendly, however, it is under tremendous pressure due to the initiation of technological changes (Matthew, 2015). Pramod, (2010) has reported that the SSFs witnessed a forced displacement of fishes from their traditional fishing grounds during last two decades due to the acidification of water, salinity variation, eutrophication, changes in nearshore current under the climate change scenarios etc., (Jena & George, 2018) while the expenses of the fishers have been grown up owing to the increasing number of crew members and harshness of money lenders because of their weaker economy. In India, SSFs are suffered from insufficient landing centre facilities, poor wholesale and retail market infrastructure, deficiencies in cold chain and logistic shortfalls etc. (Jena & George, 2018).

Post India’s transformation as an independent and sovereign state, the Government of India (GoI) placed emphasis on the fishery sector for rapidly achieving food security as well as improvements in the socio-economic conditions through creating employment in fisheries and allied sectors (Singh & Patnaik, 2014). Empirically, the SSFs community used to follow the traditional indicators of ocean features such as temperature and colour “breaks”, feeding birds, foam, accumulation of floating objects, etc. for fishing (Miguel & Santos, 2000). Moreover, the weather extremeness i.e., tropical cyclone, storm surges, high waves and tides are also highly associated with the capture of fishes in the marine environment, especially in the Bay of Bengal (BoB) coast. Therefore, the unavailability of fishes in the traditionally known regions along with extreme weather events pushed their livelihoods in more difficulty (Balasubramanian, 2015). In this connection, Government of India (GoI) has launched Potential Fishing Zone (PFZ) and Ocean State Forecast (OSF) advisories since the late 1990s and late 2010s respectively to reduce the uncertainty and risk in the marine fisheries sector. The Indian National Centre for Ocean Information Services (INCOIS) utilizes remotely sensed data to develop these advisories, and disseminates through various information and communication bases tools (ICTs) to all the coastal community (ESSO-INCOIS, 2020b; ESSO-INCOIS, 2020a; MPEDA, 2020). While PFZ advisory helps the fishers to locate reliable fish aggregation zone, OSF provides them and their family greater sense security by avoiding the loss of lives and properties (MSSRF, 2014b). It has been cited in several studies that PFZ advisory is found more beneficial for the traditional, motorized, and small mechanized fishing practices, engaging in pelagic capture (Hossain et al., 2015; Balasubramanian, 2015; ESSO-INCOIS, 2020b), however, the benefits of the PFZ and OSF advisories have yet not been assessed well in some states like Odisha, especially in case of SSFs. In this context, the present study has been planned to delineate the role of PFZ and OSF advisories as the geospatial technology in the marine fisheries sector for the sustainable development of small scale fisheries in India with a special focus on the state of Odisha.

STUDY REGION

According to current FAO report, India has emerged as the sixth-largest marine fish producer country after China, Indonesia, USA, Russia, and Peru with 4.5 per cent of the total global contribution. India earned more than ₹45,000 crores through the export of marine products last year. A total of 3288 marine fishing villages are present across the nine maritime states and two UTs (with the exception of Lakshadweep; Andaman and Nicobar Islands) of India (Fig. 1), employing more than 4 million marine fisherfolk population comprising of over 8,64,550 families (CMFRI, 2010a). Nearly 61 per cent of the traditional fishing families are below the poverty line (BPL) and 44 per cent of fisherfolk population are illiterate. Predominantly active fishers are found to be males, while the females are engaged in allied activities (NCAER, 2015). The estimated marine fish landings in 2018 is 3.49 MTs indicating a declined trend by 9 per cent compared to 3.83 MTs in 2017. Due to cyclonic storm, the fishing activities in West Bengal, Odisha, Andhra Pradesh, Tamil Nadu and Puducherry have been affected sparsely. While Gujarat remained in the first position with 0.78 MT marine fish landings (22.4 per cent) among nine maritime states in India followed by Tamil Nadu with 0.70 MT production, The maximum species diversity were recorded from the states of Tamil Nadu and Kerala (735 species) while the bulk landings (63%) were contributed by the southeast and northwest coastal regions of India (DARE-ICAR, 2018).

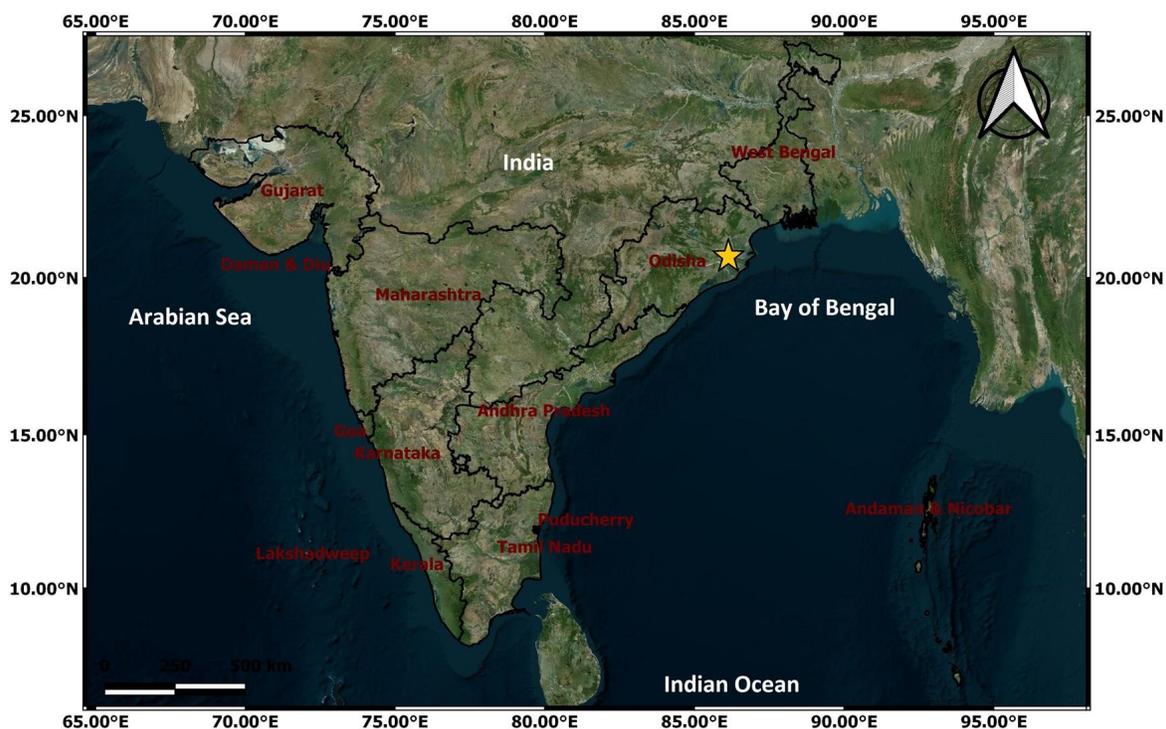


Figure 1: Location of nine maritime states and four union territories (UTs) of India along its 8,118 km of long coastline. Star-mark indicates the state of Odisha in eastern coast in India.

Odisha was ranked 8th with 0.09 MT landings (share only 2.6 per cent of total marine landings in India), with a recent decline of 30 per cent compared to the landings in 2017 in Odisha. Despite the huge potential to harness marine fishes and a resource-base of the second-largest population of active marine fishers, the contributions of Odisha, India has been unremarkable in the recent years attributed to the backwardness of the state (CMFRI, 2010b). Odisha is also vulnerable to weather extremeness i.e., cyclone, storm surges, etc. which also play an important role in the livelihoods of the community (OXFAM India, 2017). As per the study of Dasgupta & Priyadarshini (2019) Odisha has experienced 110 major tropical cyclones which are the highest number among any other Indian maritime states in between 1891 to 2018.

ROLE OF GEOSPATIAL TECHNOLOGY FOR SUSTAINABLE DEVELOPMENT

About 16 million people are engaged in Small-scale Fisheries in India as active fishers and double the number are dependent on the value chain of the fisheries sector (NABARD, 2018). The use of marine fishery advisories in the form of PFZ, produced using geospatial technology has been found to be beneficial throughout the year except during the fishing ban period for the traditional, motorised, as well as small-scale mechanised crafts for pelagic fishing practices in India (Balasubramanian, 2015). Going by the trends, it is expected that the high yielding of marine fishes due to the utilization of PFZ advisory will boost the economy of the SSF community in the coming decade (Karthikeyan, 2012).

• Geospatial technology in marine fisheries

Traditionally, the marine fishers depended on several indicators such as temperature and colour breaks, feeding of birds, presence of foam, accumulation of floating objects, etc. to identify regions of fish aggregation in the sea, which were not based on any scientific input (Miguel & Santos, 2000). Moreover, the unpredictable extreme weather conditions such as tropical cyclone, storm surges, high waves hampered the lives and livelihoods of the marine fishing community (Balasubramanian, 2015). To tackle the challenge of low marine production in the face of extreme weather, the Ministry of Earth Sciences (MoES), Government of India developed satellite-derived PFZ and OSF advisories, disseminated to all the coastal community, except the fishing ban period through its constituent institute INCOIS since 1999 and 2009, respectively. The remotely sensed data, chlorophyll-a and sea surface temperature (SST) are the basic inputs for the development of PFZ advisory (as shown in Fig. 2) while OSF includes the weather forecast related to the wave heights, wave direction, wind speed and wind direction, tides, and currents etc. (ESSO-INCOIS, 2020b, 2020a). PFZ helps the fishers to locate large fish aggregation zones in the ocean with the least searching time while OSF ensures the safety of the marine fishers as a decision-making tool associated with the venturing into the deep ocean, also helpful for the coastal community.

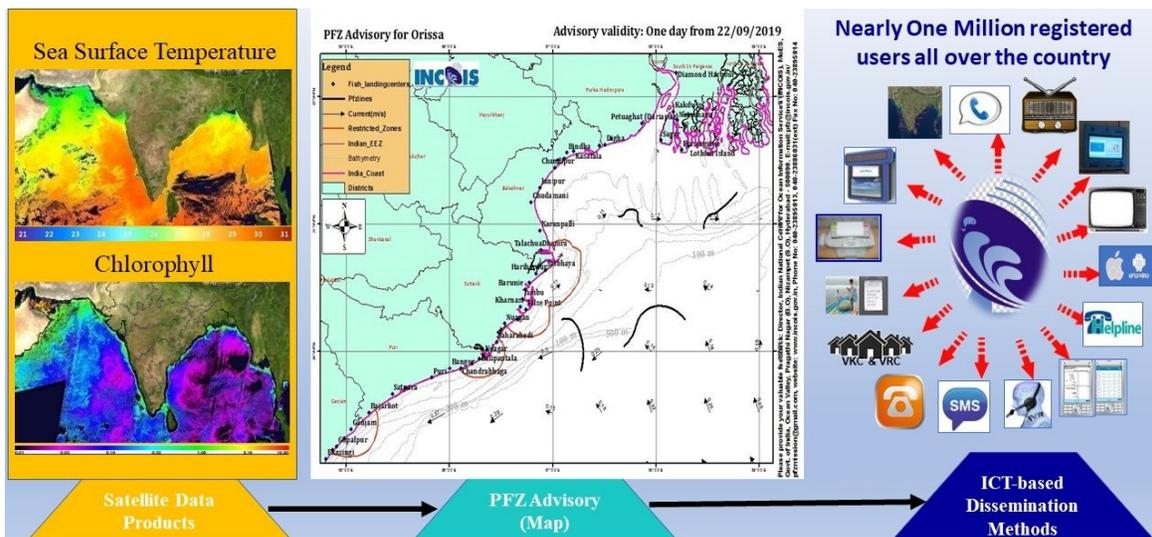


Figure 2: Schematic representation of Potential Fishing Zone (PFZ) advisory preparation and dissemination processes of PFZ to the marine fishers. The inset images of SST and Chlorophyll-a, as well as the PFZ advisory, were provided by ESSO-INCOIS as examples.

• Benefits of PFZ and OSF advisories

Identification of PFZ enhances fish productivity, significantly increase the catch per unit effort (CPUE), reduces the fuel consumption by minimising the searching time (NCAER, 2010). At the same time, OSF advisory has been found to be useful in timing the departure of marine vessels as well as sequencing on-shore activities in the ocean (NCAER, 2010). It is also quite helpful for avoiding fishing expeditions under uncertain weather conditions which can increase the risks. Apart from the economic benefits, PFZ is also environment-friendly as one litre of less diesel consumption can be used to the minimise search times and result in the reduction of 2.63 kgs of carbon-dioxide in the marine environment (NCAER, 2015).

Recent studies conducted by National Council of Applied Economic Research (NCAER), and M S Swaminathan Research Foundation (MSSRF) with the collaboration of INCOIS showed that a considerable population of marine fishers along the

coastal areas of the country accrued enormous economic benefits through the utilisation of PFZ and OSF advisories. These studies also highlight the immense scope for the transformation of the fishery industry to realize enhanced economic benefits to the tune of ₹34,000 crores to ₹50,000 crores per annum through effective use of the PFZ and OSF advisories throughout the country. As shown in Figure 3, effective use of the PFZ and OSF advisories by the marine fishers will increase their CPUE which in turn will enhance the net profit for the fishers while ensuring the safety of their lives and expensive fishing gears and crafts. Case studies have shown that these advisories also improved the preparedness of the fishers to manage their employability in the face of extreme weather conditions (ESSO-INCOIS, 2020a, 2020b) apart from aiding in achieving the targets of Sustainable Development Goals (SDG) 14 prescribed by the United Nations.

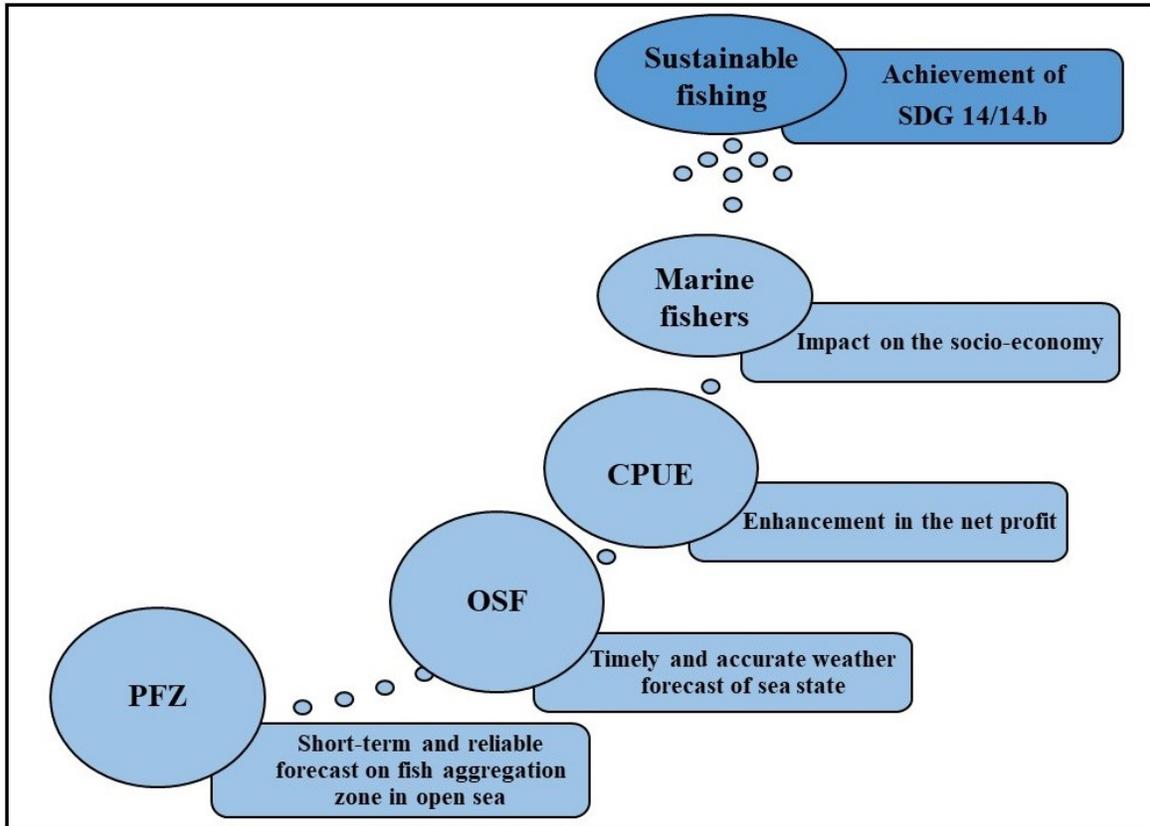


Figure 3: Combined benefits of PFZ and OSF advisories for achieving sustainable development goal 14 (SDG 14)

CHALLENGES IN SMALL-SCALE FISHERIES

SSFs in Odisha suffer from a variety of challenges due to the lack of infrastructure, overfishing, pollution, habitat degradation, insufficient market information, post-harvest losses, weak organizations, a lack of access to financial services etc. which includes fishery resources, land and market, as observed elsewhere in the world (FAO, 2018). Due to the lack of reliable socio-economic data, SSF community also suffer from the lack of technological advancements due to illiteracy, access to modern technology, capital, health care, markets, electricity, education, manpower, etc. (Matthew, 2015). Therefore, it is very crucial to make appropriate legal as well as a regulatory framework to achieve SDG 14, especially 14.b; “provide access for small-scale artisanal fishers to marine resources and markets” for India and for Odisha in particular.

While across the other maritime states and union territories such as Andhra Pradesh, Tamil Nadu, Puducherry, Kerala, Maharashtra, the socio-economic benefits of the PFZ and OSF advisories, have been studied (NCAER, 2010, 2015; Singh, 2012; MSSRF, 2014a, 2014b), while, similar assessments are lacking for Odisha. Moreover, the SSF community of the state stay outside the radar of development planning, regulation and marine policy due to which the productivity of the marine sector has been quite low. Factors such as gender distribution among the fishers, low literacy levels, ownership of crafts and gears as fishing units and differences in the dissemination and levels of assimilation of PFZ advisories among the fishers pose challenges to integrating the socio-economic development with sustainable fishing practices in the state.

SSFs offer Odisha the unique advantage of increased annual sustainable yields within less running costs, resulting in less fuel consumption, low negative impacts on the ecology, and lower construction and maintenance costs (Matthew, 2015). The use of PFZ advisories has the potential to improve the productivity of SSF. Hence, ongoing research on the assessment of the roles of PFZ and OSF advisories for the sustainable development of SSFs in India, especially for Odisha state is quite crucial. Field-based investigations of marine villages associated with fish landing centres across six coastal districts in Odisha to understand the grassroots scenario of the SSF community in Odisha is underway.

CONCLUSIONS

INCOIS has been disseminating PFZ and OSF advisories to the fishing communities since 1999 and 2009, respectively. Presently, the emphasis is being given to the assessment of the impacts of long-term usages of PFZ and OSF advisories, especially on the SSF community to make the process of dissemination and utilization effective. Three variables with respect to the engagement of the SSFs i.e., existing regulators, ongoing guidelines, and existence mechanism identified by FAO, (2018) need to be implemented based on the FAO Code of Conduct for Responsible Fisheries (CCRF) for the Indian scenario, with specific reference to the ground-level assessments in Odisha. Present investigations highlight the absence of reliable methods to collect the information at a national level which can include a multi-stakeholder, multi-disciplinary and participatory approach. A holistic database to evaluate the status of the SSF in the developing nations like India where exchanges of thoughts at various levels among the countries can take place is the need of the hour (FAO, 2018).

Capacity building program for the use of geospatially-derived advisories is another key area, which needs to be recognized. . Technological challenges in the use of ICTs for disseminating need to be addressed through the workshop, media campaigns, pieces of training, social media etc. to the target groups. A recent programme of the Government of India, (2020) such as the formulation of national indicator framework to assist the traditional fishers for attaining the advantageous fishing unit combinations to maximise yields and the use of Fibre Reinforced Plastic (FRP) boats along with other associated fishing implements in an annual basis need to be evaluated periodically to derive suitable policy frameworks to ensure sustainable development.

DISCLOSURES

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Sudip Kumar Kundu is currently a PhD Scholar under Energy and Environment Programme (EEP) in National Institute of Advanced Studies (NIAS), IISc campus, Bengaluru. His area of interests includes the following: Assessment of socio-economic impacts of PFZ and OSF advisories, Geospatial analyses of multi-platform datasets related to the preparation of fishery advisories, Marine fishing population welfare, Climate data analysis, Changing pattern of rainfall under climate change scenarios. During 2018-19, he was associated with Centre for Atmospheric and Oceanic Sciences, IISc. He has an MTech degree (Distinction) from the Indian Institute of Remote Sensing (IIRS), Dehradun in Remote Sensing and GIS with specialization in Marine and Atmospheric Sciences. Apart from this, he has a BSc (Honours) in Geography with Mathematics and Physics as general subjects from Chandernagore College under The University of Burdwan. He has also participated and presented more than ten papers in different National/International level seminars, conferences, and workshops across the country. He has a UGC NET Lectureship in Geography.

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Dr. Harini Santhanam an environmental scientist with experience in studying multiple aspects of coastal systems such as biogeochemistry, hydro-geological processes and land-water-human nexus from an ecosystem perspective. She has been a long-term researcher with IISc Bangalore, working in multi-disciplinary teams with a focus on water-related issues. She has a PhD in coastal ecosystem modelling and an M.Sc. degree in Environmental Science from Anna University, Chennai. Recently, she has also been the Principal Investigator of a DST-funded Woman Scientists project (2015-2018) at IISc. Her research interests include the use of integrated modelling approaches for aquatic ecosystem investigations and investigating short-term and long-term changes of lacustrine systems using environmental proxies.

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Prof. R Srikanth is Professor and Dean School of Natural Sciences and Engineering, Head of the Energy and Environment Programme at NIAS. He graduated from the Indian School of Mines in 1984, and received the ISM Gold Medal in Mining Engineering. He worked in coal mines for six years before commencing research on projects funded by the US Bureau of Mines at Pennsylvania State University, where he obtained a dual PhD in Mining Engineering & Operations Research in 1996. His work experience spans across, operations, projects, strategy, and governance, while his research interests include energy studies, sustainability, minerals, public policy and management. In addition to his work at NIAS, he is actively involved with the Government of India on areas related to energy and environment.

ABSTRACT

The total fish production in India is estimated to be 13.42 million metric tons (MT) of which nearly 3.71 MT are contributed by marine fisheries. The fisheries sector provides direct livelihood support to approximately 16 million people, of which marine fishers constitute a dominant subset and almost double the number along the value chain. In the past, the fisheries community in India had relied on traditional indicators of fish abundance such as the congregation of birds, colour of sea water, bubble breaking in the sea water and muddy/oily water on the sea surface in their traditionally known fishing grounds. The increased frequency of extreme weather events observed in recent times, have been related to major losses in marine ecosystem services. Further, the livelihoods of Small Scale Fisheries (SSF) communities are endangered not only by their limited understanding of the magnitude of the risks associated with natural hazards but also by the diminishing returns of relying on traditional knowledge for accurate prediction of the fishing stock at their usual locations.

Therefore, the Government of India has launched several programs to use geospatial technologies for the benefit of marine pelagic fisheries in India for the sustainable development of the SSF communities. However, the lives of SSF communities are also challenged by complex, inter-linked socio-economic factors. In this paper, we focus on the maritime state of Odisha which is affected by several extreme weather events (cyclones) in the Bay of Bengal. We describe the socio-economic and technological factors which determine the degree of assimilation of the Potential Fishing Zone (PFZ) and Ocean State Forecast (OSF) advisories provided by the Indian National Centre for Ocean Information Services (INCOIS) with a focus on the threads linking natural and anthropocentric factors that produce significant changes in the Catch Per Unit Effort (CPUE) and net profit for pelagic fisheries of Odisha. More importantly, we identify the research and implementation gaps that must be addressed so that science, technology, and societal interactions can be used to enhance the sustainable development of the SSF communities.

Keywords: Potential fishing zone, Catch per unit effort, Ocean state forecast, Geospatial technology.

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