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# IDENTIFYING MESOSCALE EDDIES- RELEVANCE TO MUD BANKS AND FISHERY

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## Mud bank fisheries - an introduction

The most popular fishing area during mud bank formation in Kerala is off Punnapra coast in Alapuzha district. This place is equipped with unique crafts such as one-man operated expanded polystyrene thermocol made gill netters, and several other traditional crafts. The fishermen community along this coast is vigilant against any mechanized fishing during mud bank period which falls in the southwest monsoon months when there is a ban on mechanized crafts. There are comparable datasets, from mud bank vis-à-vis non mud bank in this region, which indicate that, the catch per unit effort (CPUE) do not vary significantly. Fishing in Thrissur and Malappuram districts are not restricted by the formation of mud banks. In these districts modified outboard crafts such as pair trawlers operating double net and the high horse power of the out board engines are generally on a look out for non-mud bank resources also. In Malappuram district, the occurrence of the mud bank fishery is for limited days and generally less reported. Therefore, the analysis of data sets indicated better production and CPUE from non-mud banks in Malappuram. In general we can say that there is no significant increase in abundance of fishes reported from the mud bank regions. But the calm waters generated at certain pockets of the otherwise disturbed coastal waters act as areas for seasonal landings of fish.

The pattern of occurrences of different fish species during the mud bank season is also associated with the physical formations. A highly benthic fish *Trypauchen vagina* which is not a commercial fishery is considered as an indicator of mud bank formation. The possible triggering for the upward movement of this benthic fish is due to the physical presence of anoxic or low oxygenated waters associated with upwelling which is setting along with the physical formation of mud banks. There is a progressive succession of other benthic crustaceans such as *Metapenaeus dobsoni* of higher size popularly known as 'Poovalan Chemmeen' and *Fenneropenaeus indicus,* Indian white shrimp. During certain years there are notable landings of Indian oil sardines in the mud bank which are the dominant pelagic fishes in these regions. But during sardine deficient years, mackerel, lesser sardines and anchovies tend to dominate in the pelagic fishery of mud banks.

**Table: Fishing pattern and catch per unit effort (kg/hr) in mud bank and non-mud bank regions in Kerala**

| District | Year | Mechanized | | Non-motorized | | Motorized | | p-value |
|---|---|---|---|---|---|---|---|---|
| | | MB | NMB | MB | NMB | MB | NMB | |
| Alappuzha | 2013 | 0.00 | 633.48 | 10.15 | 13.43 | 269.18 | 208.09 | 0.267 |
| | 2014 | 0.00 | 924.32 | 18.20 | 17.37 | 364.05 | 163.27 | |
| | 2015 | 777.03 | 460.75 | 23.74 | 16.33 | 329.66 | 121.61 | |
| Thrissur | 2013 | 948.57 | 2094.54 | 163.42 | 12.85 | 218.58 | 64.24 | 0.77 |
| | 2014 | 1090.91 | 1204.93 | 29.35 | 8.17 | 207.14 | 26.46 | |
| | 2015 | 493.10 | 1904.58 | 22.63 | 13.43 | 148.60 | 32.63 | |
| Malappuram | 2013 | 1874.65 | 1526.33 | 0.00 | 10.24 | 385.60 | 43.58 | 0 |
| | 2014 | 1814.81 | 716.16 | 0.00 | 18.86 | 222.82 | 34.41 | |
| | 2015 | 1083.53 | 1116.15 | 9.81 | 21.12 | 258.73 | 34.83 | |
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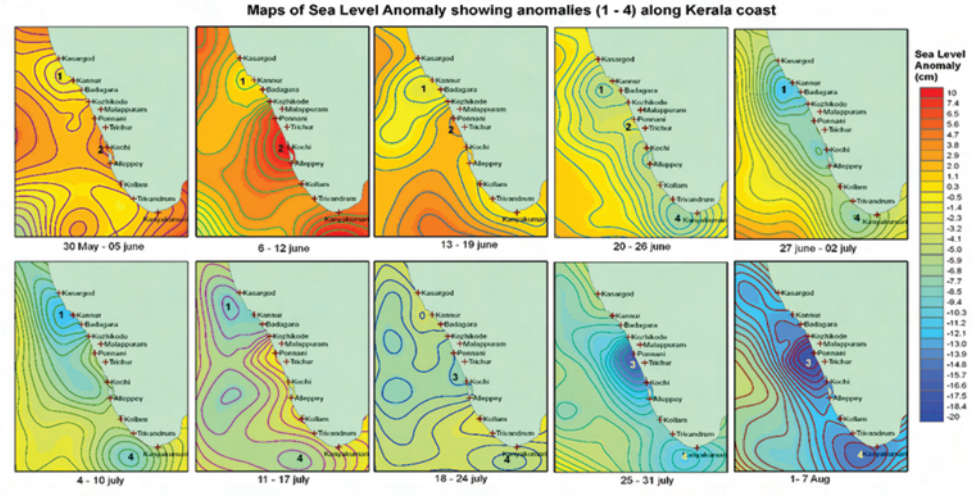


*Map 1. Map showing the sea level anomaly along Kerala coast*

The mean sea level anomaly was slightly positive along Malappuram coast of Kerala before second week of June in 2013. During second of June, the mean sea level anomaly started to become negative (fall) at Malappuram, while same was positive in southern coast. The intensity of fall in sea level further increased in third week of July and at same time drop in sea level anomaly appeared at Thrissur, Alappuzha and Kanyakumari. The appeared fall in sea level was further intensified at these coasts and reached a peak during the first week of August (Map 1).

Coastal eddy forms in Malappuram Thrissur, Alappuzha and Kanyakumari coast during southwest monsoon. Coastal eddies pumping nutrients and biogenic material from deep to shallow waters, whereby generate large productivity in the centre of upwelling cyclonic eddies and at the periphery of convergent anticyclonic eddies (Oschlies and Garcon, 1998; Mordasova *et al.*, 2002, Kahru *et al.*, 2007 and Waite *et al.,* 2007). The change in the West Indian coastal current (WICC) is associated with the change in season. By early January, positive anomalies of sea level spread offshore and northward along the west coast of India and by April, positive anomalies in the sea level are seen all over the Arabian Sea. But the sea level anomalies become low during south-west monsoon (Shetye, 1998), which was observed in current study, the mean sea level anomaly was slightly positive along Malappuram coast of Kerala before second week of June in 2013, while sea level anomalies drops in second week of June at Malappuram coast. Similar result was observed in south west coast of India by (Shetye, 1998). Negative Sea Surface Height Anomalies (SSHA) associated to a negative Indian Ocean Dipole phase induce a shift in the intensity and position of the tropical eddies (Palastanga *et al.,* 2006), which support our result where last week of May, coastal eddy started at Malappuram region. Further, the oceanographic feature might have changed comparatively in southern coast of Kerala and favoured the development of coastal eddy at Thrissur, Alappuzha and Vizhinjam region. The chlorophyll-a concentration in seawater is increased during upwelling, associated with negative mean sea level anomalies, while positive sea level anomalies create down welling in the sea (Kahru *et al.*, 2007). Coastal eddy enhances biological production in the ocean by increasing the net upward flux of limiting nutrients. Here, we examine temporal and spatial relationship between satellite-derived eddy appearance and sea surface anomalies.Temperature inversion takes place 30-50 metres depth due to the eddy (Beena *et al.*, 2005), which might favour the several poikilothermic fish species in the eddy region. We have examined that fishermen are involved in fishing up to 40 m depth by comparatively high inboard seine netter, where there was no significance difference in the catch per unit effort between mud bank and non-mud bank region at Alappuzha and Thrissur. Mud banks are seen within the depth 15 m (Muraleedharan *et al.,* 2017), provide a favourable and calmness water condition even roughest monsoon season for traditional fishermen. Thus, our result show that the appearance of eddy improves

the productivity rather than only the mud has the role in enhancement of fish biomass. We examine that mud bank is dominated by small pelagic resources such as *Sardinella longiceps*, Anchovy, other clupeids, sciaenid, carangid and *Rastrelliger kanagurta*, which are planktivorous fish and directly associated with primary productivity in the eddy occurrence zone (Cury *et al.*, 2000). The high biomass of *M. dobsoni* in the mud bank area might be linked with high load of detritus organic material in the mud bank where sunlight penetration is less (Reghunathan *et al.*, 1981). The mud deposition focus on physical and geological aspects of the process rather than on biodiversity (Mont'Alverne *et al.*, 2012). This is supported by our result that there are no statistically significant (p values > 0.05) in CPUE of mud bank is same as CPUE of non-bank for Alleppey and Thrissur districts. However, large number of different types of non-mechanized and motorized crafts are engaged in mud bank area due to calmness of surface in mud bank region.

A localized eddy started to appear in last week of May along the coast of Malappuram, before the monsoon strike in India at first time at Kerala. But by the entering of monsoon in Kerala, the expansion of eddy at pre-existed area is taken place and at the same time the formation of eddy is taken place on different possible zone such as near Thrissur, Alappuzha and Vizhinjam. By the starting of monsoon, a huge river discharge brings the mud through the coastal region of Kerala coast, but appear at northern coast due to the demarcation in coastal topography. Therefore, southern part of Kerala does not show the appearance of mud bank even though there is an existing negative sea level anomaly and eddy during the south west monsoon. Muddy/sandy bottom of northern part of Kerala support to form calm sea surface, which provide the stability of fishing craft in monsoon season, but the primary productivity might be enhanced by localized appearance of eddy and negative level anomalies with huge nutrient rich river discharge rather than only mud bank formation in the area.

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