Climate Change and Marine Fisheries: Stakeholders' Perspective from Coastal District of Odisha, India


## ABSTRACT

The marine fisheries sector is badly affected by the impact of climate change.The small-scale fishing communities, their livelihoods and the infrastructure are more vulnerable to the impacts of climate change, but it has been occasionally investigated at the regional level. Climate change literature and various reports from government and international agencies indicate that Coastal Odisha is one of the hotspot regions as far as the occurrence of extreme weather and slow-onset events are concerned. It is in this context the paper attempts to study how climate change is affecting the small-scale marine fishers through a case of Kendrapara district of Odisha. The paper attempts to understand the overall fish production scenarioand captures the perceptions of small-scale marine fishers regarding different climate and non-climate drivers through focus group discussions and key informant interviews. The findings from the paper reflect that marine fishers recognize the impact of climate change on the sector in terms of dwindling fish catch, reduction in number of fishing days, longer fishing trips and damage to boats and nets. The small scale marine fishers also believe that the impact of climate change in future will be so severe that their land and settlements might be engulfed completely by sea.



Keywords: *Climate Change, Marine fisher folk communities, Coastal Odisha, Stakeholder Perception*


## 1. INTRODUCTION

The Intergovernmental Panel on Climate Change (IPCC) latest sixth assessment report, 2021, states in the coming decades, thenegative impact of climate change will be felt across all regions of the globe. According to the India Network for Climate Change Assessment (INCCA, 2010) report by the Ministry of Environment and Forest, Government of India,Odisha is among 13 coastal states in India, which is more susceptible to sea level rise and cyclones in the country. The report also highlights that a large chunk of the coastline's population depends on climate-sensitive sectors such as marine fisheries and agriculture. The coastline of Odisha is prone to cyclonic disturbances(Patwardhan et al., 2003; Chittibabu et al., 2004; Kumar et al., 2006; Sharma et al., 2008; Bahinipati et al., 2012; Kumar et al., 2010). In the last decade, around ten cyclones of different intensitieshave affected Odisha's State, particularly coastal Odisha. The aftermath was extensive damage to agriculture and its subsectors such as fisheries, telecom and energy sectors (Annual Reports on Natural Calamities 2001-2013, Special Relief Commissioner,Government of Odisha).These cyclonic events have affected the livelihood of many vulnerable people dependent on the climate-sensitive sector(Bahanipati et al., 2012).Despite this high level of vulnerability due to changing dynamics of climate change, Odisha has been very successful in managing natural disasters and keeping the number of casualtiesto a minimum.

Climate change impacts marine fisheries through various variables, such as rising sea surface temperatures, circulation patterns, ocean acidification and the frequency and severity of extreme weather events(Badjecket al.,2010). This leads tothe migration of fish, breeding behaviour, growth, mortality, and reproduction(Brander, 2010). The effects of climate change on marine fisheries include alterations in the distribution, quantity, composition of species, and a reduction in biodiversity (Vivekanandan, 2011). As a result, susceptible species may no longer be economically viable, leading to a decline in catches and potentially forcing fishermen to relocate to inland regions (Vivekanandan, 2011).

The fisheries sector plays a crucial role in the socio-economic development of Odisha. Apart from generating income and creating employment opportunities, it also contributes to the development of related industries. This sector serves as a primary source of livelihood for a considerable portion of the vulnerable population of the state.Enhancing the fisheries industry and its ability to withstand the effects of climate change has the potential to address food insecurity and unemployment in the area. However, the prevalence of climate-related natural calamities in the Bay of Bengal region, specifically in the state of Odisha, has made marine fishing a vulnerable livelihood option. Thus, the paper's objective is to understand the overall fisheries productionscenario vis-à-vis marine fisheries status; and to capture fishing communities' perception regarding changing climate change dynamics.

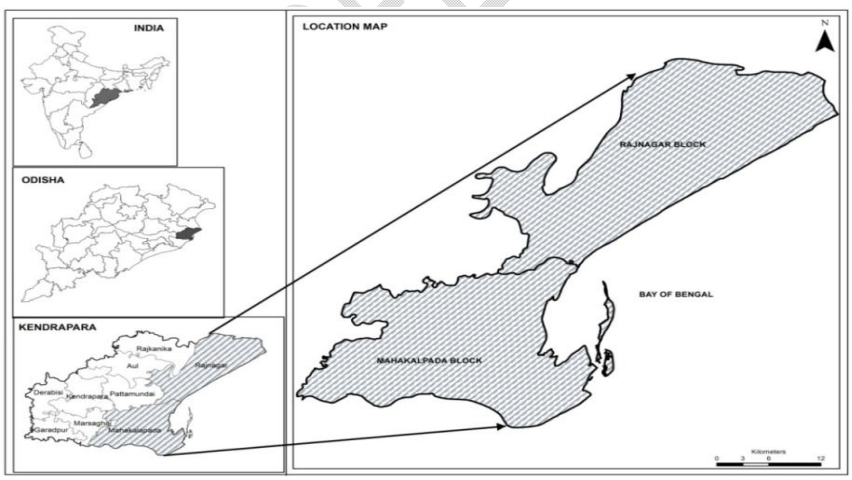
**Comment [mp1]:** This section should be supplemented with scientific data (results of previous research) related to the impact that fishermen are already feeling due to climate change, and to make it easier to draw conclusions, this section should also be added with specific research questions.

## 2. STUDY AREA AND METHODOLOGY

### 2.1 Study Area Description

Kendrapara district in the State of Odisha, India,is one of the vulnerable coastal districts in the context of climate-induced natural disasters such as cyclonic disturbances, flooding, and coastal erosion.The district falls in the high risk zone category in terms of cyclone vulnerability(EM-DAT: The OFDRA/CRED, International Disaster Database and cyclone e-atlas, IMD). The district also falls in the category of high risk flood zones(Radarsat dataof different years).Thus, afteranalyzingdifferent indicators of climate change, as mentioned above, it can be inferred that climate-induced natural hazards impact the Kendrapara district in a significant way. This article focused on understanding the marine fishing communities residing in the two blocks (Rajnagar and Mahakalpara) in the Kendrapara district of Odisha. Thetwo blocks were chosenpurposively because of their proximity to the sea and high vulnerability to climate-induced natural disasters.

Figure 1: Study Area Map




### 2.2 Methodology

The methodology adopted was qualitative techniques (such as focus group discussions and key informant interviews) for collecting perception data regarding the small-scale marine fisherfolk communities. The authors have undertaken a field visit to Rajnagar and Mahakalpara blocks in the Kendrapara district of Odisha.

Eightfocus group discussions (FGDs) and around 25 Key Informant Interviews (KIIs)were conducted to understand the perception of climate change, how it affects marine fishing communities and also reflect upon other non-climate drivers that are exacerbating the pre-existing vulnerabilities. The author utilized their personal network and the "snowball sampling" technique (Biernacki & Waldorf, 1981) to reach out to respondents. While this approach may result in biased sampling and limited generalizability, it is often the only way to access respondents, particularly in developing countries where personal referrals are crucial (Cammett, 2006).

The FGDs included both men and women to consider gendered differences in perception. At the beginning of the discussion, the concept of climate change and its indicators was discussed with the fishing communities to understand their knowledge level and tounderstand their traditional knowledge about climate change indicators and their impacts. The respondents were asked to provide their perceptions regarding indicators and the impact of climate change. In the FGDs, different livelihood groups, such as boat owners, shared boat owners, net menders and fish traders, participated.

……..

**Comment [mp2]:** Kindly,
1.Create subtitles here (Result)
2.Please write down the data that the researcher has collected, such as the results of interviews or the results of focus group discussions, also include the results of data reduction or extraction so that they can answer research questions
3.The results of extracting information about perception regarding changing climate change dynamics of fishing communities are not yet clearly described, please write this down in the results and conduct an adequate discussion

## 3. DISCUSSION AND ANALYSIS

### 3.1 Fish Production in Odisha-Coastal District Scenario

Odisha has a high potential for inland, brackish and marine fishery resources. It has a long coastline of 480 km with a continental shelf area of 24,000 sq. km along the Bay of Bengal. The fish production in Odisha from 2000-01 to 2020-21is reflected in Table-1. It shows the quantity of fish production from inland (i.e., freshwater and brackish water) and marine. TheAGRof fish production from inland fisheries shows positive but fluctuates over the period. The growth rate of inland fisheries was 0.73%, lowest in 2013-14 and was 20.73%, highest in 2016-17. The production from the source of marine fisheries is not impressive. The AGR was negative over the three years (2001-02, 2009-10 and 2011-12). In other years, it was positive. The highest growth rate of fish production from marine water accounted for 10.99% (133211 MT) in 2014-15. On the other hand, the lowest growth rate was 14.37% (114296 MT) in 2011-12. The fish production from all sources (both inland and marine) indicates aggregate production. The trend of fish production rose from 2000-01 to 2008-09. The aggregate fish production was highest (16.66%) in 2016-17. However, the growth rate dropped to 13.45, 11.02 in 2014-15 and 2015-16. In particular, the AGR of fish was negative (-1.11 and -1.13) during 2009-10 and 2011-12. If we took a look at marine fish production (i.e., capture fisheries) in 2001-02, the marine fish production registered a negative annual growth rate of (-5.94%) and during the decade from (2001-02 to 2009-10) it increased at a decreasing rate and even in 2009-10, again the AGR was negative (-4.54). Overall in marine fisheries, the AGR has been fluctuating; for instance, in 2014-15(AGR was -10.99%) and 2012-13(AGR 3.51%) and in 2013-14(the AGR 1.44%).

**Table 1: Fish production in Odisha (in MT)**

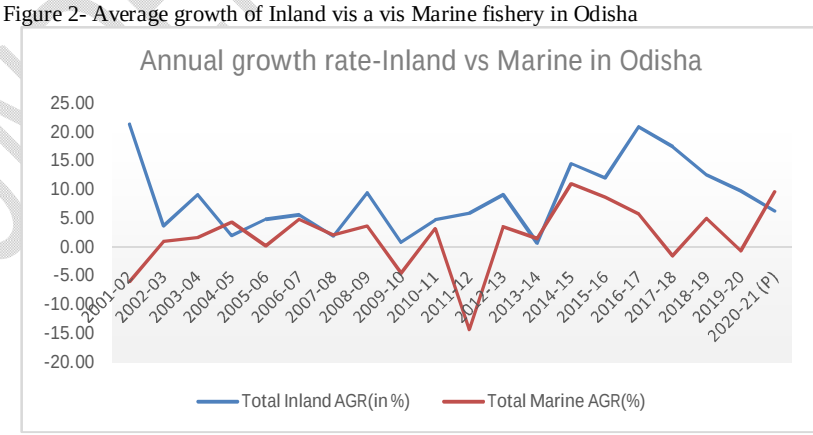
| Year | Freshwater | Brackish water | Total Inland | AGR (in %) | Marine | AGR (in %) | Grand Total | AGR (in %) |
|---|---|---|---|---|---|---|---|---|
| 2000-01 | 125114 | 13442 | 138556 | | 121086 | | 259642 | |
| 2001-02 | 147400 | 20660 | 168060 | 21.29 | 113893 | -5.94 | 281953 | 8.59 |
| 2002-03 | 154237 | 19964 | 174201 | 3.65 | 115009 | 0.98 | 289210 | 2.57 |
| 2003-04 | 165594 | 24477 | 190071 | 9.11 | 116880 | 1.63 | 306951 | 6.13 |
| 2004-05 | 170091 | 23776 | 193867 | 2.00 | 121929 | 4.32 | 315796 | 2.88 |
| 2005-06 | 179740 | 23495 | 203235 | 4.83 | 122214 | 0.23 | 325449 | 3.06 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 2006-07 | 191632 | 22951 | 214583 | 5.58 | 128141 | 4.85 | 342724 | 5.31 |
| 2007-08 | 195747 | 22969 | 218716 | 1.93 | 130767 | 2.05 | 349483 | 1.97 |
| 2008-09 | 213003 | 26332 | 239335 | 9.43 | 135487 | 3.61 | 374822 | 7.25 |
| 2009-10 | 215803 | 25508 | 241311 | 0.83 | 129332 | -4.54 | 370643 | -1.11 |
| 2010-11 | 224956 | 27750 | 252706 | 4.72 | 133479 | 3.21 | 386185 | 4.19 |
| 2011-12 | 237470 | 30062 | 267532 | 5.87 | 114296 | -14.37 | 381828 | -1.13 |
| 2012-13 | 261919 | 29914 | 291833 | 9.08 | 118311 | 3.51 | 410144 | 7.42 |
| 2013-14 | 263862 | 30007 | 293869 | 0.70 | 120020 | 1.44 | 413889 | 0.91 |
| 2014-15 | 300964 | 35373 | 336337 | 14.45 | 133211 | 10.99 | 469548 | 13.45 |
| 2015-16 | 336216 | 40307 | 376523 | 11.95 | 144755 | 8.67 | 521278 | 11.02 |
| 2016-17 | 393730 | 61268 | 454998 | 20.84 | 153102 | 5.77 | 608100 | 16.66 |
| 2017-18 | 454189 | 79936 | 534124 | 17.39 | 150839 | -1.48 | 684963 | 12.64 |
| 2018-19 | 506608 | 94033 | 600641 | 12.45 | 158321 | 4.96 | 758962 | 10.80 |
| 2019-20 | 543049 | 116099 | 659148 | 9.74 | 157310 | -0.64 | 816458 | 7.58 |
| 2020-21 (P) | 574983 | 125521 | 700504 | 6.27 | 172469 | 9.64 | 872973 | 6.92 |

Source: Directorate of Fisheries, Govt. of Odisha, Note- AGR (Annual Growth Rate), MT-Million Tonnesand P-Provisional

The fish production from all sources (both inland and marine) indicates aggregate production. The trend of fish production was on the rise from 2000-01 to 2008-09. However, after that, it fluctuated with positive and negative growth rates. The comparison between marine fish production and total fish production in Odisha during 2000-01 to 2020-21 is depicted in Figure1. It is apparent that the total fish production has increased consistently, while the production of marine fish has been fluctuating over the period. The fluctuating growth of marine fish production has caused the total quantity of production to grow at a slow rate. It is also observed from the data that in the years when a natural disaster, generally a severe cyclonic storm, strikes, like Cyclone Phailin in the year 2013-14, the AGR fluctuated, and it came down in comparison to the previous year. The same pattern of observation can be inferred in the year 2019-20, where the AGR was negative(-0.64%).Thus, during focus group discussions and key informant interviews with marine fishing communities in Rajnagar and Mahakalpara blocks, the fishers community were of the view that the fish catch declined during the cyclone-affected years, and they mentioned that in the Bay of Bengal region, the number of depressions/ deep depressions have increased which result in loss of fishing days and subsequently reduces fish catch.

Figure 2- Average growth of Inland vis a vis Marine fishery in Odisha



*Source: Directorate of Fisheries, Govt. of Odisha*

The marine fishers believed that their fishing trips had reduced considerablydue to the changingdynamics of weather and climate. Due to the deep depressioninthe Bay of Bengal region, we lose around 35 to 40 fishing days on average. The small-scale fishers believed that 20-25 years back, our trips used to be shorter, and we used to catch a good number of different varieties of fish. But now,the fish catch diversity has also reduced. This has affected our livelihood and earnings from the fisheries sector. Thefindings from the focus group discussion corroborate with research undertaken by Central Marine Fisheries Research Institute (Zacharia, 2016).

According to Zacharia et al. (2016), a study conducted on the east coast of India has found that various fish species in the region are susceptible to the impacts of climate change. Out of the 68 species studied, 69% were identified as vulnerable to the effects of climate change. These species include Bombay duck, tuna, sharks, different types of shrimp, pomfrets, and catfish. The study indicates that fish living near the surface or inhabiting surface waters, such as tuna, mackerel, and sardines, are the most affected by changes in temperature. Additionally, the research suggests that overfishing contributes to the increased sensitivity of these fish species to climate fluctuations. Thus, the vulnerability of fishing communities in the area is not only due to changes in climatic conditions but also the pressure from fishing and reduced productivity.

Table 2below depicts the district-wise production of marine fish in Odisha from 2000-01 to 2020-21. The districts are Balasore, Bhadrak, Jagatsinghpur, Kendrapara, Puri, and Ganjam. In the Balasore district, the highest growth rate (18.05%) was recorded in 2014-15 and the lowest (-22.30%) in 2011-12. Similarly, the AGR of marine fish production in Bhadrak district was registered with the highest (13.43%) in 2012-13. In contrast, this district was recorded with the lowest production growth rate (-22.63%) in 2011-12. Likewise, Jagatsinghpur district accounted for 20.52% (36632 MT) as the highest AGR of marine fish production in 2014-15. However, the district has accounted for a negatively high growth rate of fish production (-19.58%) in 2011-12. In Kendrapara district, the highest quantity of marine fish production was 13594 MT in 2001-02, and the corresponding lowest quantity was 4798 MT in 2009-10. Regarding AGR, the district recorded the highest growth rate (52.59%) in 2013-14 and the lowest (-34.84%) in 2009-10. Thus, from the data, we can conclude that marine fish production in coastal districts of Odisha has been fluctuating, with positive and negative growth rates during the last decade.

Table 2: District-wise production of marine fish from 2001 to 2016-17(in MT)

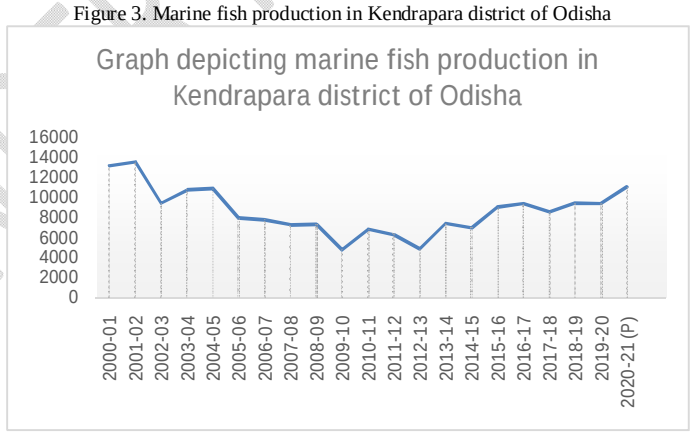
| Year | Balasore | AGR (in %) | Bhadrak | AGR (in %) | Jagatsinghpur | AGR (in %) | Kendrapara | AGR (in %) | Puri | AGR (in %) | Ganjam | AGR (in %) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2000-01 | 34915 | | 9350 | | 33899 | | 13206 | | 22939 | | 6777 | |
| 2001-02 | 30341 | -13.10 | 9216 | -1.43 | 28196 | -16.82 | 13594 | 2.94 | 25168 | 9.72 | 7378 | 8.87 |
| 2002-03 | 32009 | 5.50 | 10405 | 12.90 | 28527 | 1.17 | 9483 | -30.24 | 26164 | 3.96 | 8421 | 14.14 |
| 2003-04 | 30061 | -6.09 | 10001 | -3.88 | 29344 | 2.86 | 10795 | 13.84 | 27503 | 5.12 | 9176 | 8.97 |
| 2004-05 | 32400 | 7.78 | 10853 | 8.52 | 29985 | 2.18 | 10923 | 1.19 | 27911 | 1.48 | 9857 | 7.42 |
| 2005-06 | 33788 | 4.28 | 10856 | 0.03 | 31008 | 3.41 | 7971 | -27.03 | 28557 | 2.31 | 10034 | 1.80 |
| 2006-07 | 34938 | 3.40 | 11854 | 9.19 | 33179 | 7.00 | 7787 | -2.31 | 30283 | 6.04 | 10100 | 0.66 |
| 2007-08 | 35163 | 0.64 | 11973 | 1.00 | 33026 | -0.46 | 7289 | -6.40 | 32243 | 6.47 | 11073 | 9.63 |
| 2008-09 | 35916 | 2.14 | 12310 | 2.81 | 34388 | 4.12 | 7363 | 1.02 | 34325 | 6.46 | 11185 | 1.01 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2009-10 | 35998 | 0.23 | 12811 | 4.07 | 33012 | -4.00 | 4798 | -34.84 | 31431 | -8.43 | 11282 | 0.87 |
| 2010-11 | 35183 | -2.26 | 12631 | -1.41 | 35656 | 8.01 | 6853 | 42.83 | 31880 | 1.43 | 11276 | -0.05 |
| 2011-12 | 27338 | -22.30 | 9773 | -22.63 | 28675 | -19.58 | 6339 | -7.50 | 31000 | -2.76 | 11171 | -0.93 |
| 2012-13 | 27234 | -0.38 | 11086 | 13.43 | 32971 | 14.98 | 4898 | -22.73 | 30774 | -0.73 | 11348 | 1.58 |
| 2013-14 | 29819 | 9.49 | 11076 | -0.09 | 30395 | -7.81 | 7474 | 52.59 | 30938 | 0.53 | 10319 | -9.07 |
| 2014-15 | 35201 | 18.05 | 11721 | 5.82 | 36632 | 20.52 | 7009 | -6.22 | 30989 | 0.16 | 11659 | 12.99 |
| 2015-16 | 39327 | 11.72 | 12006 | 2.43 | 34503 | -5.81 | 9059 | 29.25 | 37979 | 22.56 | 11881 | 1.90 |
| 2016-17 | 39490 | 0.41 | 12001 | -0.04 | 40284 | 16.76 | 9409 | 3.86 | 39598 | 4.26 | 12320 | 3.69 |
| 2017-18 | 38017 | -3.73 | 12060 | 0.49 | 41319 | 2.57 | 8566 | -8.96 | 38906 | -1.75 | 11971 | -2.83 |
| 2018-19 | 43133 | 13.46 | 13010 | 7.88 | 42469 | 2.78 | 9475 | 10.61 | 38033 | -2.24 | 12201 | 1.92 |
| 2019-20 | 41100 | -4.71 | 13358 | 2.67 | 42725 | 0.60 | 9399 | -0.80 | 38165 | 0.35 | 12563 | 2.97 |
| 2020-21 (P) | 45085 | 9.70 | 15583 | 16.66 | 43634 | 2.13 | 11076 | 17.84 | 42000 | 10.05 | 15091 | 20.12 |

Source: Directorate of Fisheries, Govt. of Odisha

The trend of marine fish production in Kendrapara district is reflected in Figure 2 shows a downward trend until 2009-10. However, it started rising after that year, but production kept on fluctuating. Thus, it can be said that marine fish production was not impressive in the Kendrapara district. The decrease in capture fisheries and subsequently fluctuating production prompted the authors to understand the driversbehind this trend.In the context of the table below, it was observed that marine fish production has fluctuated in the Kendrapara district of Odisha. The table below depicts the picture in a graphical representation.

Figure 3. Marine fish production in Kendrapara district of Odisha




Source: Data sourced from the Directorate of Fisheries, Government of Odisha

So, in this context, an empirical study was conducted to understand how different climate and non-climate drivers have affected marine fishing communities. The next section deals with the divers of climate change as perceived by the community and reflects on how non-climate drivers affect the marine fishing communities in the context of the study area.

3.2 Perception of Marine Fishing Communities

The fishers' perceptions of climate change were captured through FGDs and KIIs regarding their understanding of different climate variables and how they affect marine fisheries.

**3.2.1 Climate drivers**

Increase in frequency and intensity of cyclonic storms

The fishermen were of the view that "climate has changed definitely". It has been reflected in terms of the increase in frequency and intensity of cyclonic storms. These storms caused extensive damage to the fishing industry, including infrastructure, fishing gear, and the livelihoods of fishermen. Moreover, in the Bay of Bengal, the low pressure reduced depressions brings bad weather and rainfall, restricting our fishing trips and reducing the number of fishing days.

To quote one of the respondents- *"It is still vivid in my memory the massive destruction from the 1999 super cyclone. I have also witnessed back-to-back cyclones in the year 2013 and 2014. Now, summer cyclones have become quite a regular phenomenon. Cyclone "Fani" followed by cyclone Amphan has caused huge-scale devastation. One of the prime indicators of climate change is that very few high-value species are seen nowadays. If we set a timeline and observe the trend, 30-40 years ago, there were abundant fish species, but now it hardly comes in our catch" Respondent, Age-55, Rajnagar Block, Kendrapara*

Rise in temperature

The marine fishing communities understand the impact of rising temperatures. They believe that the rise in sea surface temperature plays a significant role in determining the fish catch and types of species being caught. The perception of small-scale marine fishermen is that the increase in sea surface temperature, along with pollution from industries, has significantly impacted the entire sea ecosystem. According to the fishermen, many pelagic species have moved to lower layers of the sea.

Changes in wind patterns and seasonality

The seasonal wind patterns have changed; winds bringing fishhave changed overtime. The fishing communities rely on the monsoons just as much as the farming communities, and if the monsoons are late or inadequate, it can have significant impacts on them as well. The arrival of monsoons, particularly the southwest monsoon, is crucial for successful fishing. However, the monsoons have become more unpredictable, leading to changes in seasonal patterns and a reduction in the catch of some important fish species.

Coastal erosion

During an FGD at Rajnagar block of Kendrapara district of Odisha- the communities recounted that "the sea is eroding our land and settlements, and we soon realized that we must abandon our ancestral home and relocate." The evidence was evident when the state government of Odisha resettled the people of Satabhaya village to a new location called Bagapatia village in Rajnagar block of Kendrapara district of Odisha.

**3.2.2 Non-climatic drivers**

The climate drivers exacerbate the pre-existing vulnerabilities, such as increased competition has led tothe overexploitation of resources by resource-rich players in the fishing sector. Various fishing-related factors worsen the effects of climate change on fisheries. These include the expansion of fishing fleets, with larger

vessels equipped with more powerful engines and higher capacities. Additionally, some fishing methods are ecologically harmful and destructive, which can further exacerbate the negative impacts of climate change. Furthermore, poor engine and fuel efficiencies can also contribute to the problem. Even in cases where fishing activities do not directly contribute to climate change, they can still have adverse effects on the health of fish populations, making it more difficult for fishers to adapt to the changing conditions.

The decline in fish catch and the subsequent reduction in income for fishermen is also attributed to pollution in water bodies. In addition, the seven-month fishing ban to protect endangered marine species negatively impacts the entire marine fisheries sector. Although the government offers alternative livelihood options to mitigate the ban's effects on fishermen, traditional fishermen believe it is insufficient to compensate for their lost earnings.According to the marine fishermen, although the government has introduced various incentives, subsidies, and welfare programs for them, they believe that it's crucial to focus on developing appropriate landing facilities and sufficient cold storage infrastructure as the fishing industry is highly vulnerable to climate change. Additionally, they suggest that it's essential to undertake skill enhancement initiatives to enable effective diversification of livelihoods.

## CONCLUSION

The fisheries production data reveals that marine fish production has not been consistent with inland fisheries and has been fluctuating in some districts. But, specifically, in the Kendrapara district, there has been a decline in fish catch. The primary survey of the fishing community reveals that the fish catch has gone down, and one of the critical reasons for this is changing climate dynamics in this part of the world. The climate drivers identified by fishing communities are erratic or uneven rainfall, increased frequency of floods, and increased frequency of cyclonic storms or deep depressions,leading to reduced catch from marine fisheries. Though, the fishing communities do not ignore the already existing problems plaguing the sector, such as water pollution which has disturbed the aquatic ecosystem at large, inadequate incentives from the government, over-exploitation of fishery resources and the presence of layers of intermediaries which ultimately take a toll on the margin of the fishing communities.

**Comment [mp3]:** Do researchers agree with the opinion of this fishing community..?is climate change the main causative factor or a causal factor in the decrease in the number of fishermen's catches

## REFERENCES


1. Annual report on natural calamities-2001-2008, *Special Relief Commissioner, Bhubaneswar, Government of Odisha*.
2. Badjeck, M. C., Allison, E. H., Halls, A. S. & Dulvy, N. K. 2010. Impacts of climate variability and change on fishery-based livelihoods. *Marine Policy, 34,375-383*
3. Bahinipati, C. S., and Sahu, N. Mangrove Conservation as Sustainable Adaptation to Cyclonic Risk in Kendrapada District of Odisha, India. *Asian Journal of Environment and Disaster Management (AJEDM). 4. 183-202. 10.3850/S1793924012001137. (2012).*
4. Barange, M., et al., 2014. Impacts of climate change on marine ecosystem production in societies dependent on fisheries. *Nat. Clim. Change 4, 211–216*.
5. Biernacki, P. and Waldorf, D. (1981) Snowball Sampling: Problems and Techniques of Chain Referral Sampling. *Sociological Methods & Research, 10, 141-163.*
6. Chittibabu, P., Dube, S. K., Macnabb, J. B., Murty, T. S., Rao, A. D., Mohanty, U.C. and Sinha, P. C. Mitigation of Flooding and Cyclone Hazard in Orissa, India, Natural Hazards, **31**, 455–85, (2004).
7. Cammet, M. (2006). Political ethnography in deeply divided societies. *Qualitative Methods, 2(4), 15–17.*

8. IPCC 2007a. Climate Change 2007: Impacts, Adaptation and Vulnerability. *Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, In: Parry, M. L., Canziani, O. F., Palutikof, J. P., Van Der Linden, P. J. & Hanson, C. E. (Eds. Cambridge, Cambridge University Press*

9. IPCC 2007b. Climate Change 2007: The Physical Science Basis. *Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panelon Climate Change, In: Solomon, S., Qin, D., Manning, M., Chen, Z.,Marquis, M., Averyt, K. B., Tignor, M. & Miller, H. L. (Eds.).Cambridge, Cambridge University Press*

10. Indian Network of Climate Change Assessment, *Ministry of forest and Environment, Government of India, 2010*

11. Kumar, K. S. K. and Tholkappian, S., Relative vulnerability of Indian coastal districts to sea-level rise and climate extremes, *International Review for Environmental Strategies,**6**(1), 3–22, (2006).*

12. Kumar, T. S., Mahendra, R. S., Nayak, S., Radhakrishnan, K. and Sahu, K. C.' Coastal vulnerability assessment for Orissa, State, East coast of India', *Journal of Coastal Research, **26**(3), 523–34, (2010)*

13. Patwardhan, A., K. Narayanan, D. Parthasarathy and U. Sharma, U., Impacts of climate change on coastal Zones, Shukla, P.R., S.K. Sharma, N.H. Ravindranath, A. Garg andS. Bhattacharya, eds, Climate change and India: *Vulnerability assessment and Adaptation,(Hyderabad: University Press (India) Private limited), 326–59 (2003).*

14. Sharma, U. and Patwardhan, A. Methodology for identifying vulnerability hotspots to tropical cyclone hazard in India, *Mitigation and Adaptation Strategies for Global Change, 13(7), 703–17, (2008).*

15. Vivekanandan, E. (2006). Impact of climate change on marine fisheries. *CMFRI Newsletter No.112 October-December 2006*, *112*, 1–4. http://eprints.cmfri.org.in/6647/

16. Zacharia, P. U., Gopalakrishan, A., George, G., Muralidhar, M., & Vijayan, K. K. (2016). *Climate change impact on coastal fisheries and aquaculture in SAARC regions:Country paper-India*.