Current Journal of Applied Science and Technology

Volume 42, Issue 48, Page 176-196, 2023; Article no.CJAST.112395
ISSN: 2457-1024
(Past name: British Journal of Applied Science & Technology, Past ISSN: 2231-0843, NLM ID: 101664541)

Anthropocene Impacts on Marine Fishers: South Odisha Coast, India

Siba Prasad Mishra [a,b*] and Saswat Mohapatra [a]

[a] SPANDAN, Puri, Odisha, India.
[b] School of Engineering and Technology, Centurion University of Technology and Management, Jatni, Bhubaneswar Odisha, India.

Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

Article Information

DOI: 10.9734/CJAST/2023/v42i484352

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/112395

Original Research Article

Received: 25/10/2023
Accepted: 29/12/2023
Published: 30/12/2023

ABSTRACT

This work envisages reporting, detailing, and analyzing the fisher's villages and the fisher's community along the South Odisha coast extending from the Konark (Puri) to Sonapur (Ganjam). The hardworking fisher's community residing in shanty clusters are economically, politically and socially disadvantaged. They face the challenges of devastating floods, droughts, erosions, high waves, and cyclones consequential in low catch, resulting in migration or marginalization.

The silent combat between orthodox fishing practices and the modern method of synthetic boats/nets has challenged their livelihood, catch, and resources. About 27 coastal villages were surveyed. The primary data are gathered through questionnaires, interactions and focused group discussions by sampling methods. The secondary latest data is collected from electronic resources, and past literature was analyzed,

The lack of infrastructure, and plastic fishing crafts, banned during mass nesting put the fishers in poverty. The unhealthy living conditions, low economy settings, and non-application of IoT lack of circular economy worsen the setting. Illiteracy, gender parity, nonadaptation of technology and language problems mechanization of fishing art, modernization, societal innovations and the financial assistance for the ban period and adaptation of circular economy, adaptation of sustainability measures can improve their social status.

**Corresponding author: E-mail: 2sibamishra@gmail.com;*

Keywords: Anthropocene; blue resources; fishing community; livelihoods; women empowerment; South Odisha coast.

1. INTRODUCTION

1.1 Anthropocene

Planet Earth is formed 4.5 billion years before the present (BP) and passed through many aeons, followed by eras, periods, epochs, and ages. The new planetary geological time scale is proposed as the Phanerozoic Eon, Cenozoic era, Quaternary period, Anthropocene epoch and Golden spike stage for the mother earth. The Anthropocene epoch is the age of man where Homosapiens conquered over geo-bio-hydro and atmosphere, [1,2]. The post-Holocene is the Meghalayan age (4200 to 74YBP) has left imprints of the Little Ice Age (LIA), the northerly shift of Indian summer monsoon, (ISM), westerly disturbances, Intertropical Convergence Zone (ITCZ), and El Nino Southerly Oscillation (ENSO), the shift of strand lines, formation of lagoons, change in agriculture, urbanisation and sculptures along the South Odisha Coast. etc. The seaward shift, the formation of the largest lagoon, the Chilika the northward shift of the Kushabhadra River dysfunctioning of the old Sunamunhi River are the imprints of the Anthropocene which need structuring of the fisher's settlements along the South Odisha Coast from Konark Coast to Sonapur near Berhampur, (Fig. 1),[3].

1.2 Changes in Fish Production

Odisha is a state along India's Bay of Bengal coast comprising 549.5km of coastal stretch [4]. The marine sea catches oceanic fish landing 133 TMT in 2022 against that of 180 TMT in 2021, fetching 33.880 billion INR in the retail sector [5]. India has 4127TMT of marine fish production in India in the year 2020-21, [6]. The per capita fish consumption in the state is 16.34kg. Six coastal districts such as Balasore, Bhadrak, Kendra Pada, Jagatsinpur, Puri and Ganjam are the districts on the shore of the Bay of Bengal with a continental self-area of 23830 sq. km as per the Government of Odisha (GOO). Out of 2383 sq. km continental shelf area i.e. 6820 sq. km, 8650 sq. km, 4810 sq. km, and 3550 sq. km in 0-20m, 20-50m, 50-100m, and 100-200m depth zones respectively, [7]. Fig. 2.

Indian coast and the functionaries of the angler's community in India have 4127TMT in 1547 notified landing and 193 fish landing centres for Marine Fisheries production in FY 21-22. Odisha has 25 Marine Fish Landing Centres, 4 Units of Fishing Harbours, and 25 fishing Jetties,(GOO, Annual Activity Report Fisheries Sector 2020-21 [7]. Marine fishing crafts in Odisha are 1741, 12507 and 9160 mechanised, motorised and country fishing crafts operated by about 518000 marine fishermen living in 115228 houses, drying their excess fishes in 10 fish drying platforms of capacity 326900MT, [8].

The present study is contemplated along the coastal stretch from Konark (the Kushabhadra River mouth) to the Bahuda River estuary of length 162.94km out of which a part lies in Puri District (about 80km) and entire the Ganjam coast (60.9Km). The coast houses 41 fisher villages, except villages lying within the barrier spit of the Chilika Lagoon, Fig. 3.

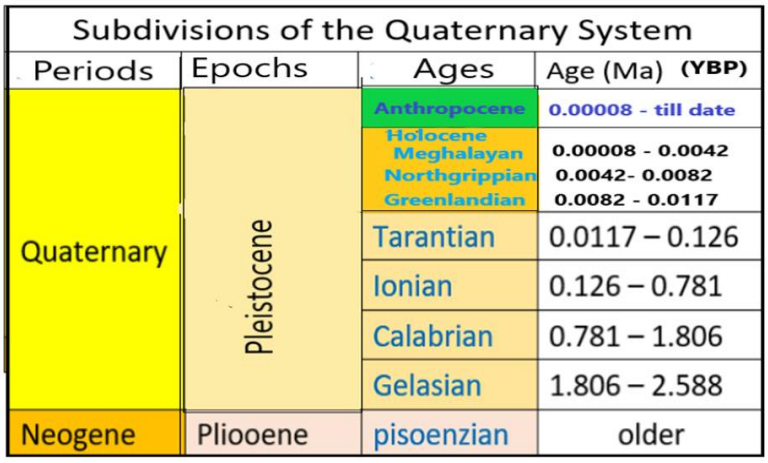
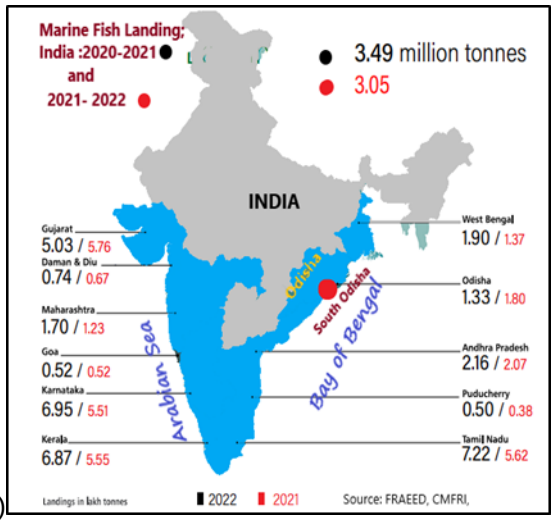


Fig. 1. The proposed classification of the Holocene and the Anthropocene Epoch (Mishra 2022)

(a)



(b)

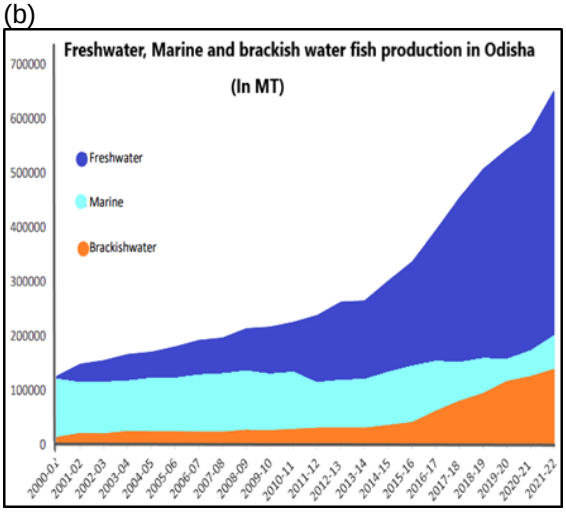


Fig. 2(a & b). The fish production in (a) India 2020-21 and 2021-22 (b)Odisha (Marine, brackish and freshwater) (source: Annual Activity Report 2021-22: Fisheries Dept, GoO)

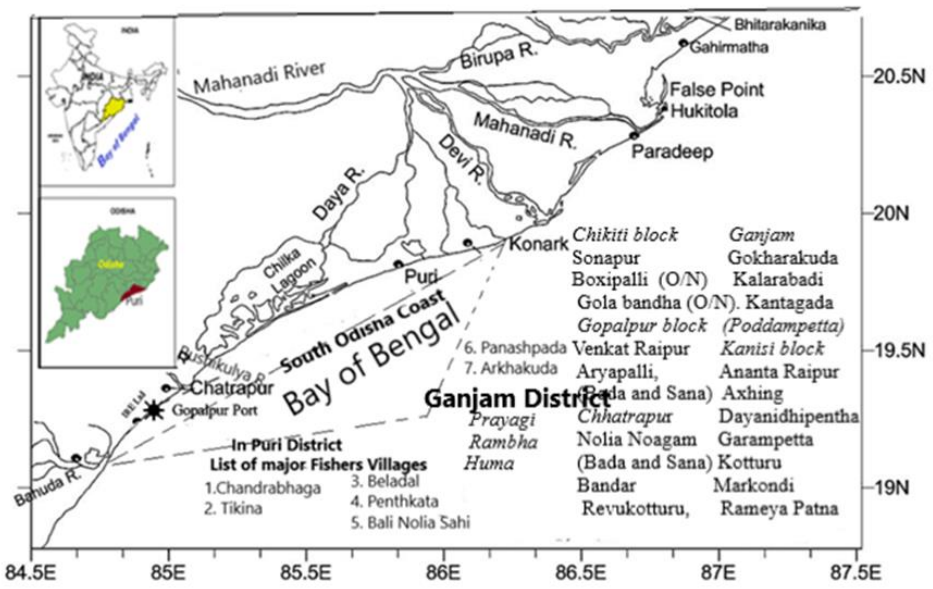


Fig. 3. The index map of the South Odisha Coast and important marine villages

2. REVIEW OF LITERATURE

The nylon gillnets are resourceful to catch but non-biodegradable associated with ghost fishing whereas the biodegradable gillnets are safe and eco-friendly, [9]. In 2020 only, India produced high-density (HD) polyethene about 1.9 mi MT out of which metric tons. This represented an increase from a production volume of around 1.2 million metric tons in 2013 and annually formed 500000 MT to 1 million MT tons of fishing gear [10]. It has become pertinent to save the marine ecosystem, the coastal users must think of reduction, reuse or recycling of the ghost nets and adding to a circular economy, [11,12]. About 17.7% of total plastic waste originated on beaches collected from marine fishing exposures such as ≈5.7% from fishing gear, ≈8.6% from traps and ≈29% from fishing lines globally, [13,14,15]. As per the Census 1980, in Puri and Ganjam districts, the fisher's villages were 27 and 28 respectively whereas presently the number of villages increased to Ganjam [26] and Puri [41], Scariah et al., Census [16].

Community-Based Fisheries Management (CBFM) is relevant to achieve sustainable fisheries expansion which is to be done for

different coasts. Bioplastics are produced from bio-based polymers for a circular economy as can have more commercial plastic recycling, [17]. 1. The noxious Cr, Cu, Pb, and Se adsorption onto old and used fishing nets occurs in the first 10 min to 6 h but selenium adsorbs up to one day. In the case of old end-of-life PE fishing nets, [18].

Coastline changes, distracted extreme weather in BoB, River challenges, waste disposal and anthropogenic interventions have reduced yield and hence their income, fish sales, storage, market prices, and corporate issues [19]. IoT can predict extreme weather and fish populations which can be used, [20]. Reporting of exact quantity is needed about the quality of illegal, discarded, unreported, unregulated deep-sea fishing and overfishing is to be avoided, [21,22,23].

The marine fisher's community, open and healthy sea is included in SDG 14, where SDG 14.2 promotes the importance of the marine environment, and its fishermen in SDG 14.2. Clause 14.4 ensures to management and protection of marine and coastal ecosystems. to achieve healthy and productive oceans, and SDG 14.4, to effectively regulate harvesting and end overfishing, https://unstats.un.org/sdgs/files/metadata-compilation/metadata-goal-14.pdf Community - Based Fisheries Management (CBFM) study of the SOC needs investigation and reports.

2.1 Objectives

The objective of the present study along the SOC has been done for:

1. Community-Based Fisheries Management (CBFM) of SOC is to be done to achieve sustainable fisheries development as per SDG 14, SDG 14.2, and SDG 14.4.
2. The changes in fishing crafts and gears along the South Odisha coast
3. Various Fishing communities and their issues related to their livelihood and DRR
4. To identify strategic issues like livelihood, WASH and developmental planning
5. Addressing the shortfall and developing empowerment among the underemployed women in the fisher community

2.1.1 Blue resources in the Anthropocene

After the prevalence of the Anthropocene epoch (year 1950AD) and the start year of its golden spike period (1980) when the of rate rise of the human population overweighed the rate of rise in food production, the exploration of marine fish products have been given the utmost importance. The prior thought of the vast ocean as an inexhaustible dump yard for waste. The production potential from the sea is to be surged and related policies are to be framed to shorten the gap between demand and supply from the food sector globally. The nutrients received from sea food-stuffs contain protein, minerals, essential vitamins, and long-chain omega-3 fatty acids that are lacking in low trophic species (LTS) foods received from plant-source or other on-land animal proteins, [24,25,26].

Past studies reveal that about 87–90% of ocean surface areas in the globe explored, a decline of 38% from 1970 to 2000 in ocean fish abundance due to an increase of blue carbon and carbon sequestration caused by anthropogenic interventions in the marine domain, loss of global biodiversity exuberating sixth mass extinction during Anthropogenic impacts [27,28].

2.1.2 Climate change strategies

Climate Change (CC) will hurt the marine sea catches of the global ocean by 6% by the end of the century (2100 AD) and by 11% in the tropical oceanic zone [29]. According to NASA, the BoB, a semi-enclosed large basin shall have an average SST surge between 2°C and 6°C by 2100. It is due to the rise of solar radiation This warming will occur even if future greenhouse gas emissions are reduced. In the last decade, the temperature has climbed its apex with a rising trend which will certainly affect the location, production, and distribution, of marine fishes near shore [30,31].

The challenges encountered by the fisher's community the Anthropocene climate change, global warming, unstable north Indian Ocean, associated regional sea level rise, cyclones, Tsunamis, high waves, erosion, resulting in fish catch depletion/ production, overfishing, and meagre income. Climate change has affected the coastal waters, fish yield, deteriorating coastal ecosystems, biodiversity, faunal stock, and migration, [32], Fig. 4.

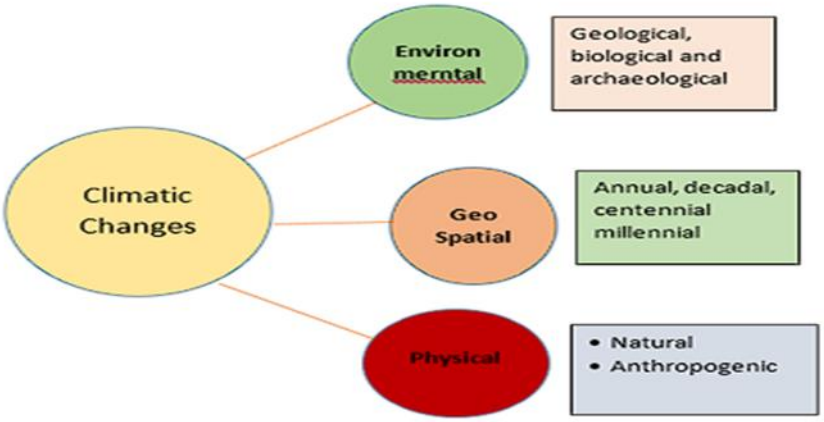


Fig. 4. The Climate change initiatives on the livelihood of the marine fishers community

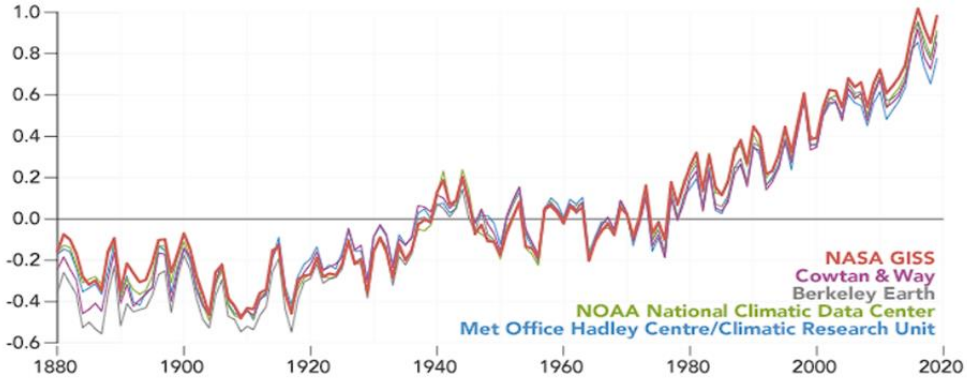


Fig. 5. Temperature anomalies (1880 to 2020 observed by NASA, NOAA, the Earth research group (Berkeley), the Hadley Centre Met Office (UK) with the Cowtan and Way analysis, https://earthobservatory.nasa.gov/world-of-change/global-temperatures

2.2 Quantifying Offshore Fish Accumulation

Quantifying offshore fish accumulation and grouping wind turbines play an important role in Wind turbines play a pivotal role in displacing fishermen from their areas, changing the distribution changes, and lacking abundance, and composition of species of fish. in an area adding to livelihood losses. SOC have no wind turbines onshore/ offshore Pollution, fishing, salinity, anthropogenic interventions, habitat obliteration, over-exploitation, invasive species proliferation, and CC are the players in quantifying a marine ecosystem. Baited Remote Underwater Stereo-Video systems (stereo BRUVs) are considered an appropriate tool for assessing the clustering and assemblage of marine fishes offshore. [33,34]. The temperature, humidity and monsoon rainfall play important roles in fish production, clustering/accumulation and catch. There has been a continuous rise in temperature from 1980 onwards along the East Coast of India as established by NASA GISS. On ground-truthing it is ascertained that the fish catch has been reduced, though the number of fishing crafts have been surged sizably, [35].

2.2.1 Blue ocean in anthropocene

The blue economy is widely studied for fixed land resources and exhaustively overexploited around the globe. To mitigate food scarcity only the marine ecosystem can help during the Anthropocene. Demand for food. Presently the vast ocean needs exploitation to satisfy the food paucity as per demand of SDG-2. Further hunger has dominated in countries that rely upon agri-food. India's agriculture is solely reliant on rainfall and temperature. The promotion of ocean-based activities has obeyed no laws. Fish production or recreational activities

onshore/offshore have become unethical. The prevailing legal framework made for the marine domain is not strictly adhered to. Oceans promise to destroy the coastal habitats and nature's pledging through RSLR, coastal erosion has an impact on the sustainability of the SOC's coastal ecosystem. Sustainable Development Goal (SDG 14) aims at a supportable offshore and onshore ecosystem, which can be possible through proper planning and management.

2.2.2 Ethics and bonds in the blue domain

The blue economy, blue ethics and blue bond only can be possible through the greening of ocean development strategies [36]. The blue bonds cover food security, Livelihood, energy security, mineral resources, environmental sustainability, ecological resilience, and climate adaptation. The coasts of India are mainly maritime coastline, fishery resources, ports and connectivity [37]. Climate change impacts during the Anthropocene along SOC are regional sea level rise (RSLR), Anthropocene interventions, increased frequency and intensity of cyclonic storms, less /heavy rainfall, heat waves, winds and waves and coastal erosion. and rainfall events. The anthropogenic actions are ports and harbours, coastal retreats, more motorised fishing crafts, and surged greenhouse gases (GHGs).

2.2.3 Shifting of strandlines

There is a continuous regression and aggradation of the coastlines based on changing sun Earth's geometry geospatially. Wind, waves, estuaries and littoral drifts cause the coast to be eroding, accredit or remain stable. The 204km long South Odisha coast of wide golden sandy beaches intervened by eastern ghats extension of rocky spurs piercing to sea [4,38]. It is well documented that the shoreline has sifted seawards in the post-Holocene period and the proxies are Konark Temple, Beleswar Temple, Daria Mahabir, Hara Chandi, and many coast parallel sand ridges found onshore 1.5 to 2km away from the present shoreline, (Fig. 6). Researchers have well-documented shoreline changes along the Odisha Coast by aeolian/tidal forces accompanied by littoral drifts, high waves, droughts, floods and storms. The anthropogenic causes that contribute to the shoreline changes are ports and harbours, coast parallel channels and lakes (SAR Lake, Samang Lake, Tampara, Palur and Sunamunhi), inland river regulatory works, beach nourishment, urbanisation, sand mining, sea walls and beach nourishment works, [39,40,4,41].

2.2.4 Erosion and accretion along SOC

As per the study, the Odisha coast erodes by 46%, the accretion and 36% of shoreline accrediting and the rest 18% is stable. Recent studies reveal that 52.47% of Odisha's coastline is eroding, accrediting 34.70% and stable of length where projection has been made that by 2053 the erosion and accreditation shall be 45% and 55% of Odisha's 480 km shoreline calculated by Ramesh et al as 480km in 2012, Table 1.

Fig. 6. Coastal erosion near Rama Chandi-Konark Road after the great Indian Tsunami 2004

Table 1. The status of fisher's villages of South Odisha Coastal (ICAR report 2010 updated)

Dist.	Length of Coast	Erosion (H, M, L)	Accretion (H.M.L)	Fisher 's vill.	Fish landing	Fishers Families	Fisher's Populn
	Km	Km	Km	No.	Centres	≈ Nos	Nos
Ganjam	62.90	14.06	30.38	26	20 No	8601	35263
Puri	140.04	21.4	109.46	41	16No	14675	63829
J- Singapura	58.72	34.22	15.26	119	05No	17508	94812
Kendra pada	135.82	48.96	32.6	117	7No	13527	76361
Bhadrak	59.88	13.56	42.18	95	10No	12765	4574
Balasore	92.14	21.6	52.3	415	15No	471162	270675
Total	549.5	153.8	282.18	813	73No	114238	605514

J- Singapura: Jagat Singpur; H.M.L: High, Medium, Lo; Nos: Numbers : Populn: Population

Source: [42,4]

The South Odisha coast extends(SOC) from Kushabhadra River Mouth to the left of Bahuda Estuary (Sonapur beach). The SOC partly covers the Puri coast and the total Ganjam coast is highly erosional/accretional. After the Great Indian Tsunami of 2004, it is observed that pockets of erosion in the Ganjam and Puri districts have surprisingly surged up. However, the process of erosion occurs towards the north of the estuaries and deposition to the south and is harmonical. The SOC accommodates traditional fishermen about 50thousand traditional fishermen of Telugu speaking migrated from Andhra Pradesh and they are of two communities i.e. awardeverjelu and Ratnamverjelu. The SOC beach is a golden sandy zone except for a small Rocky stretch (near Gopalpur), (Table 1).

The coastal villages Boxipalli and Poddampetta have receded ≈ 40m and ≈60m respectively from the 21st Century. In the Puri district, the erosional areas are river mouths of Mangala River, (Starling Hotel), Nuanai mouth (Beldal Village) and Kushabhadra River mouth (Rama Chandi), of about 70m, 100m and 68m respectively [43].

2.2.5 Demographic census

Out of more than 115K fisher families, live along SOC (South Odisha coast), Odisha, Out of them about 77% are from the traditional fisher community. The part of SOC along the Puri district starts from Chandrabhaga, Tikina, Behera Sahi (Beldal), Penthakata and the Chilika Coast, which accommodates more than 50k marine fishermen both local and traditional. The 60km coastal from of the Ganjam, Chhatrapur, Rangeilunda and ChikitGanjam district is more than 35 thousand. The average family size was observed 4-5 persons/family, and an average of 750 people are in one fisher's hamlet in Odisha. The male-female ratio is 1000: 970 along the south Odisha coast. Major fisher families in hamlets of the SOC were below the poverty line. The males are more educated than females but higher education among the Fisher community is sparse. Occupationally the percentage of active fishers is much higher.

2.2.6 Fish ban period

There is a ban on fishing twice annually by the State Government, from 15th April to 15th June and Nov. 1st to May 31st for Olive Ridley nesting and breeding period for fish and during cyclonic storms. For livelihood support to marine fishers during the fishing ban period it was decided by the Govt. of Odisha has declared financial assistance amounting Rs15000/- to affected marine fishermen families for the financial year 2022-23 and 2023-24 (Fisheries and ARD department O/O dt 16.12.2022.

2.2.7 South Odisha Coast (SOC)

The SOC is from Konark Beach to Pati Sonapur Sea Beach, Ganjam. The beach geomorphology is long sandy onshore with a small pocket of rocks near Gopalpur. The SOC is from the Kushabhadra to the Bahuda River estuaries with plenty of marine fishery resources. The marine fisher communities are settled in hamlets within 203km of coasts Fig. 2(a &b). The olive ridley turtle, one of the endangered species, has a growth and breeding period is about 15 years drove Govt. of Odisha to an eponymic project [41,44]. The Fisher communities along the Ganjam coast are under threat due to erosion due to dredging activities, storm surges and anthropogenic interventions [45].

2.2.8 Marine Fish Landing Centers

Along the SOC, the marine fish landing centres in PURI district are Chandrabhaga (Konark),

Penthakata (N&S), Arakhakuda Puri (North and South), Sudhikeswar (Taila), Gundalova, Anakona & Dalukani, Sana Patna (Manikapatna, Khirisahi, Siandi, Rama Lanka, Astranga. The GANJAM district has fish landing centres at Kontiogada (Poddampeta), Gokurkuda, Noagaon (Bada, and Noagaon), Sana Arjiyaally, Bander, Gopalpur-I and II, Ramayapatna, Pati Sonapur, New Baxipeta (Venkatarayapur), Golabandha, Garayammapeta, Markondi, Keuta Sonapur, Eksinghi, Anantraipur, Old Baxipeta, and Prayagi, [42].

3. METHODS AND METHODOLOGY

Primary data is poised from the various stakeholders from various major coastal villages of Chandrabhaga, Penthakata, Arakhakuda, Poddampetta, Aryapalli and a few major villages engaged in fishing activities. These stakeholders are divergent and from community, caste, region, and state. They have a similar unique profession and socio-economic system. Emphasis is given to the focused group of discussion (FGDs) for validation of the primary data and secondary data gathered from various individual groups and offices and revalidated. With Panchayat Raj PR institutions and others. The study was about two districts i.e. Part of the Puri coast and the Ganjam coastal stretch (Fig. 7).

Fishers Community are of three types. *Full-time fishers* (≥ 90% of their occupation and livelihood). When expenditure is 30% to 90% are *part-time workers* and *occasional* fisher groups spend ≤30%. The fishing crafts used by these fishermen (motorised, mechanised and traditional), fishing gears, the angler's group, the boat makers (both fibre and wooden planks) and financial investors were consulted. The focused group discussions (FGDs) were made separately gender-wise or combined in both districts combinedly. The PR institutions and the Government departments (mainly Fisheries dept.) were contacted. the fishing communities in coastal Odisha are also prone to frequent natural calamities. The poverty and the lack of WASH availability have deteriorated the well-being of these fishers along the coast, [46,47,48].

3.1 Mass Nesting Along SOC

Gokharakuda to Konark is most conducive for breeding of the IUCN endangered species Olive Ridley which does not prefer to breed along an accretional coastline. The rockery stretch is prevented from catching marine fish from the month Nov to March. For the conservation of these Olive Ridley turtles, the Government of Orissa (GoO) along with the Govt. of India (GoI) has banned all varieties of gill nets along the nearshore or estuaries fishing. Not having an alternative means of support for their living, they are urged to migrate or marginalise to other towns for an alternate job, [49].

3.2 Fishing Crafts

Odisha state (previously named Utkal) bears a long history of navigation, port and harbour activities and was the connector between East and West. The Odiya's were the great architects for boat building since 2500YBP. The Naval architecture (Boita) of Odisha was datable to 4200 YBP (Meghalayan era of Holocene epoch) evidenced by the historical excavations of Golabai Sasan, along the Chilika coast (Fig. 8).

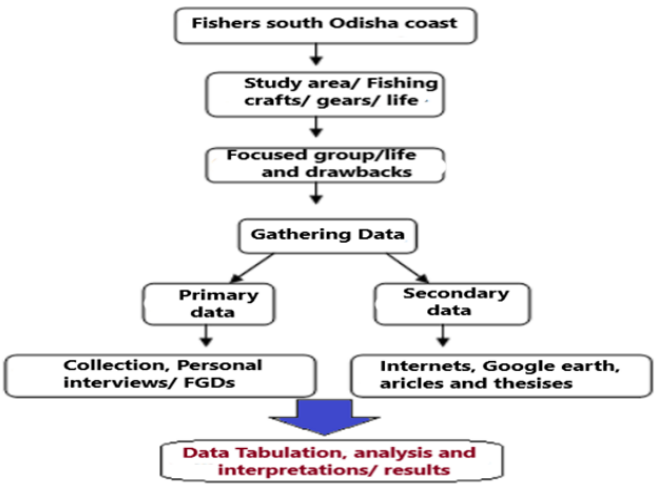


Fig. 7. The flow chart of the study of the fisher's community along the South Odisha Coast

Fig. 8. Various fishing crafts, and activities along SOC Community Hall, Odisha

Fig. 9(a to d). The unhygienic/unsafe livelihood (a) Penthakata (WASH) (b) Chandrabhaga(Fire prone houses (c) Banki Muhan (Puri town's liquid waste to sea) (d) Beach debris management

3.2.2 Socio-economic challenges

On the coasts of both districts, fishing crafts (boats) are either motorized or nonmotorized. The other way the classification of boats can be of local wood, Metallic or PVC make. (Trawler) Teppa (Small medium and Large), Kattumaram, Padava, or Ahula Danga etc. However, for diverse catches the fishing craft and gears used are different. The fishing gears used in the SOC are mainly gillnets, liners and bag nets. Fishing activities along the SOC are governed by craft owners who do not venture into the sea for fishing. The pedamansaru, the boat owners engage 5 to 8 persons who fish in the sea and receive the agreed share. Presently motorised crafts are common in SOC.

3.2.1 The unhealthy living

The profile of Fisher's group is analysed to reach a general unique conclusion. The major

observations are that they are from the Fisher community, both from Odisha, and Andhra Pradesh and mostly Telugu-speaking. They are all mostly in shanty towns where the ambulance accessibility to each doorstep is difficult and are Water, Sanitation and Hygiene (WASH) deficient. Many of the villages have no drains and directly discharging to BoB.

There exists continuous conflict between the fishing group and the state Fisheries dept. and forest department against turtle conservation. There is constant depreciation in fish due to deep-sea fishing, and a rise in the number of mechanised trawlers engaged in fishing. They (forest guards) ban going into the sea during the mass nesting period, storms and disastrous weather. As a result, the fisher group prefers marginalisation to migration instead of becoming idle at home, Fig. 9 (a-d) **(**results of interaction 2023**)**

Major fisher communities engaged in fishing activity are males having an age group of 30 to 50 years. The ladies engaged in household works, marketing fish, dry fish works and collection of firewood. The fisher's group has mostly(about 60%) primary education but is deprived of higher education (about 18%). The community faces language problems as high schools are unavailable near the villages as less populous [50,51].

Fishing is a seasonal activity. During the 1950s, these Noliaya's used to move to their native places in Andhra Pradesh to take up 2ndry occupations to supplement their livelihood. Those who remain in their huts take up dry fish business and other activities to manage their livelihood during the lean seasons. Presently they engage themselves in fish processing/selling or as daily labour in knitting or boat building during the off-season, [52,53].

Presently the average annual income from sample households is up to Rs. 1,00,000/- one-third of families, more than Rs. 3,00,000/- Rs5,00,000 (possessing motorised different fishing crafts) and the rest in other jobs. Rarely does a family possess a fishing craft, The boat owners and net owners have updated insurance and bank accounts only. Many fishers' family has no recorded land rights, under the Jaga Mission, under the local government as slum dwellers at Penthakata out of about 12000 house owners. The only tangible properties are their country boats and fishing gear and gadgets Presently fishers' communities are taking part in Local governance and elections.

3.3 Disasters

After the Indian Ocean Tsunami -2004, the regular high waves are eroding SOC. The 21st-century calamities are the Indian Ocean Tsunami of 2004, and the historically high flood in 2008, 2022. in the last decade due to Cyclone (1999), Phailin (2013), Hudhud (2014), Titli (2018), Fani (2019), Gulab (2021), Asani (2022), Micha Ung (2023) has blown away the thatched huts of the fisher community along SOC and traumatised the economy of the marine fisher's community, [34]. The Odisha state has confronted 17 natural disasters, including 10 severe cyclones in the last 13 years which have shattered the community life along the coast of SOC including COVID-19. The economic and social life of the marine fisher's community was threatened by the hammering effect of the Pandemic 2019-2022. The very severe historic flood in the Mahanadi basin in August 2008 2019, and 2022.

3.3.1 The targeted area

Along the SOC, the populous fishermen clusters are Andhra-based, Telugu-speaking communities from Konark, Puri, Chilika, Krushna Prasad, Prayagi, Noliya Nuagaon (Bada and Sana), Arya Pali (new and old), and Ramya Patna etc. Among the south Odisha coast, the fishermen's cluster at Penthakata is the largest among all accommodating 12212 families of about 35000 fishermen in four wards encompassing about 3.5km. The only source of living is fishing from the BoB.

3.3.2 Faunal diversity of the entire SOC

Ecologically the SOC is earmarked as the longest sandy beach in India from Gopalpur to Konark for an expanse of 170km. Also, globally the stretch claims importance for its red crabs and lofty shrimps and prawns along the SOC coast due to the housing of Asia's largest brackish water lagoon Chilika with the largest congregation of high latitude arctic winter avifauna as lies in the path of Central Asian Flyway (CAF). The largest Rookery for the endangered species is Olive Ridley at Gokhara Kuda in the Rushikulya estuary. The longest sandy beach attracts plenty of marine fish. The fish catch is swelling and potential fishing zones identified under the technical advisories of INCOIS, India, and Marine Fisheries Dept. GoO

& GoI [54], The rare endangered species are susceptible to their life for entanglement or strangulation, Fig. 10 (a-f).

Our marine resources are at a crossroads for sustainability through incentives and information which is completely lacking along South Odisha Coast. Potential initiatives towards by digital revolution, and big data assimilation about marine resources landing, accumulation and mobility only can augment yield. The climate and type of catch at Puri coast, Table 2.

However, the marine fishing art was an age-old development between the SOC and North Andhra coasts. The two large marine fisher's clusters have built up presently, around Chilika Lagoon and the next is at Penthakata Puri comprising three wards accommodating about 35000 people in a 3 sq. km area. Fig. 10 (a-f).

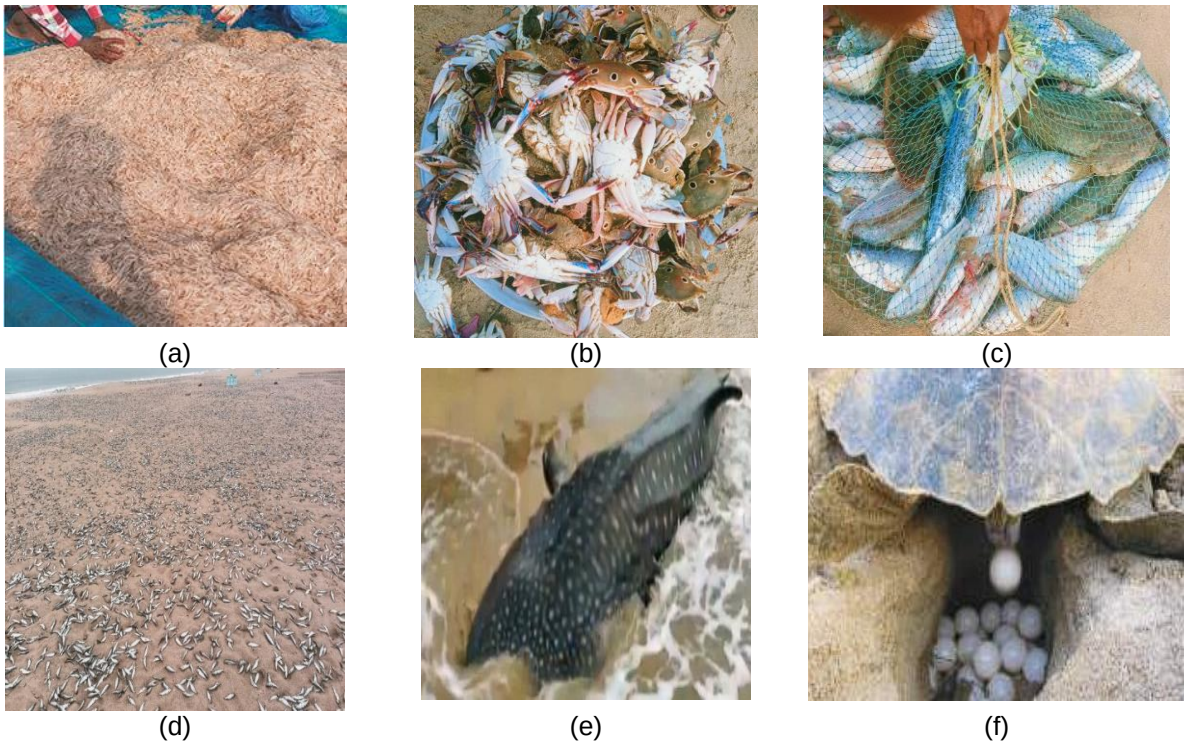
3.4 Fishing Gears

Fishing gears have changed from natural organic fibres to PA Polyamide Nylon 6 or 66, polyethene (PE), Polypropylene (PP) and Polyester (PES) fibres due to their increased longevity and flexibility, in transportation. Still, its debris called ghost nets is dangerous to the marine resources and ecosystem as non-degradable and poorly absorbed by nature [55,56]).

The south Odisha coast has a steep continental shelf with a sharp slope and surf-beaten so they opt for marine fishermen are seines, boat seines, lift nets, gillnets and lines which are used [57]. In the 1980s, cotton and hemp nets were used to catch but were later replaced by Nylon, PA, PE, and PP nets. Fishing gears can be active or passive based on target fishes and shrimps, gear materials availability, nature of coastline, and depth. The use of active gears (Fyke and crab lift nets) is for catching crabs and large fishes. The local names along the South Odisha coast are drift/gill nets plentiful fishing gears followed by hooks and lines and boat seines. Fishing tackles used are hooks, swivels, floats, sinkers, leaders, slit rings, wires, snaps, blades, jars, lights, spoons, beads and spinners, Fig. 8 (a-b).

Table 2. The weather and fish Production at Penthakata Puri (Burf statistics and without local market consumption

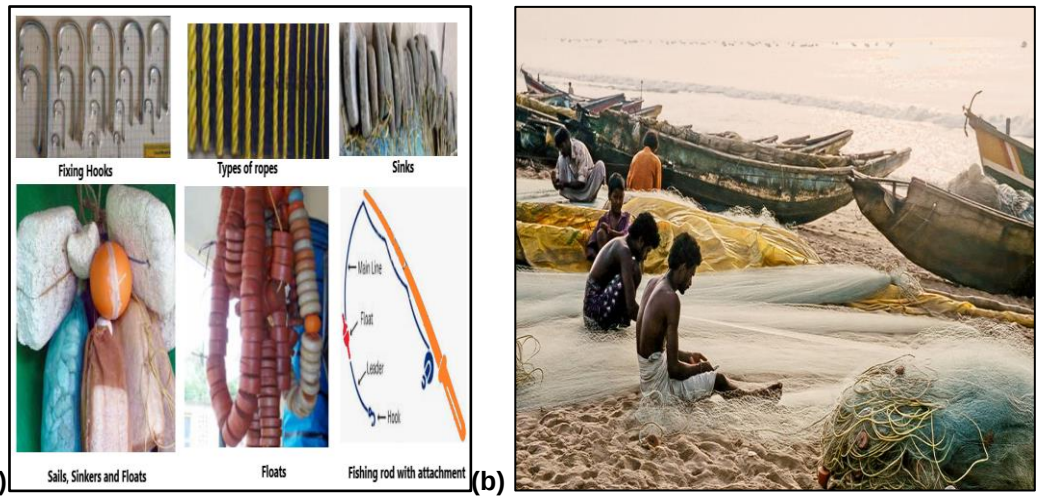
Month	Rainfall	Humidity	Temp	wind direction	Fish of the Month	Fish
	mm	%	mean ^{0}C	Av.	Local name	MT
January	13.6mm	60..84	24.83	E-ly	Koni, Kantia, fish, crabs Patharmundi, ribbon	3.5MT
February	16.23mm	64.55	27	SSW	Koni, Kantia, fish, crabs Patharmundi, ribbon	3.5MT
March	18.57mm	69.24	29.45	SSW	Koni, Kantia, ribbon fish, crabs Patharmundi,	3.5MT
April, May, and June: No Fishing for Fish Breeding and the catch is much less						
July	358.24mm	74.59	30.62	SW	Kantia, Kokali, Galara, nagmundi	1.6MT
August	387.39mm	75.78	30.25	SW	Prawn, Para	1.8MT
Sept. r	308.61mm	76.54	30.11	SSW	Prawn, Yellow and Bada Para, Samudra Todi	1.65MT
Oct.	266.35mm	72.93	29.24	SE	Prawn, Sankar, Kokali, Balanga (Chhota Hlsa)	1.0MT
Nov.	87.47mm	65	27.42	NE	Prawn, Crabs, Koni, Sharks	2.3MT
December	146.49mm	58.54	25.2	NE	Prawn, Crabs, Koni, Sharks	2.5MT
Fishes along SOC): Kokali (Dussumieria elopsooides), *Large Prawn*, (Penaeus Mondon), Mullets, Bada(Large) Tumbuda, Bada Kabala, Black Prawn, Gulibinda, Gulibinda, Large Para fish, Singhi Kani, Meji, Pathara-mundi,(Kara, Kumutimuna), Crab, Ksnagudia, Kabala, Nakhamachha, Gania, Bagada Prawn, Kab Chandi, Surangi, Disco Kabala, Chanara, Elisa, Samudra Kantala, other saradine and anchovies						



(a) (b) (c)

(d) (e) (f)

Fig. 10 (a-f). Loss of bio-diversity along SOC, (a) Prawn (b) Crabs (c) Fishes (d) Unhygienic drying fish (e) Blue shark whale (f) the Olive Ridley Tortoise laying eggs



(a) (b)

Fig. 11(a-b). Fishing tackles and net repair used along SOC (at Penthakata (b) Chandrabhaga

3.4.1 Polymer nets

A fishing net must have the physical properties of a solid with easy sustenance, light in weight, strong, high mechanical properties, non-breakable under higher loading, and resistance to saline water or oil liquids. Nylon 6 or 66 have better transparency, are soft, flexible, strong and do not break easily. As these high-tenacity materials on elongation tightly hold the knots, they are more opted for fishing gear [58].

Modern fibres used for knitting nets are Aramid fibres, ultra-high molecular weight polyethene (UHMWPE or Dyneema fibres SK 60 and SK 75), polyphenylene Terephthalamide (PPTA) and liquid crystal polymer are rarely used. UHMWPE is used for ropes, cordage, fisheries and textile applications, (Table 3) [61].

Table 3. Various properties and uses of nets used as fishing gear along the South Odisha Coast

haracteristics	Unit	PA	HDPE	PP	PVC	PVA	PES
		Polyamide Nylon 6/ 66)	**Poly-ethylene**	**Polypropylene**	**Polyvinyl chloride**	**Polyvinyl Alcohol**	**Poly ester**
Sp. Gr.	Nil	1.14	0.95	0.91	1.4	1.72	1.38
Tenacity	g/de)	9	5	7	2.0	Up to 7	9
Alkali Resistant		Good	Good	Good	Good	Good	Week
Acid resistant		Week	Week	Good	Good	Good	Good
Weather resistance		Medium	Medium	Not UV resistant	Very High	Poor water resistance	High
Abrasion resistance		Very High	High	Medium	High	High	High
Flammability (light flame)		Melt/burn	Melt/burm/shrink/curls	Shrink/ Melt /Burns	Shrinks do not burn	Shrinks/curl /burn	Melt/ burns
After Flame (burning)		Stops burning	Continue burning	Continue burning	Do not stretch	Burn/stretch rapidly	stops burning
Breaking load /elongation	%	23 (Strong than Ny-06)	20	18	Low	Medium	14
Durability		Medium	Medium	Poor	Very high	High	High
Suitable for fishing gear		Gill nets, purse seines	Trawls	Entangling nets	Set nets, Lift nets	Purse seines	

Source: Radhalekshmy et al [59], Thomas [60], Thomas et al [61],

Fig. 12 (a-d). Women activities; (a) Unhygienic collection of fish (b) Fishes ready to despatch; Decision-making women activities (c) Penthakata (d) Noliya Nuagaon (Interactions)

3.5 Women Dominated Fish Marketing

The gents in the fisher's community are engaged solely in the fishing activity or knitting/ repair of nets during idle and ban periods or fishing-allied labour works are marketing, knitting or boat-building, ice plants and go-downs (locally called Burf) activities. Their additional fishing works are to sort and segregate catches, in nearby construction units as women workers (Mishra et al., 2023).

The women are severely affected during the ban period as the catch is disrupted drastically by the mass nesting ban and put to financial threats. Any compensation is not given to women working members of the family, though they have a pivotal role in the marine fisher's society, (Fig. 11(a-d). The fishing trade in the marine fisher community is dominated and the lion's share from fishing by Pedamansaru, the middlemen or brokers. The women opined that the country's liquor needs prohibition and constituting cooperatives among women to augment the fishing. That will enhance women's empowerment.

4. DISCUSSION

Fish is a significant dietary source in coastal states. The women in SOC villages combined to reduce the fish trader's dominance, empower the fishing community and achieve economic stability for which proper education and training, development skills, availability of Government amenities and land rights, and more NGO activities among the fisher's communities are essential. The challenges are:

Since the hamlets on the sandy beach are close to the high tidal zone (HTZ) are suffering from increased meteorological disturbances in the Bay of Bengal (BoB), with regular cyclic erosions and accretions. The increased exploitation of fisher's crafts, modern gears, fishing zone forecasts, and Anthropogenic coastal activities have depleted the quantum of fish. With the increase in population and demand for fish and depletion in catch from the marine fishing sector, the fishermen's migration and marginalization are surging up [49].

The community is financially, and socially backyard and they dwell in slums. The language, education, ignorance of modern catch technologies, IT/GIS knowledge, and meagre of government assistance still make their lifestyle much away from modern living., The erratic fishing, habitat devastation, and pollution have led to stagnant marine fisheries production over the last ten years. The fisher's group of the SOC, the small-scale fishing communities were largely unorganised. Some NGOs consistently work for the upliftment of the fisher community in various spheres.

4.1 Climate Change

Climate change including global warming causes a rise in sea surface temperature and a rise in rise in sea level. Climate change is shifting their behaviour, lifestyle, arrival, and breeding, which is making many species threatening or endangered. The rise in surface temperature, erosion, and increased cyclonic storms have compelled the marine fishers to resettle, migrate or marginalise. The outsee fishermen faced challenges of adjustment to their new environment. It is obvious that the fish population in the sea has declined, but the reasons for deterioration in the marine ecosystem are understudied.

4.2 Overfishing

The mechanized marine fishing crafts caused overfishing. The fishing in the deep sea and the use of small nets for small fishes only. Fishers lose their catch potential which affects the economy of the fisher group and their sustainability.

4.3 Technology Innovation and Poor Adaptation

Since 1990, there has been technology transformation combined with traditional fishing systems. The constraints and their redressals are found, (Fig. 12). Innovative fishing crafts, gears, and tools are influencing the catch's efficiency and yield. Failing adaptation of innovative technologies, not using modern crafts, gears, and technical skills, and use of weather predictions, cold storage units, Ice factories, and modern solar drying units lead to economic growth and lessening harvest losses. Local NGOs think that marine production is considered lucrative but quite expensive, (Fig. 12).

4.3.1 IoT Knowledge

The application of IoT for decision-making processes has not widely circulated among the marine fisher's community in time. Recent

developments in IoT technology have facilitated marine fishers to locate the position of dense availability of fish, innovative microscale prediction of extreme meteorological events, fast and widespread information transmission to all marine fishers can help them in marketing and dry fish making for the fisher's community in marine villages.

4.3.2 Occupational hazards

The occupational hazards are increasing the health care costs of the marine fisher's community along SOC and the present compensation due to insurance is inadequate. The Group Accidental Insurance Scheme (GIAS) under the schemes of GOI during accidents and deaths is only supplemented by GOI but GOO has no such provisions.

4.3.3 Women in trade and circular economy

The fishermen are engaged in the hard work of fishing along SOC. The fishing work in Odisha operates under the localized craft owners who are allied with the burf (Go-downs) owners. The marketing of their yield is in the hands of fisher's women. But in traditional systems, the marketing and value addition to fishermen, in small communities carry the yield to access to nearby large markets. Women in the fisher's community should take part in circular entrepreneurship.

4.3.4 Conducive environment

The dimensions of fisher's livelihood and women's empowerment were threatened due to poverty, nonavailability of basic infrastructure and gender disparity. only active involvement in all phases of lags and intervention. The conduce environment can have involvement of scientific, technology and IT methods applications in fishing activities could play a grave role in gender mainstreaming. Application of geographical information systems (GIS) in marine fishing, selection of the type of fishing gear, location of fish clusters within the sea, and use of fast and noiseless trawlers have become a bare necessity for them.

4.3.5 Tax and Government benefits

The marine fishers due to their ignorance and illiteracy are over-pressed by tax hurdles (like goods and service taxes; (GST) @12%), non-availability of GoO and GoI reimbursements and sanctions provided to them. Particularly the government concessions given to the fishermen during the ban period are only to male members.

4.3.6 Environmental and ALDFG issues

Solid waste, waste plastics and ghost nets are disposed of directly to sea including urban liquid wastes carrying noxious materials both onshore and marine species. The abandoned, lost or otherwise discarded fishing gear (ALDFGs), recreational activity left-outs, and marine carcasses to dry are air polluting the coastal environment. Pollutants from industries, townships, and settlements, near the coast are also contributing to contamination of the onshore/ offshore.

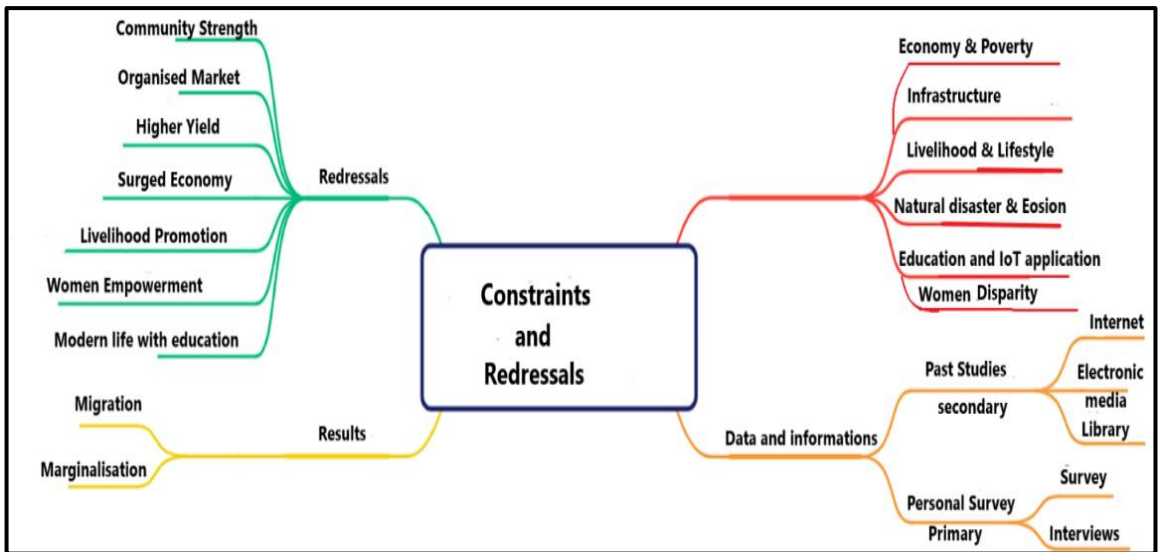


Fig. 13. The constraints, and redressal of marine fisher societies on SOC

Fig. 14(a-d). The weather stations by Astha Hasta Trust at (a)Penthakata, Puri (b) Chandrabhaga, (Konark) (c) Palur canal renovated (Ganjam) (d) Rookery at Gokharakuda, Ganjam

4.4 Other Constraints

4.4.1 Space constraint

Fishers' rights to conserve and govern coastal spaces are contested by non-fishing communities. In many coastal villages, fishing communities live with service-providing non-fishing communities. While these non-fishing communities are not primarily dependent on the beach spaces for their livelihood, they also access and use them in multiple ways for leisure, salt farming, agriculture, cattle grazing or undertaking commercial activities. The private ownership of the beach space is also distributed between diverse coastal communities, not just fishers.

4.4.2 Language Problem

The ignorance of concurrent federal sanctions is due to inadequate qualifications added to the problem of language. Interaction with the marine community reveals that even many do not have an idea about the companion sanctioned by the GOI and GoO during the ban period of mass nesting and idle period.

4.4.3 Social Issues

The fisher's communities near shore settlements lack access to education, modern living, WASH facilities, a green energy economy, healthcare, and societal security. Their lifestyle and capabilities of enhancing livelihood are deteriorating and in jeopardy.

4.5 Centrally Sponsored Plan and Schemes

The elderly and experienced fishers about the mounting unpredictability of climate/weather. Lack of market, drying area, and cold storage facilities compel the marine fishers to sell the catches at throwaway prices. Fisherwomen, are illiterate or have little education. Government initiatives have failed to educate them. Some schools in the marine fisher community are managed by the government, and NGOs and philanthropic/voluntary organisations are running with less attendance.

The incentives of the establishment of Fishing Harbour & FLCs are not received by all uniformly. Construction of a cold storage/ice plant, and modernization of old dysfunctional existing cold storage/ ice plants fish transport vehicles (185) of different capacities became delayed due to COVID-19. [62]

5. CONCLUSIONS

It is accepted that there is an overall decline in fish catch along SOC. The proceeding of interaction with the fisher community against depletion of catch in SOC is due to liquid waste disposal offshore from nearby settlements and by the effluents coastal factories and industries. The survey results of the marine fisher's villages are due to the livelihood diversity and deterioration of the village vegetation and Gramya Jungle (forest). The villagers need to be properly compensated for the loss of livelihood by the new conservation regime and alternative livelihood options provided by the ICZMP. Compensation during the ban period should be made available to each marine family whether engaged in fishing or other associated fishing activities so that they can earn their livelihood properly and live with dignity.

Government support to clean up and dispose of the debris is dependent upon being able to produce high-quality products made from waste that reflect the unique cultures in the region. The emergence of different waste streams within regions for more efficient transportation and processing will be important to achieve economies of scale.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Mishra SP. The apocalyptic anthropocene epoch and its management in India, Int. Jour. Adv. Research. 2017;5(3):645-663. DOI: 10.21474/IJAR01/3555
2. Liana C, Fair H. 2023. Anthropocene. In the open encyclopaedia of anthropology, edited by Felix Stein. Facsimile of the first edition in the cambridge encyclopaedia of anthropology; 2019. Available:http://doi.org/10.29164/19anthro
3. Mishra SP. Catastrophism and uniformitarianism in decision making of Meghalayan age in East India. Int. Journal of Environment and Climate Change. 2022;12(4):19-37. DOI: 10.9734/ IJECC/2022/v12i43065
4. Kankara RS, Murthy MVR, Rajeevan M, National assessment of shoreline change along the Indian coast, A status report for 26 years 1990-2016. (2018),.NCCR Publication; 2022. Available:http://www.nccr.gov.in
5. FRAEED, CMFRI. Marine fish landings in India-2022. Technical report, CMFRI booklet series No. 31/2023. ICAR-Central Marine Fisheries Research Institute, Kochi; 2023.
6. Govt of India. Handbook on fisheries statistics, 2022. Dept of fisheries, Ministry of fisheries, Animal Husbandry and Dairying, GoI. 2022;1-218.
7. Government of Odisha (GOO). Annual activity report fisheries sector 2020-21. Fisheries & Animal Resources Development Department, GOO. 2021;1-77.
8. CMFRI. Annual report 2016-17. Central Marine Fisheries Research Institute, Kochi. 2017;292.
9. Herrmann BG, Su B, Fore HM, Vollstad J, Olsen L, Larsen RB, Tatone I, Comparison of fishing efficiency between biodegradable gillnets and conventional nylon gillnets. Fisheries Res. 2019;213:67-74. DOI: org/10.1016/j.fishres.2019.01.003
10. Macfadyen G, Huntington T, Cappell R. Abandoned, Lost or otherwise discarded fishing gear; FAO fisheries and aquaculture technical paper 523; UNEP Regional Seas Reports and Studies 185; FAO: Rome, Italy; 2009.
11. Ryan PG. A brief history of marine litter research. In: Bergmann M, Gutow L, Klages M. (eds) Marine anthropogenic litter. Springer, Cham; 2015.

Available:https://doi.org/10.1007/978-3-319-16510-3_1
12. Kozioł A, Paso KG, Kuciel S. Properties and recyclability of abandoned fishing net-based plastic debris. Catalysts. 2022;12(9):948. Available:https://doi.org/10.3390/catal12090948
13. Sheavly SB. National marine debris monitoring program: Final program report, Data analysis and summary; Prepared for U.S. Environmental Protection Agency; Sheavly Consultants, Inc.: Virginia Beach, VA, USA; 2010.
14. Richardson K, Asmutis-Silvia R, Drinkwin J, Gilardi KV, Giskes I, Jones G, O'Brien K. et al. Building evidence around ghost gear: Global trends and analysis for sustainable solutions at scale. Mar. Pollut. Bull. 2019;138:222–229.
15. Gajanur AR, Jaafar Z. Abandoned, lost, or discarded fishing gear at urban coastlines. Mar. Pollut. Bull. 2022;175:113341.
16. Scariah KS, Philipose V, Dan SS, Nair PK, Subramanya G. An appraisal of the marine fisheries in Orissa. PSBR. James, Director of CMFRI, In the 40th Anniv. Celebrations of CMFRI; 1987.
17. Rosenboom JG, Langer R, Traverso G. Bioplastics for a circular economy. Nat Rev Mater. 2022;7:117–137. Available:https://doi.org/10.1038/s41578-021-00407-8
18. Bertelsen IMG, Lima ATM, Ottosen LM. Possible applications for waste fishing nets in construction material. In: Grimstad SMF, Ottosen LM, James NA. (eds) Marine Plastics: Innovative Solutions to Tackling Waste. Springer, Cham; 2023. Available:https://doi.org/10.1007/978-3-031-31058-4_12
19. Fabinyi M, Barclay K. Fishing livelihoods and wellbeing. In: Asia-pacific fishing livelihoods. Palgrave Macmillan, Cham; 2022. Available:https://doi.org/10.1007/978-3-030-79591-7_5
20. Cooke SJ, Fulton EA, Sauer WHH. et al. Towards vibrant fish populations and sustainable fisheries that benefit all: learning from the last 30 years to inform the next 30 years. Rev Fish Biol Fisheries. 2023;33:317–347. Available:https://doi.org/10.1007/s11160-023-09765-8
21. Raes L, Jain A, Nguyen Ba T, Savels R. The economic impact of marine plastics, including ghost fishing, on fishing boats in Phước Tinh and Loc An, Ba Ria Vung Tau Province, Viet Nam. Gland, Switzerland: IUCN; 2022.
22. Swath. Review paper on livelihood condition of marine fishing community in India. Journal of Research in Humanities and Social Science. 2023;11(6):239-241.
23. Lima ATM, Bertelsen IMG, Ottosen LM, James N. The effect of fishing nets aging on metal uptake. In SMF, Grimstad LM, Ottosen, James NA. (Eds.), Marine plastics: Innovative solutions to tackling waste (pp. 189-210). Springer; 2023. Available:ttps://doi.org/10.1007/978-3-031-31058-4_11
24. Mishra SP. The apocalyptic anthropocene epoch and its management in India, Int. Jour. Adv. Research. 2017;5(3):645-663. DOI: 10.21474/IJAR01/3555
25. Costello C, Cao L, Gelcich S. et al. The future of food from the sea. Nature. 2020;588:95–100. Available:https://doi.org/10.1038/s41586-020-2616-y
26. Samarajeewa U. Emerging challenges in maintaining marine food-fish availability and food safety. Compr Rev Food Sci Food Saf. 2023;22(6):4734-4757. DOI: 10.1111/1541-4337.13239
27. Jones KR, Klein CJ, Halpern BS et al. The location and protection status of Earth's diminishing marine wilderness. Curr Biol. 2018;28:2506–2512. Available:https://doi.org/10.1016/j.cub.2018.06.010
28. Luypaert T, Hagan JG, McCarthy ML, Poti M. Status of marine BIODIVERSITY in the anthropocene. In: Jungblut S, Liebich V, Bode-Dalby M. (eds) YOUMARES 9 - The Oceans: Our research, Our Future. Springer, Cham; 2020. Available:https://doi.org/10.1007/978-3-030-20389-4_4
29. FAO UN. The state of world fisheries and aquaculture 2018 in brief. meeting the sustainable development goals; 2018. Available:https://www.fao.org/3/ca0191en/ca0191en.pdf
30. Vivekanandan E. Impact of climate change in the Indian marine fisheries and the potential adaptation options; 2008. Available:https://core.ac.uk/download/pdf/33018848.pdf
31. Das I, Lauria V, Kay S, Cazcarro I, Arto I, Fernandes JA, Hazra S, Effects of climate change and management policies on

marine fisheries productivity in the north-east coast of India Science of The Total Environment. 2020;724.
Available:https://doi.org/10.1016/j.scitotenv.2020.138082

32. Mishra SP, Jena JG. Geo-climatic abstractions of South Mahanadi Delta and Chilika Lagoon, India: Post anthropogenic interventions, World Applied Sciences Journal, WASJ. 2015;33(2):326-335.
33. Hill NA, Barrett N, Lawrence E, Hulls J, Dambacher JM, Nichol S, Williams A, Hayes KR. Quantifying fish assemblages in large, offshore marine protected areas: An Australian case study. PLoS One. 2014;9(10):e110831.
DOI: 10.1371/journal.pone.0110831
34. Griffin RA, Robinson GJ, West A, Gloyne-Phillips IT, Unsworth RKF. Assessing fish and motile fauna around offshore windfarms using stereo baited video. PLoS ONE. 2016;11(3):e0149701.
Available:https://doi.org/10.1371/journal.pone.0149701
35. Mishra SP, Mishra SK. The cataclysm of geo-bio-climate in short-lived holocene and anthropocene epochs: A critical review. International Journal of Science and Research (IJSR); 2018.
36. Cousteau Jacques Yves. Water and air, the two essential fluids on which all life depends, have become global garbage cans. Clean oceans and the blue economy overview, 1-8, European Investment Bank; 2023.
37. Martínez-Vázquez RM, Milán-García J, de Pablo Valenciano J. Challenges of the blue economy: Evidence and research trends. Environ Sci Eur. 2021;33:61.
Available:https://doi.org/10.1186/s12302-021-00502-
38. Mishra Siba Prasad, Sethi KC. The imprints of holocene climate and environmental changes in the South Mahanadi Delta and the Chilika lagoon, Odisha, India—An overview, In book: Holocene Climate Change and Environment, ELSEVIER. 2021;457-482.
Available:https://doi.org/10.1016/B978-0-323-90085-0.00015-2
39. Mahalik NK, Das C, Maejima W. Geomorphology and evolution of the Mahanadi Delta, India. Journal of Geosciences. 1996;39:3-122.
40. Mishra SP. Estuaries and lateral channel development along the east coast of India, International Journal of Advance Research. 2016;4(12):2360-2371
41. Mishra SP, Mohapatra S. Ecosystem and vulnerabilities to fisher's community: Tampara Wetland, South Odisha Coast, India. CJAST. 2023;42(48):1-22.
DOI: 10.9734/CJAST/2023/v42i484326
42. ICAR-Kochi, CMFRI. Marine fisheries census 2010 Part II Odisha. Ministry of Agriculture and Farmers Welfare, and MoAH&D. 2010;1-503.
43. Mishra S P, Mishra SK. The cataclysm of Geo-bio-climate in short-lived holocene and in anthropocene epochs: A critical review, (IJSR). 2018;7(9):1445–1462.
DOI: 10.21275/ART20191537
44. Nair NV, Nayak PK, Uncovering water quality and evaluating vulnerabilities of small-scale fisheries in Chilika Lagoon, India. Front. Mar. Sci. 2023;10:1087296.
DOI: 10.3389/fmars.2023.1087296
45. Sridhar A, Muralidharan M. Marine fishing craft and gear of Odisha. Dakshin Foundation, Bangalore. 2013;1- 92.
46. Chandrama R, Krishnan MM, Shanker K. Long-term monitoring and community-based conservation of olive ridley turtles, (2019) Odisha. CMPA Technical Series No. 7. Indo-German Biodiversity Programme, GIZ-India, New Delhi; 2013.
47. Mondal M. Assessing health & developmental needs of fisher communities in southern Odisha. Dakshin Foundation, Bengaluru. 2019;1-27.
48. Alam MS, Yousuf A. Fishermen's community livelihood and socio-economic constraints in coastal areas: An exploratory analysis. Environmental Challenges. 2024;14:100810.
49. Tripathy S. Fishers, Community resilience, and disaster management: Learning from the grassroots of Odisha, India. In: Singh, A. (eds) International Handbook of Disaster Research. Springer, Singapore; 2023.
Available:https://doi.org/10.1007/978-981-19-8388-7_204
50. Bezbaroa I. What are commons? Dakshin Foundation. 2020;1-10.
Available:https://www.dakshin.org/wp-content/uploads/2020/08/What-are-the-commons-.pdf
51. Venugopal Das BS, Namboothiri N , Sridhar A. Commoning coastal Odisha. Dakshin Foundation; 2021.
Available:https://www.dakshin.org/wp-content/uploads/2021/07/2021_Commonin

g-Coastal-Odisha_ Dakshin-Report_Compressed-2.pdf
52. Panda S, Mishra SP. Confronting and coping with resilient environment by fishermen community of penthakata, Puri during Fani, Adalya Journal. 2020;9(1):230-242.
53. Mishra SP, Panigrahi RK. Storm impact on south Odisha coast, India, International Journal of Advanced Research in Science and Engineering, IJARSE. 2014;3,(11):209-225.
54. Santhanam H, Kundu SK. Assessment of socio-technical constraints of marine fishers in the utilisation of marine fishery advisories in Southern Odisha, India. Anthr. Sci. 2022;1:109–120. Available:https://doi.org/10.1007/s44177-022-00014-4
55. Das BS, Rao M. An Assessment of fishing practices & fisheries governance in Ganjam. Dakshin Foundation, Bangalore, 1-29. CWE & sustainable fisheries programmes; 2022.
56. Pradhan SK, Nayak PK, Haque CE. Mapping social-ecological-oriented dried fish value chain: Evidence from coastal communities of Odisha and West Bengal in India. Coasts. 2023;3(1):45-73. Available:https://doi.org/10.3390/coasts3010004
57. Cunningham C, Mohapatra P, Tietze U. Fishing technology and fishermen's perception of their marine environment, Chapter -2, artisanal marine fisherfolk of Orissa: Study of Their Technology, Economic Status. 2022;1-58.
58. Thomas SN, Sandhya KM. Ghost nets: Invisible fishers in the seas. Aqua International. 2019;66.
59. Radhalekshmy K, Gopalan Nayar S. Synthetic fibres for fishing gear. Aqua docs. Fishery Technology, 142-167. 1973; 10(2):21973.
60. Thomas SN. Netting specifications and maintenance of cages for finfish culture, National fisheries development board, National Training on 'Cage Culture of Seabass' held at CMFRI, Kochi. 2009;23-32.
61. Thomas SN, Mandhir SK, Krishnankutty H, Baby KAM, Ghosh KAA. Ghost fishing capacity of lost experimental gillnets: A preliminary study from Indian waters. Env. Sci Pollut. Res Int. 2023;30(14):40062-40072. DOI: 10.1007/s11356-022-25029-7
62. CMFRI. Annual report 2021. Central Marine Fisheries Research Institute, Kochi. 2022;300.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/112395