Communing Marine Fishing Community on the South Odisha Coast

Abstract:

The present study envisages reporting, detailing, and analyzing the fisher's villages and primarily of the fisher's community along the South Odisha coast (SOC) which extends about 180 km from the Kushabhadra R. outfall (Konark) to the Bahuda River mouth at Sonapur (Ganjam). The dominating Telugu Noliya in the fisher's community has deteriorated economically, ~~Politically~~ politically and societally after the devastating floods, erosions, high waves, low catch, deep sea fishing and frequent intense cyclonic storms which compel them for migration or marginalization. Their ignorance and low literacy of modern mechanization of fishing art, tempted by modernization and societal innovations and the four-month ban on fishing have deteriorated their financial stability.

Around 95thousand fishers have their primary livelihood on marine fishing resources living in 67 coastal villages of SOC. The fisher's community of the Chilika Lagoon is not included. The narrative emphasizes the statistics and the socio-economic settings of the marine fisher group of the SOC comprising from Konark to Sonapur. The primary data is collected from the field through questionnaires, interactions and focused group Discussions through sampling methods from some important Noliya villages along the coastal expanse of the study area. The secondary latest data is collected from the internet, Google Earth, libraries, journals and thesis and were analyzed, descriptive statistics and arrived at poorly vented areas.

Though the sandy SOC, fish availability is abundant whereas catch is much less due to lagging infrastructure, less mechanized marine fishing crafts, skills and high fuel costs under banning, disasters, unhealthy living and low economy settings. The application of IoT for decision-making processes has not widely circulated among the marine fisher's community in time. The ignorance of concurrent federal sanctions is due to inadequate qualifications added to the problem of language.

Key Words: Fishing community, Livelihoods, Beach debris, Women empowerment, South Odisha Coast.

1.0.0 Introduction

Odisha, a state along the east coast of India comprising 549.5 km of coastal stretch (Kankara et al, 2019[1]) of the Bay of Bengal, has an oceanic fish landing of 133 TMT in 2022 against that of 180 TMT in 2021fetching 33880million INR in the retail sector (FRAEED, GOI, 2022[2]). India has 4127 TMT of marine fish production in India in the year 2020-21, (Handbook of Fisheries Statistics 2022[3]). The per capita fish consumption in the state is 16.34 kg. 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, (Annual activity report, 2021, GoO[4]). Indian coast and the functionaries of the fisher's community in India have 4127 TMTin 1547 notified landing and

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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,(Annual Activity Report Fisheries Sector 2020-21). 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 326900 MT, (CMFRI census 2016[6], Activity report Fisheries Dept, GoO 2020-21[4]).

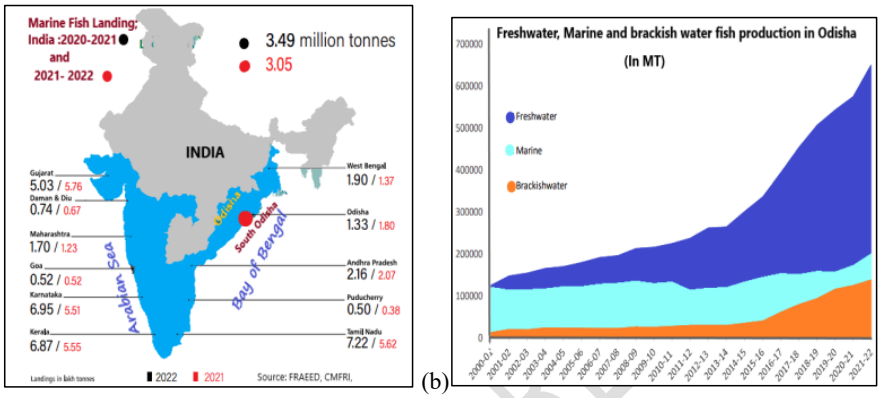

Fig 1: The fish production in (a) India 2020-21 and 2021-22 (b)Odisha (Marine, brackish and freshwater) (source: Annual Activity Report 2021-22: Fisheries Dept, GoO)

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 Popul^{n}
	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 : Popul^{n}: Population							

Source: ICAR -2010[7], Kankara et al 2018[1],

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 stretch of rocky (near Gopalpur), **(Fig 1(a & b), and Table 1)**

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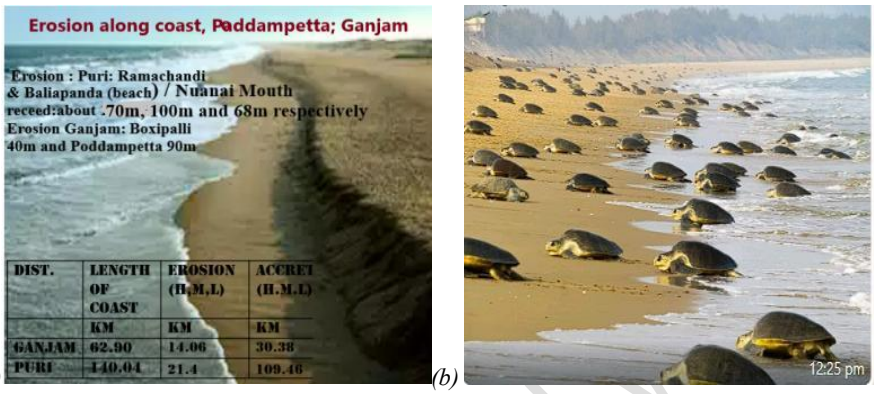
The coastal villages Boxipalli and Poddampetta have receded ≈ 40 m and ≈60 m respectively from the 21st Century. In the Puri district, the erosional areas are river mouths of Mangala River, (Starling Hotel), Nuanai mouth (Beldal Village) and Kushabhadra River mouth (Rama Chandi), of about 70m, 100m and 68m respectively (Mishra et al, 2018) (**Fig 1**).



(a) *(b)*

Fig 2: The deposition and erosion statistics of the South Odisha coast (a) Poddampetta (b) Gokharakuda (mass nesting) (Kankara et al, 2019[1])

1.1.0 Demographic census

Out of more than 115K fisher families, in Odisha, about 77% are from the traditional fisher's community. The SOC consists of Chandrabhaga and Penthakata including the Puri coast, which accommodates more than 50k marine fishermen, and the Ganjam district 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.

1.2.0 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. The gents are engaged in fishing activity or knitting/minor repair of nets during idle and ban periods The women group are engaged in household work, collecting firewood or fish drying activities. The fishing-allied labour works are marketing, knitting or boat-building ice plants and peeling activities.

2.0.0 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, (Herman et al, 2019, Ritesh Ku. et al, 2019[8]). 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 (Macfadyen et al, 2009[09]). It has become pertinent to save the marine ecosystem, the

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coastal users must think of reduction, reuse or recycling of the ghost nets and adding to a circular economy, (Ryan 2015[11], Koziol et al, 20231[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, (Sheavly 2010[13], Richardson et al, 2019[14], Gajanur et al, 2022[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 1987[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, (Rosenboom et al., 2022[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, (Bertilsen et al 2023[18]).

Erosion and distracted extreme weather in BoB with River challenges, waste disposal and anthropogenic interventions have reduced yield and hence their income, fish sales, storage, market prices, and corporate issues(Fabinyi et al, 2022[19]). IoT can predict extreme weather and fish populations which can be used, (Coke et al, 2023[20]). Reporting of exact quantity is needed and quality of illegal, discarded, unreported, unregulated deep-sea Fishing and Overfishing is to be avoided, (Raes et al, 2023[21], Lima et al 2023[22])

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.

2.1.0 Objectives

Indian Council of Agricultural Research along with the Central Institute of Fisheries Technology (ICAR-CIFT) are entrusted to conduct studies on the global issue. The objective of the present study along the SOC is an update records made in 2010. The present study is:

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

3.0.0 South Odisha Coast (SOC):

The state of Odisha in India housed on the East Coast of India extending for 549Km (Kankara et al, 2018[1]), comprising of wide major deltas of the hexa-river system, mainly of rivers, the Subarnarekha, the Budhabalang, the Baitarani, the Brahmani, the Mahanadi and the Rushikulya. 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

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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 for an eponymous project (Mishra SP. 2023[23], Nair et al., 2023[24]). The Fisher communities along the Ganjam coast are under threat attributed to erosion due to dredging activities, storm surges and anthropogenic interventions (Sridhar et al, 2013[25]).

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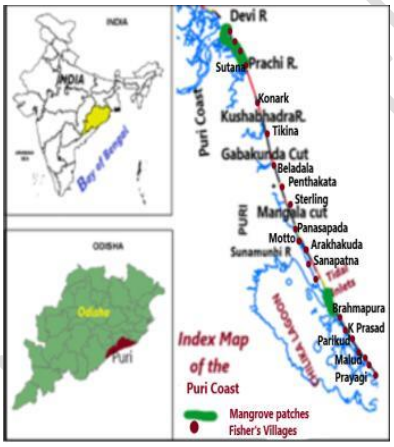
3.0.1 The Marine Fish Landing Centers:

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, (ICAR Fisheries statistics 2010[7])

3.0.20 Marine Fishing Villages (SOC)

The marine fishing Villages in Konark Block are Banbarada and Chandrabhaga. Whereas Puri block houses hamlets in Balinolia Sahi, Gourbad sahi, Nuasahi, and Penthakata and 135 Hamlets in and around Chilika Lake (not considered).

(a) 

(b) 

Fig 3: (a) Index map of (a) Puri (b) Ganjam coast main fishers' villages, the SOC

The district Ganjam has Fishers villages at Sonapur, Baxipalli (old and new), Durgapur Gola bandha (Old and new), Gopalpur, and Venkatraipur. The block Chhatrapur has marine fisher villages Aryapalli, (Bada and Sana), Nolia Noagam (Bada and Sana), Bandar, Revukotturu, and the block Ganjam possesses Gokharakuda, Kalarabadi, Kontiogada (Poddampeta), and block: KONISI have marine fisher's settlements are Anantraipur, Axhing, Dayanidhipentho, Garampeta, Kotturu, Markondi Ramayapatna, and Sonapur, (**Fig 3 a&b**)

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* (Tripathy S. 2023[26]).

3.1.0 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 4**).

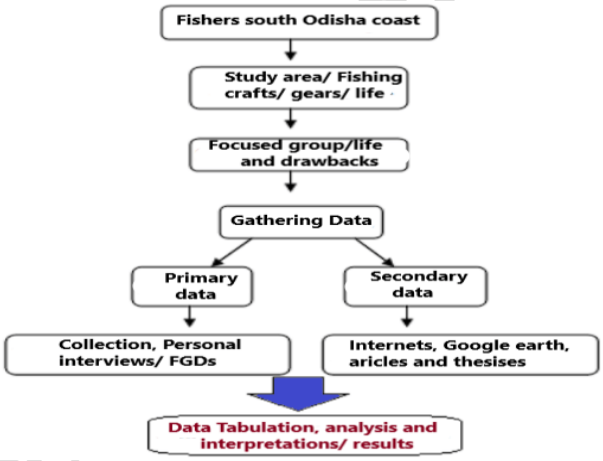


Fig 4: The flow chart of the study of the fisher's community along the South Odisha Coast

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, (Chandrama et al, 2017[27], Mondal 2019[28], Alam et al., 2024[29])

Result

3.2.0 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, (Tripathy et al, 2019[31]).

3.3.0 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 5).**

(a)  (b) 

Fig 5: Various fishing crafts, and activities along SOC Community Hall, Odisha

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.

3.4.0 The results of FGD in coastal stretch

The profile of Fisher's group is analysed to reach a general unique conclusion. The major observations are that they are from the Noliya community (less Odiyas or Sundhi) belonging

to Hinduism as their religion and Telugu as their mother tongue. There are mainly two types of community among the Telugu caste Awardeverjelu and Swarnavejelu.

(a)  (b) 

(c)  (d) 

Fig 6(a, b)): The unhygienic/unsafe livelihood (a) Penthakata (WASH) (b) Chandrabhaga(Fire prone houses (c) Banki Muhan (Puri town Liquid waste to sea) (d) Beach debris management.

3.4.1 Socio-Economic challenges:

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 6 (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 (Bejbaroa 2020[32], Venugopal et al., 2021[33]).

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, (Panda et al, 2020[30]).

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 the Local governance and elections.

3.4.1 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. 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, (Mishra et al., 2019[34]). 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 and the 2019 flood in the Rushikulya River basin have affected the livelihood of the marine fishermen along the south Odisha coast. *The fisher 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.*

3.4.2 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, Arya Pali, 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.

3.4.3 Faunal diversity of 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 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 plentily 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, (Santharam et al., 2022[35]), The rare endangered species are susceptible to their life for entanglement or strangulation , (**Fig 7 a-f**).

Availability of different fish species (Local names) are Macrells such as Kokoli (Dussumieria elopsooides), Large Prawn, (Penaeus Mondon), Mullets, Bada 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,

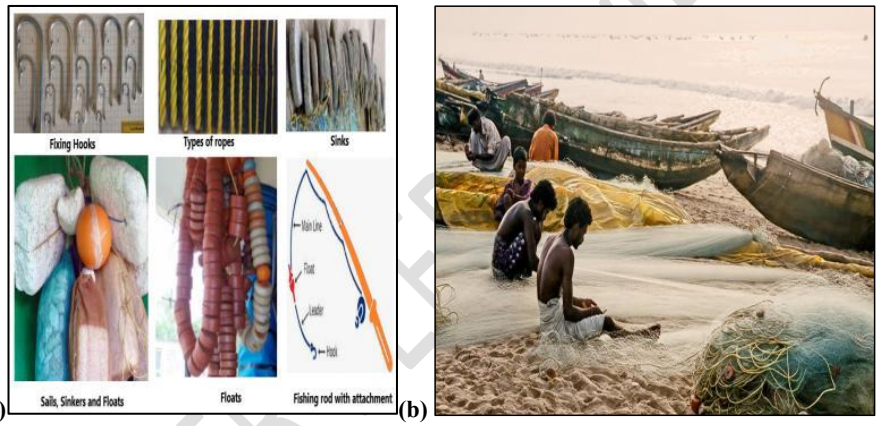
Surangi, Disco Kabala, Chanara, Elisa, Samudra Kantala, other saradine and anchovies. The marine fish landing centres (FLCs) in Puri district are at Konark (Chandrabhaga) and Puri (Penthakata). (GOI 2023) The district Ganjam has two FLCs one at Markondi and the other at Ramaya Patna, (Mishra et al., 2021[36]).

Fig 7 (a-f): Faunal diversity found at stake in SOC: Loss of prone diversity, (a) Prawn (b) Crabs (c) Fishes (d) Rare Stings (e) Jellyfish (f) the mass nesting of Olive Ridley Tortoise

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 3 sq km area. The fishing crafts have been mainly investigated for SOC, **Fig 7 (a-f).**

3.5.0 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 dur 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 (Das et al., 2022[37], Pradhan et al, 2023[13]). The marine fishing gear used in SOC and with local names are disco Jal (for prawns and Cho pada), Menjiram Jal (Hilsa and small pomfret), Jaga Jal (Menjiram, Kantia), Kabala Jal (Sardines and Kabala), Chandi Jal (Pamphlet), Kani Jal (Kana, Telia and Kontia), Ring Jal (large, medium and small) for Koni, Magar, large Kabala, Kokkali, Chingudi and kabala etc. The necessity of Koni, Kabala and Menjiram are used only during the SW monsoon period and others can be used for the whole year, (Weather Champions of SPANDAN)



(a) (b)

Fig 8: Fishing tackles and nets used along SOC (at Penthakata (b) Chandrabhaga

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, (Cunningham, et al, 2007[39]). 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)).**

3.5.1 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 (Thomas et al, 2019[40]).

Table 2: Various properties and uses of nets used as fishing gear along the South Odisha Coast

Charcateristics	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/burn/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, 1973[41], Thomas 2009[42], Thomas et al, 2023 {43},

Fig 9: Various polymer nets available in Puri and Ganjam market for use in South Odisha Coast.

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, (**Fig 9 and Table 2**) (Thomas et al, 2023[43]).

3.6.0 Livelihood major fishers' communities SoC:

3.6.1 Chandrabhaga (Konark)

The marine fishing village Chandrabhaga is a marine fishermen village that lives in one ward of Konark NAC. About 1200 temporary palm leaf sheds in an unhygienic atmosphere housed about 1200 fishermen families having about 6000 people, like slum dwellers in urban for more than 40 years. The Odisha Land Rights to Slum Dwellers Act, 2017 lists it as the first village to have a Slum Dwellers Association (SDA) with land titles. The major challenges to them are Tourists, WASH and Oil depots for their motorised boats, toilets for all families and higher education, (**Fig 10 (a-b**)).

3.6.2 Penthakata Puri: Presently, it is one of the largest marine permanent fishermen clusters that has developed since independence with these periodically migrant Telugu fisher communities of adjacent Andhra state. The congregation of more than 35 thousand fishers are distributed in 35 hamlets in 4wards of the Puri Municipality. Cyclone centres, weather stations, ration cards and government facilities are available for the vulnerable groups, the transgender, the destitute etc. Though these villages are economically and politically active, societally managing their livelihood by being deprived of WASH facilities, Transportation, drainage system.

a)  (b) 

Fig 10, a-b: Women's Activities and Empowerment in Marine Fishers Village in SOC

3.6.2 Prayagi: The fisher's village consisting of about 90 numbers of houses belonging to the Telugu community at Prayagi is housed along the southern fag end of the great Chilika lagoon. After the great Indian Ocean tsunami in 2004, and the cyclonic storm Fani and Hudhud, about 45 numbers of rehabilitation houses were constructed under the ODRP (Odisha Disaster Recovery Projects)The area is developed as nearer and well communicated to the NH 216. All areas being surrounded by the Casuarina Forest have a good market and are facilitated with modern requirements. The major problem with the area is the loss of village forest, and fisher groups are either migrating or marginalised.

3.6.3 Poddampetta: The coastal stretch is dominated by fishers and Hamlets are dominated by Telugu communities. The coast lies on the right coast of the Rushikulya estuary which has been suffering from erosion since 2004. The erosion along the coastline forced about 800 families to be oustees either by migration or marginalisation after the great Indian tsunami, and the sand mining activities. and the extremely severe cyclonic storms. ODRP (Odisha Disaster Recovery Projects), constructed a new resettlement village called Sidhant Nagar comprising 120 houses (leaving behind 20-30 families) in Kantiagadda Paddampeta so that the new colony again shifted to the south but hamlets are at a distance from the coast. The new colony was provided with all community development schemes of the Govt such as transport, WASH, educational and health care facilities, SHG, Mission Shakti etc. The old Paddampeta fishers are becoming weaker and their grim livelihood is limited to dry fishing activity.

3.6.4 Aryapalli: The old Aryapalli village after coastal erosion has been rehabilitated and resettled in a village as Bada Aryapalli. In Aryapalli about 8000 Telugu marine fishers are housed near Rambha, Chhatrapur, Gopalpur and Chikiti. Since 2004, the village has been suffering from high erosion and the coast has receded by about 80m due to the Indian Ocean Tsunami, sand mining, high floods, huge waves, and frequent intense storms. From the survey, it is ascertained that 1750 families with Kaibartas (Keutas) are about 190 and Nolia families are 1560. The Bada Noliya Nuagaon has one Cyclone centre, one Jetti, one ice plant and around 300 boats. The challenges faced by the marine fisher's group are distance from the coast and the market.

3.6.5 Golabandha: Golabandha, a census town, is a Telugu-speaking marine fisher's cluster comprising around 900 households and 6002 population (2011 census). Due to coastal erosion, the Puruna Golabandha is partly submerged by storms. Migration and marginalisation are the major challenges encountered by the fisher's community. The Nua Golabandha, are availing many government facilities. The new ODRP settlements at Garampetta have received assistance from the Indian army and state government but less at Puruna Golabandha. The temporary restrictions for marine fishing are faced by the fisher's community during firing training or ban periods. The Puruna Golabandha accommodates about 220 houses.

3.6.6 Gokharakuda: It is the Mass turtle nesting site having one artificial hatchery under the Odisha Forest Department near the old Palur canal, accommodating both local and Telugu marine fishers. About 200 Telugu marine fisher households, combined with about 100 Odia families stay together by sharing harbour spare spaces with the adjacent Purna Bandha The threats of scavenging of the turtles and their eggs by dogs, birds including crows and kites and poachers.

3.6.7 Puruna Bandha: Purunabandha village had about 393 households accommodating 1200 population during 2004 which increased to about 450 families in two villages (Nua and Puruna) with a population of 5000 fishermen and other communities. The fishers have fishing as their primary occupation as an income source to sustain their livelihood, (Nayak et al., 2008,[44] Tripathy et al, 2019[45]).

3.6.8 Sonapur: The Sonapur marine fisher's villages are about 18km from Berhampur. The village is on the left flank of the Bahuda River Mouth. This stretch is mainly used for solitary nesting of olive ridley sea turtles**.** The carcasses of about 100s of dead turtles and whale sharks are found on the entire beach, possibly by the fisheries crafts or being dragged by gears **(**Behera et al, 2014[46]**).** It is an eco-tourism hot spot being intervened by anthropogenic interventions.

3.7.0 Women dominated fish marketing:

Women in Noliya communities are exclusively engaged in looking after households, dry fishing, collecting firewood and marketing sea fishes in nearby fish markets. They are also engaged in working in buffs (Fish collection units,) to sort and segregate catches, nearby construction workers, and small shops of their own. The male members are engaged in fishing activities and idle periods knitting/ repairing nets. They remain under alcohol and rarely assist their opposite members, (Mishra et al., 2023).

Fig 11 (a-d): Women activities; (a) Unhygienic collection of fish (b) Fishes ready to despatch; Decision-making women activities (c) Penthakata (d) Noliya Nuagaon (Interactions)

Women outweigh the male fishers in washing, sorting, curing, processing, peeling, salt drying fish, and marketing. The women are severely affected during the ban period as the catch is disrupted drastically by the mass nesting ban. The government is presently paying Rs7500/yr to the male members only. Though women working members of the family take 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.

4.0.0 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:

4.0.1 **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.

4.0.2 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.

4.1.0 Technology Innovation and poor adaptation

Since 1990, there has been technology transformation combined with traditional fishing systems. The constraints and their redressals are found out, (**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 13**).

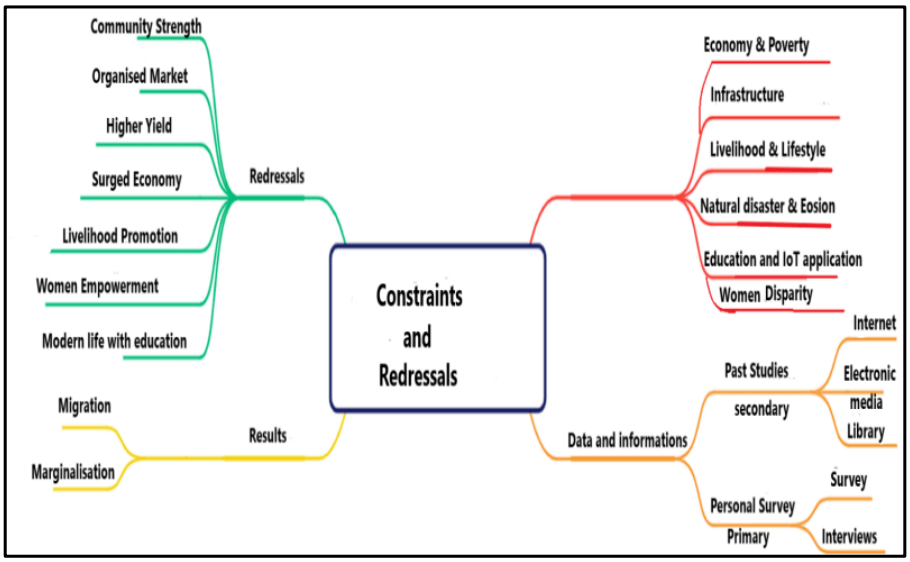


Fig12 : The constraints, and redressal of marine fisher societies on SOC (Alam et al., 2024[29])

4.1.1 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.

4.1.2 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.

4.1.3 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.

4.1.4 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.

4.1.5 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.

4.1.6 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.

4.2.0 Other Constraints

4.2.1 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.

4.2.2 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.

4.2.3 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.

(a) (b) (c) (d)

Fig 13(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

4.3.0 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. (CMFRI, Activity Report 2021 [48])

5.0.0 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.

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