Rebirth Ecosystemand Vulnerabilitiesto Fisher's Community: Tampara Wetland,South OdishaCoast, India

Abstract:

The Nolia Nuagaon (Badanoliya and Sana Noliya Nuagaon), fisher communitiesrehabilitated between the newlyrevivedTampara Lake, Bay of Bengal,and Rushikulya Estuary.The coastal ecosystemand habitation within this sandy beach vegetation in the pastare regularly affected by storm surges, coastal erosionand floods. The fisher group are reliant onthe seaand the estuaryfor their livelihood. Theyare politically, and socio-economically deprived.

The present study envisagesthe societal and economic changes that occurred due to the altered ecosystem due to climate changes, Regional sea level changes (RSLR) and human interventions. The basic tools involved are Hazard Vulnerability and Capacity Assessment (HVCA), and Ecosystem Services Shared Value Assessment (ESSVA) using the policies piloted by the International Lake Environment Committee (ILEC) forEco-DRR, Partners for Resilience (PfR). The Nolia Nuasahi (Bada and Sana) villages were under threat onthe coastal front.

The search helped to train the community to understand the pioneer issues and coercions that are surging up with time and the fishing profession, which is now replaced by migration and marginalisationadding to their age-old lifestyle. The growth of tourism activities in the nearbyTampara Lake shall bring challengesto the landscape, supporting Ecosystem services and the fishing community's régime. A joint Action Plan between the Lake and coastal ecosystem is warranted to be developed tomaintain a sustainable life for the villagesafteracceptance from the Gram Sabha and then included in the Gram Panchayat development plan (GPDP) plan to boost SDG-14.

Keywords: Lake, East coast, Bay of Bengal, Ramsar site, Eco-DRR, Ecosystem

Introduction

India is seriously suffering from a portable water emergency as 600 million people are not provided with safe, sufficient and secured potable water for drinking, agriculture and Sanitation (NITI Ayog 2019[1]). If not attended to immediately, it will widen the gap and damage national growth, accelerating its impact on human health, national yield, socio-economic gap or gender parity (SDG-5 and SDG-14) or even India's GDP. The Odisha state housed on the east coast of India had ample water resource potential but was not harnessed wisely. Out of 75 prominent wetlands in India, the Odisha state enjoys a wetland of 1335.68 ha area under the Ramsar Convention tag, established in 1971 by UNESCO[2](United Nations Educational, Scientific and Cultura Organisation)(Kodouri et al, 2023)[3]

The sweet water lake Humuri Tampara (called Tampara Lake) with coordinates 84° 58' 23" to 85° 1' 32" E. long. and 19° 19' 33" to 19° 21' 58" N. lat.) was excavated to store explosives and arms during a battle between the French colonists and the British East India Comp. in 1766 and later connected to Rushikulya River at one end and Haripur Creek at the other end.

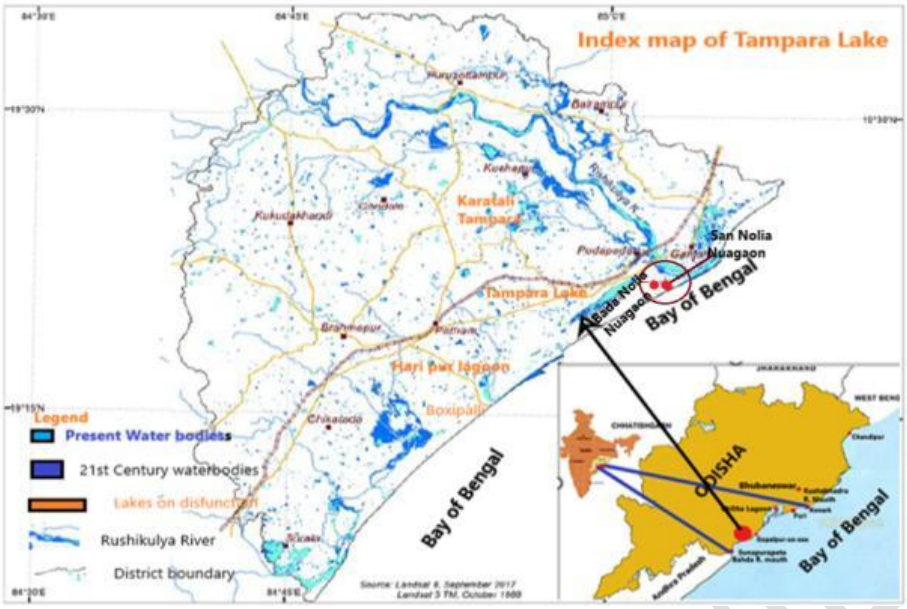


Fig 1.: The index map of the Tampara Lake, turned tourist hotspot on the south Odisha coast.

The lake enjoys both marine and inland biome that has been developed in the last decade, which has turned into a recreational hub for its panoramic view sweet water fishing zone and tourism hotspot for far and near (Fig 1), (Sethy et al., 2020[4], https://rsis.ramsar.org/ris/2489)

Table 1: List and status of RAMSAR sites in Odisha (Source:RAMSAR(RIS) Sites[5])

Wetlands Odisha/RIS no.	Location in district	System connected	Designated /declaredDate	Area in Sq km	Geomorphology and coordinate	Facts, species
Chilika lagoon (RIS No 229)	Puri/ Ganjam	SMD & north EGB Hills	Oct 1st 1981	1165 sq. km	Brackish water lagoon,(19°42'N 85°21'E)	Montreux Record 1993-2002 Losteco-health1995-99
Bhitarakanika (RIS No 1205)	Kendra pada	Anastomosed River Brahmani	Aug 19th 2002	650 sq. km	National Park, 20°39'N & 86°54'E	Mangrove /amphi - beans sanctuary
Satkoshia Gorge (RIS No 2470)	Angul	Mahanadi R.marshes & greenforests	Oct 12th 2021	981.97 sq.km	Joining biogegra -phy areas, Deccan Peninsula &EGB.	United Nations Protected Area (Ord: 20°34'N 84°49'E)
Hirakud Reservoir(RIS 2494)	Sambalpur	The Mahanadi River	Oct 12th 2021	654 sq. km	Freshwaterbody (21°36'N 83°45'E)	130 birds, & ≈ 54 fish,Dam based reservoir
Tampara LakeRIS No 2489	Ganjam	Lower delta Rushikulya R.	Oct 12th 2021	300.82Ha	Sweet water Lake (19°21'N 85°00'E)	60 birds and 46 fish @, 12MT/yr
Ansupa Lake (RIS 2487)	Cuttack	Formed by the Mahanadi	Oct 12th 2021	231Ha	Sweet water lake (20°27'N 85°36'E)	194 birds, 61fishes, 244 macrophytes, 88 butterflies &26 mammals
SMD: South Mahanadi Delta; EGB Hills: Eastern Ghat Belt Hills; RS: Ramsar site; R.: River; RIS: Ramsar Information sheet.						

Fig 2: Present status of Tampara Lake, a tourist hotspot, and recreation (Photo 18.10.2023)

The study area

The piloted hamlets for study are San Nolia and Bada Nolia Nuagaon the two consecutive villages under Agasti Nuagaon Garam panchayat(GP) in Chhatrapur block of Ganjam district,Odisha were piloted for study.The village is connected to Block Chhtrapur by a concrete road of 8 km and to Lake in NW is joined by NH 216. It is surrounded by waned jungles.

(a) 

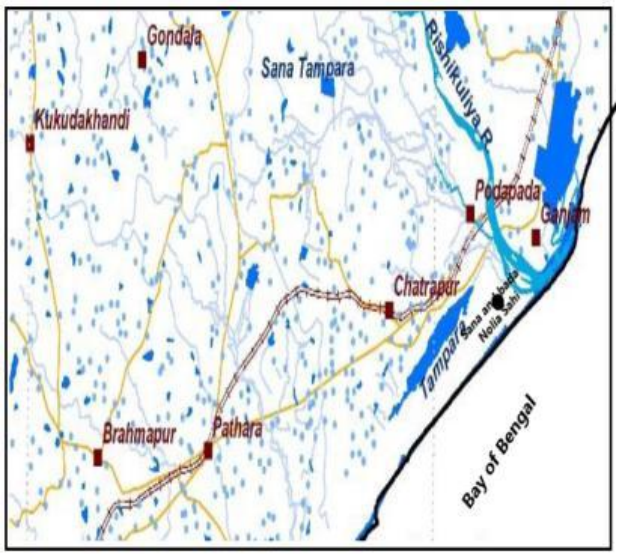
(b) 

Fig 3(a): The fisher's villages along the Ganjam coast(b) The micro study area of the Nolia Nuagaon (Sana and Bada)

The villages are located towards the outlet (NW) of the lake. Nuagaon has one Anganwadi centre and one primary school.The villages were devastated after the slam of Phailin (2013)and Hudhud (2014), (Mishra et al, 2014[6],Mishra et al., 2019[7])The affected villagers were rehabilitated by the construction of about 322 concrete dwelling units financed by the World Bank. Presently the villages have about Kucha buildings (≈22%) or Pucca buildings (≈78%)

The ecosystem services of Tampara

TheHumuri Tampara water is recycled through Santampara, Haripur Creekwith a good nutrient source for its habitats. The regulating services provided by the lakeecosystemabsorbclimate change impacts, flood of the Rushikulya-Bahuda basin, and maintain quality air. The provisional services available are fish, and forests. The cultural services are ecotourism, recreation, and water supply to about 30000 people in Chhtrapur Municipality. The lake peripheryhaspandanus junglesproviding livelihood to 7000 people and groundwater recharge(Ferrieira et al., 2023[8]).

The lake accommodates aboutavifauna(76), aqua-fauna species (46), and supports 48 varieties of phytoplankton, and seven non-mangrove floral species of inland plants and macrophytes. The lake is free of Ipomeas and water Hyacinths except for sparse patches. The common pochard (Aythya ferina), river tern (Sterna aurantia) and Amur carp (Cyprinus carpio) are available fish species withthe (common pochard) Aythya ferina, Sterna aurantia (river tern) and Cyprinus carpio (Amur carp) are vulnerable species as per IUCN (the International Union for Conservation of Nature) with lake productivity 54.54 kg/ha/yr. (Mohanta et al, 2014[9],Ramsar site 2489[5],).

The Hydrology

The hydrologyof the Lake isgoverned by runoff from EGB Hills rangesfrom west, north and south. The Tampara basin is estimated to be 1420 km^2.The lake receivesfrom its basin through major waterbodies Karatali Tampara, Haripur Creek, and Sana Tampara(June to December)during monsoon. The lake enjoys a tropical Savanna-typehumid climateon the Köppen scale **(Aw)** and has an average rainfall of about 1200mm/ year (Fig 1).

Review of Literature:

Globally, Coastal aggradation and degradation havebeen a cyclic or continuous process. The shorelineelongation or squeeze and mouthing shifts areshared results of the natural processes,sun-earth geometry, climate vagaries,Sea Level Rise (SLR), anthropogenic activities along the coast and inland riverine system, affecting individual and community safety and prosperity, (Balaji et al., 2017[10],Paola et al, 2023[11], Nath et al, 2023[12]). About 18 worst-affectedcyclonic storms have ransacked our globe causing about 1% of all deaths and approximately more than $800 billion in economic damages, since 1998, in the hydrographic cruise, North Indian Ocean,NOAA, 2023[13],https://ourworldindata.org/natural-disasters). The Bay of Bengal (BoB) has been a hotbed for cyclonic storms and shall increase abnormally, frequently and intense causing and become apocalyptic lives, property and ecosystems, especially alongthe Odisha coast (Panda et al, 2020[14],Ghosh et al, 2023[15], IPCC 214[16]),

The coastal vulnerability is associated withGeomorphological, physical, socio-environmental, ecosystem health, and socio-economic aspects. The spatial adaptability of the ecosystem changes is compensative tomaintainresilience.Social vulnerabilityis featured bycommunitiesadding tosocietal inequities and social capital. They are the vital indicators of response of the society to natural hazards and climate vagaries emphasizing resilience to coastal flooding and communities, (Hzami et al., 2021[17], Roukounis et al, 2022[18]).

South Odisha's coast is eroding from Gopalpur to the Rushikulya river mouth in Ganjam, and from the Mangala River mouth to Chandrabhagaand isvulnerable to the coastal towns and

settlements.From 1990 to 2015 The long-term assessmentof progradation is@ 0.3m/year, but cyclic (Behera et al 2019[19], Mishra et al., 2019[20], Mohanty et al., 2023[21]). The livelihoods ofFisher'scommunities along the Ganjam coast have worsened due to intensecyclones like Philine, Titli, Fani, etc.

Less scientific research is available on the history, livelihoodand landscape of the fisher's community after the inception of Tampara Lake. The impacts of hazardpredictability, societal economic values, aresilient environment, women empowerment and the capacity building for these minor communities after land use modifications arepresently studied.

During the early 21st century, the widening of NH-216, there were massive earthworks carried out for its renovation and widening from two lanes to 6-lane. There wasan inadequate drainage network provided in the NH-216. The Karatal Tampara, and San Tampara which were the feeder sources could not discharge into the Humuri Tampara. All the issues need to be attended:

The Objective of the study

Key findings required to be involvedin the present study are

a. The cause of deterioration of the Community's livelihood from the lake ecosystem.
b. landscape planning
c. Community vulnerability, lack of ecosystem services
d. Practices to be followed or not to be adhered to for eco-DRRr (risk reduction processes).
e. Exercises pertinent for the participatorymanagement of community development.

The methodologies:
Various methodologies are fixing thepossibilities of amenities under physical, socio-economical, ecosystem resilience, environmental health, and water availability by searching the opportunities. The transformation of the lake, the landscape and the land user's vulnerability need assessment after the effective development of the lake. The studies for the post-IRM (Integrated Risk arrangement) functional activities for documentation and strategic planning should be prioritised for greater issues. The Key steps involved are

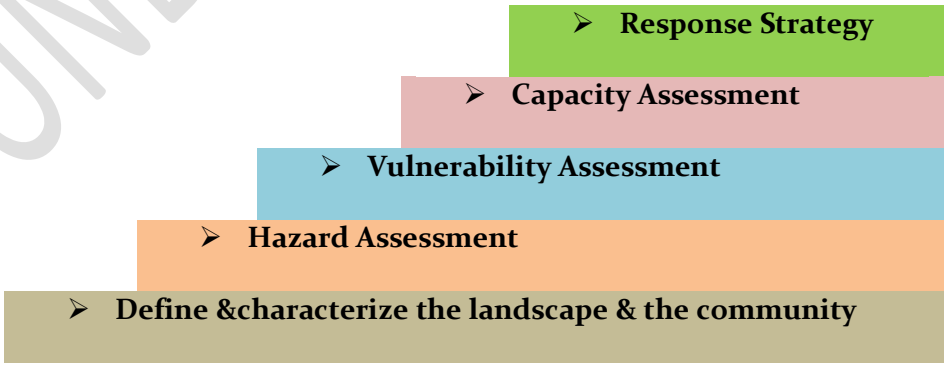


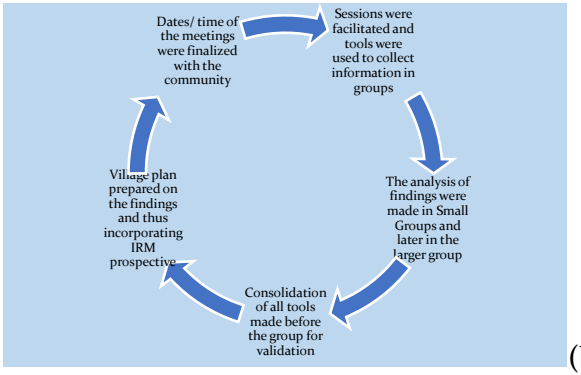
Fig 4: The key steps of the methodology adopted in the study

The focused Group Discussion was facilitated in the village. Thesepre-scheduled meetings were organized in June and July2022onthe availability of the beneficiaries.Major participants were Women SHG members, PRI members, village ASHA workers, and Anganwadiworkers for

the village. There was interaction between the Coast Net members and members and summarized. Later the proceedings and suggestions wereconsolidated at the GP level to conclude at a basin level. The cyclic methodology of the societal changes is given through Gramsava and panchayat.

The basic tools for study are Hazard vulnerability and capacity assessment (HVCA), and Ecosystem Services Shared Value Assessment (ESSVA) using the International Lake Environment Committee (ILEC) were piloted under Partners for Resilience (PfR). Two villages were under study in the lower catchment of the Lake (Fig 5(a), (b)).

(a)



(b)

Fig 5(a): The cyclic action plan of research methodology eco-DRR plan of the Tampara basin
Fig5: (b): The eco-DRR challenges during interaction in the BadaNolia village

Sana Nolia Nuagaon:

Village 'Sananolia Nuagaon', a fishermen's settlement is situated on the north-west side of the Tampara Lake. The village is located towards the outlet of the lake. It comes under Augstinuagaon Gram Panchayat in the Chhatrapur block of Ganjam District. Both the villages are called Nolia Nuagaon.The major problems faced by the villagers are cyclones, coastal erosion, storm surges, WASH (water and sanitation and Hygiene), Undernutrition, the health of the vulnerable group, waterlogging, open defecation and other environmental issues. On community level discussion it was ascertained that about 322 families were staying in both the villages which may increase to 360 families or more.The existence of 80 acres of forests hasbeen reduced to less than 30 acres. About150 acres of coastal mangroves and associates can be developed asas post-rejuvenation of the Tampara Lake (Fig 6 a-d).

(a)

(b)

(c)  (d) 

Fig 6(a): The sketch f San Nolia Sahi Fig6(b)The villagers' reaction tothe lake promotion Fig 6(c) Discussion forWomen empowerment Fig6(d):Loss of forest for firewood.

The Mission Shakti (SHG group) kept their views regarding migration or marginalizationof women who preferred alternative livelihoods for want of adequate financial support. Adequate financial support can enable them to revitalize their village-associated jungle and their socioeconomic status with women's employment and empowerment.

Bada Nolia Nuagaon:

The demographic profile of the village was collected from the Agasti Nuagaon gram panchayat the village comprises of Fishermen communities of 240 families comprising 430 males and 394 females. The community under the drinking water paucity depends on the supply of water pipes and underground lift pumps installed by the RWSS department. Besides, in some patches tube well is also used for this purpose but the salinity intruded areas are facing water problems. Sanitation has been supported by IHL, under the Swachh Bharat Abhiyan (SBA) Scheme but is inadequate, **Fig 7(a-d).**

(a)  (b) 

(c)   d)

Fig 7(a): The sketch map of positioning of Bada Nolia Sahi Fig 7(b)The old villager is Busy with livelihood Fig 7 (c)&(d)The alternate livelihood and no work with elderly women

All the pucca houses for the families have latrines. About 67% of the families have IHL facilities. Despite all these constructions, the old practice of open defecation is still prevalent. The Community mostly depends upon Marine Fishing. The village women are primarily engaged in dry fish making and selling activities so they must be promoted for alternate livelihood.

It was the entry tool of HVCA in the village. The existing hazards and immediate issues affecting the community were discussed in the large group. The hazard profiling and ranking were carried out. Gender-wise facilitation for women and men was discussed separately in the larger group.

Hazard mapping

The ranking of issues/hazards was carried out and seasonality of affectation was determined. Chart papers were used and ranking stones were used as a PRA method of ranking. The community ranked the issues and hazards in the following way in descending order:-

1) Cyclone, Storm Surge, sea level rise;
2) Salinity and Drinking water scarcity;
3) Flood and water logging,
4) IRE plant created health issues
5) Open Defecation /Sanitation

Institutional mapping

There is a village committee fully functional in the community. It takes all the decisions regarding the social and developmental matters of the community, headed by traditional leaders. The Palli Sabha (community meeting of the recognized Committee) of the village (Panchayat Raj institutions), 3 Ward members who document and represent the decisions and community plans in the Gram-panchayat level Body. Besides, there are several other social and developmental institutions in the village, that have greater influence in the social and economic living. An institutional mapping exercise was facilitated in the large group (Table 2 & Fig 7).

Table 2: Results of Institutional mapping exercises conducted in Gram Sabha of Nolia Nuagaon

Source	Food	Housing	Fisheries	Education	Insurance	Livelihood	Loan
GP/Village committee		YES					
SHG (Women)			YES				YES
NGO			YES			YES	
Bank					YES		YES
Society (Fish)			YES		YES		
Fishery Dept.			YES		YES		
Anganwadi	YES			YES			
School	YES			YES			

Since the Village Committee is taking the most important role of decision-making in several aspects, it was ranked as the highest. Followed by the Primary Fisher Cooperative Society. Bank has ranked as lowest since they feel that the services provided by this institution are less in comparison to what is expected by the people. The institutional mapping was done Later in the larger group; these institutions were ranked as per their contribution to the lives of the people in**graphic 6 (a-b).**

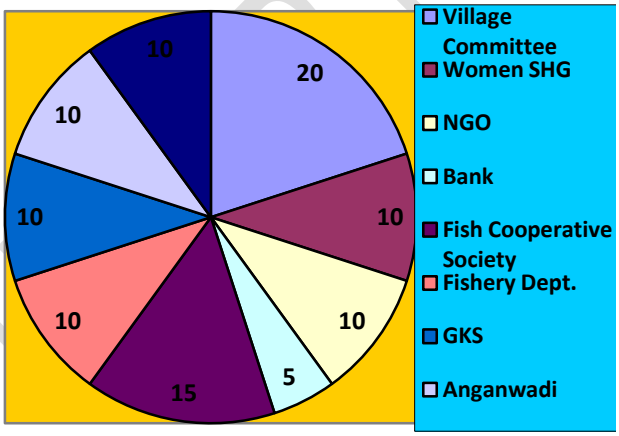


Fig8 (a): The hazard mapping of the Nolia Sahi in Ganjam district (b) focus group discussion.

Dependency of community on Natural Resources:

The tool clearly described the present understanding of the community regarding natural resource vulnerabilities across the village landscape, including the present status and future challenges. It also envisaged identifying the key causes underlying the issues (**Table-3).**

Table 3: Dependency of community with available resources with the Nolia Village, Chhatrapur

Resources	The sea and its resources	The coast and its use	Houses	Forest	Tampara waterbody
Presentuse responses	All in the fishing profession	Dry fishmaking, Boat care;opendefecation	Colonies; or unplanned houses	Gram Jungle overexploited	Regular Flood ofinflow, storm surge

		area			
Anticipated future snags	Wild waves and surges may erode morebeaches near the coast	Breach outlet,Fish loss, loss of coast,beach sands, flora,fauna so livelihood	The dearth of potable Water, salinityerosionof houses/structures	Balding jungles, afforesting and deforestation if not done	Lake may dry during drought or breaching as before 1999.
Reason	The intensified storms, and wild waves after the Indian Ocean Tsunami	No dunes or coast-saving approaches like seawalls and soft structures.	Regular support the houses to save salinity losses	As almost lost warrant new afforestation and deforestation	Excess tourism, over the use of lake water,deterioratesthe quality and illegal buildings may build up.

Natural Resource transaction and identifying the LULC status

Separate tools of threetimes scale (Past, Present and Future) were used to assess the vulnerabilities relating to the dependency of the community on the local ecosystem services and their livelihood and expense pattern. The villagers firmly acknowledged and accredited that climatechange has changed the way of living in comparison to the past decades. The majority of the youths are in markets, driving profession. The changing climate has increased the vulnerability of the community in a bigger way. There has beena huge change in the land use and land cover **(LULC)** pattern adapting to climate change scenariosover the years.
The community has had a wider coverage of forest land of 80 acres in the past 20 years back, at present it is confined to 30 acres and the future (10 years later) predication could be around 15 acres. The attributes responsibleare the climate change effect, sea level rise, anthropogenic modernization, and impact of mining activities, over-exploitation of the forest resources by the community due toan increase in families etc. (Fig 9).

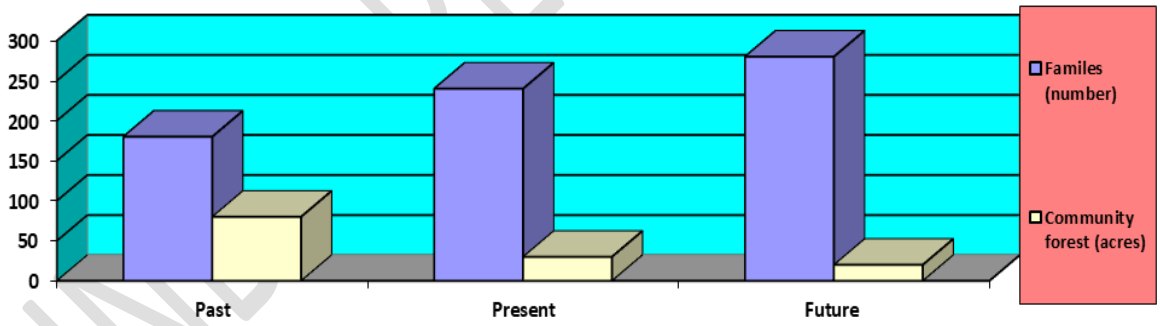


Fig 9: The risein people vs. decrease in community forests (Time scale basis)

Families and forest land with a time-scale

The community realizesthe impact of Climate Change in terms of bay disturbances and erratic rainfall. They conceptualizecoastal erosion, sea level rise, and wild waves that have increasedin intensity and scale as indicators in the villageinthe last two to three decades. Thesummers are getting warmer than earlier makingsea water than ever before.Last few years less/nofish catch and a smaller number of species are caught from the sea or Rushikulya river estuary during erratic rainfall/duringthe rainy season (Fig 10)
There is a lowering of fodder and timber products from the nearby forest, probably due to the Indian Rare Earth(IRE) mining activities in the area. Earlier community was growing backyard kitchen gardens based on the water from the outlet of the lake but nowre not there.

Ecosystem services and the perceived change -

The communities identified a total of 18 ecosystem services (6 provisioning services, 5 regulatory services, and 7 cultural services). A thematic discussion was carried out involving all the community members during the above assessment. The beach has been now used for cultural practices, Tourism, and other fish processing activities like dry fish activities, net stitching, and boat building, machine and net storage. Thebeach is shortened, tides directly heating the communityhabitations. The threat of submergingintohouses and peripherals compelsthemto either migrate or marginalize.The rehabilitation isdone by the Odisha Disaster Recovery Project (ODRF) and the World Bank. The eco-DRR is in (**Table 4**)

Table 4: Ecosystem services available for the community and the time scale trend

Ecosystem services (types)	Spheres	Sources/locations	Viability trend (Ranked (Scale- 1 to 5)	
			Present	Future
Provisioning services	Food	Marine/sea fishing	4	3
		Inland/ lake/ Canal fishing	3	1
	Raw materials	Timber from local forests	4	2
	Fuel/ Energy	Fuel wood from Community forest	3	2
	Freshwater	Drinking water	4	2
		Irrigation, water for plants/ animals	3	2
Regulating Services	Biological spheres	Diseases control/ Community threat	3	1
	Climate regulation	Temperature moderation in the locality	4	2
	Prevention of extreme events	Wind/ wave force (saline) from the sea	4	2
		Flood/ water logging after heavy rainfall	4	2
		Soil erosion around the community	3	2
	Decomposition	Waste removal from the village	3	2
Supporting Services	Soil	Quality/ salinity in and around the community	3	2
	Habitat	Beach Landscape	4	2
		The forest around the village	3	1
		Shelter	3	2
	Species maintenance	Biodiversity: Marine and other fish resources	4	2

There is a need for more (new) plantations, particularly in and around the new colony as developed by the ODRF scheme. Backyard plantation has been another measure, which was predominately put forth and priorities by the women groups. The community ranked the ecosystem services on two times scale of Past and Present (range 1 to 5). Past refers to 20 years back. The scale of 1 to 5 is in increasing order viz. higher the services/ benefits; the greater the value. The trend is descending trend as per the understanding of the community (**Fig 10 a-c**).

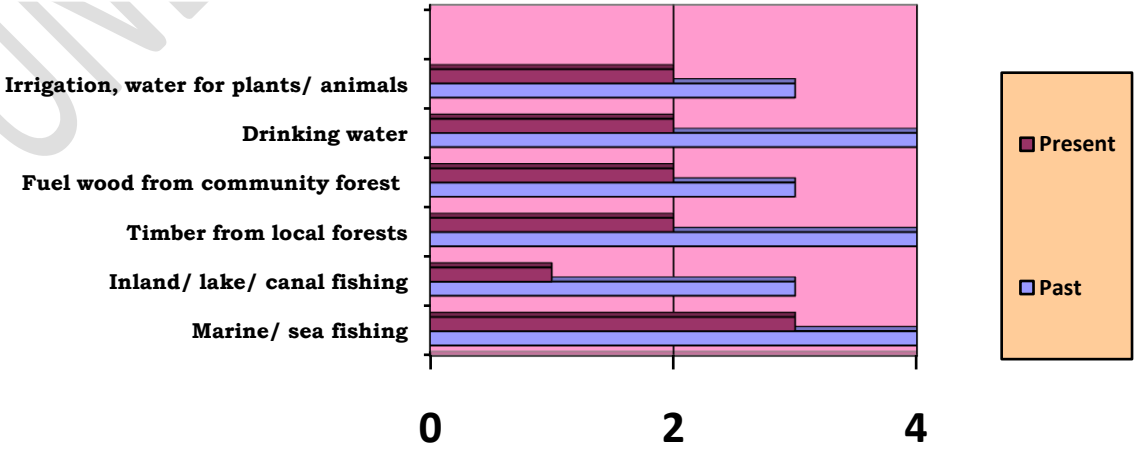


Fig 10(a): EcosystemProvision Services in the time scale(vegetation, forests and oceaninc)

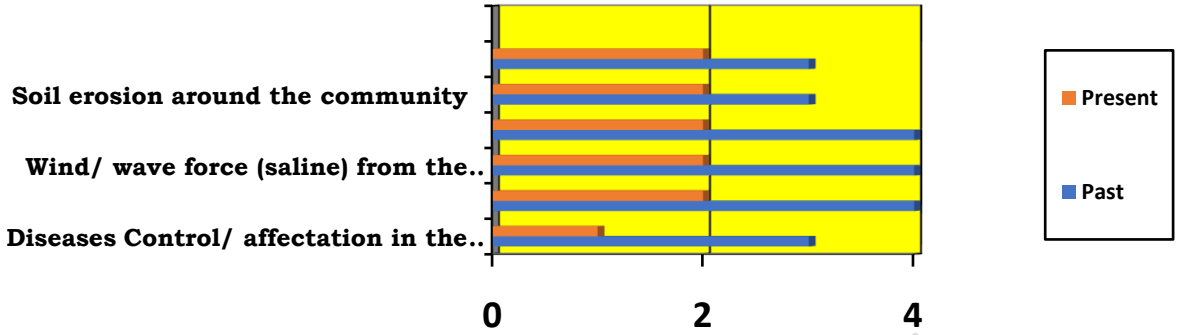


Fig 11(b):Ecosystem: *Regulating* Services of eco-DRR in time scale along the coast

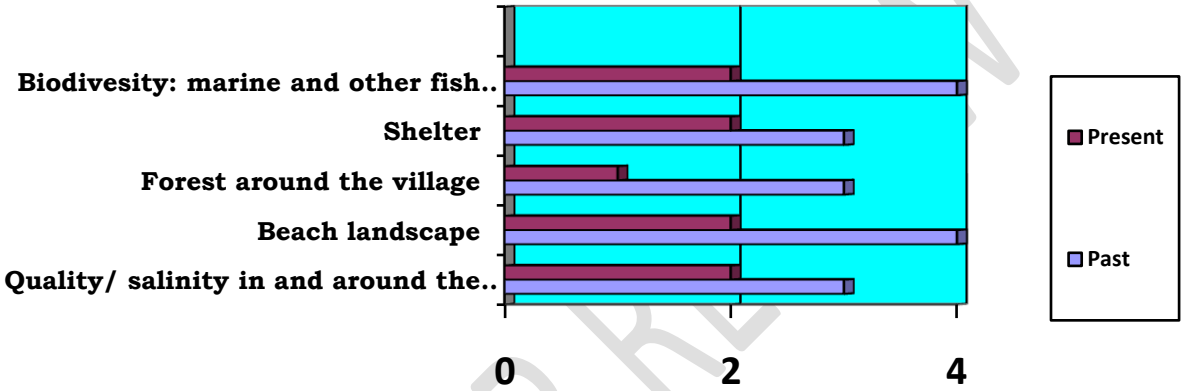


Fig 12(c): Ecosystem: Supporting Services in time scale biodiversity and water quality

Perceived Climate Change(Impacts on the natural resources and livelihoods)

The seasonality and the impacts on the communityof water-mediated risks from cyclones, storm surges, floods and waterlogging, SLRwas determined in the larger group. They are mainly fromthe activities of the Indian Rare Earths (IRE) plant. The community-induced issues are opendefecation and drinking water issuesaround the year, (**Table 5**)

Table 5: The time scale analysis of various issues of the Nolia Sahi, in Chhatrapur block

Issues	Time scale analysis			Ranking
	Past	Present	Future	
Inaccessibility to sea/ fishing activities	4 months	7 months	Shall increase	High
Inadequate services from the community forest	4 months	6 months	Shall increase	High
Migration for income	2 months	5 months	Shall increase	High
Open defecation issue	3 months	12 months	Whole year	Medium
Drinking water scarcity	2 months	8 months	Whole year	High

Hazard events and losses incurred

The community identifies 3 hazards with the most potential threats such as i) Cyclones&storm surges; ii) Salinity intrusion affecting drinking water and iii) Flood and water logging. Besides, two other major anthropogenic issues are iv) Mining-related health issues and v) Open defecation (sanitation)

causing ill health of the community. The HVCA exercise of the coast of the study area. The major coastal hazards are the impact of cyclones and coastal erosion byhigh waves affecting livelihood in part of the community. About 35 intensified cyclonic stormswhile landfall or passing near the south Odisha coast affected the lake basin (**Table 6**).

Table6: The cyclone Hazard analysis that affected the basin from 1982 to 2022 in the study area

Year	Details of the Hazard					Losses incurred in the study area			
	Severity	Month / Time	Surge height	Impact days	Basin affected	House &Setup	Lives	Land (acres	Living affected
1972	VSCS	Sept 22nd	2.4m	5days	Total	Damage(40%)	Nil	22ha	Totally
1989	SCS	July 21st	2.0m	3days	partly	Damage(20%)	Nil	Nil	partly
1995	VSCS	Nov 7th	1.5	7days	Total	Damage(75%)	Nil	28ha	Partly
1999	VSCS(F)	Oct 15th	3.5m	10days	Total	Damage(80%)	Nil	30ha	Totally
2003	DD	Oct 21st	Swell	3days	Partly	Damage(20%)	Nil	nil	less
2007	DD	Sept 21st	1.0m	5days	partly	Damage(35%)	Nil	Nil	less
2010	DD	Oct 15th	1.5m	7days	Partly	Damage(30%)	Nil	Nil	Partly
2013	VSCS(F)	Oct 12th	4.5	10days	Total	Damage(80%)	Nil	45ha	Totally
2014	VSCS	Oct 12th	2.5m	10days	Total	Damage70%)	Nil	25ha	Totally
2015	Dep.	June 21st.	2.0m	2.0days	partly	Nine missing	≈9	20ha	partly
2019	ESCS(Fani)	May 3rd	2.0	10days	Total	Blown away and heavy loss	Nil	80ha	Totally
D: depression; DD: Deep depression; CS: Cyclonic storm SCS: Severe cyclonic storms; VSCS: Very severe cyclonic storms; ESCS: Extreme severe cyclonic storms SC: Super cyclone; F: Flood									

Hazard & Vulnerability mapping: Time and Trend analysis

Cyclones, storm surges, coastal erosion, floods and waterlogging are annual in the area and their frequency and intensity have surged for the last 3-decades.The stakeholders say that the time the hazards affected the community mostly during night hours.

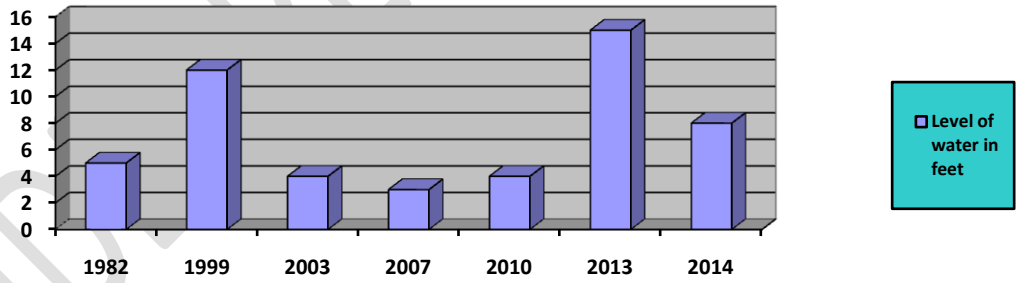


Fig13:Rainfall and Waterlogging upsetting theNolia Sahi villages in different years.

The key forces were oceanic flooding, high wind speed and water logging making the community cut off from the mainland. During multi-hazards (like cyclones followed by floods) the suffering is greater. The level of water can be an indicator. The years 1999, 2013, 2014 and 2019 were the apocalyptic years in the area followed by heavy rainfall causing flood/ water logging, except only flooding in 2008 in the area.

The other potential impacts other than natural disasters are forest cutting, mining issues and open defecation issues, It has beena herculean task to map its impact at a micro level that is affecting the community over the years, which is aggravated in recent years.

Vulnerability mapping: Change in 'practice' and 'nature' of fishing

The community depends solely on marine fishing as their primary livelihood. The increase in

uncertainty of rainfall hasa direct impact on fish catch in different seasons. The HVCA exercise helped in estimating the pattern of change in marine fishing of the community with a time scale – *Past, Present and future*.

The change in time scale is declining in order. In the Past time scale (20 years back), there was rainfall for 5 months in the areaallowing availability of fish and dry fish over 8 months in the community. In the present scenario, the rainfall month is reduced to 3-4 months. Fish catcheshave reducedin quantity forsome time to 5- 6 months. The community is predicting if the present trend in rainfall continues, the uncertain fish catch shall be for 4months.

The quality of catch and numbers of species trends the past-present-future time scale shows that there are decline in the numbers of species of the fishes and quality due to overexploitation of fish resources offshore. The community are of an opinion based on the experience of the old fisherman and other practising fishers, that there shall be a reduction of marine stuff in the coming decade. Moreover, the state Govt has banned fishing for 3-4months for the hatching of Olive Ridley tortoise, though getting Rs 1500/ month is insufficient..

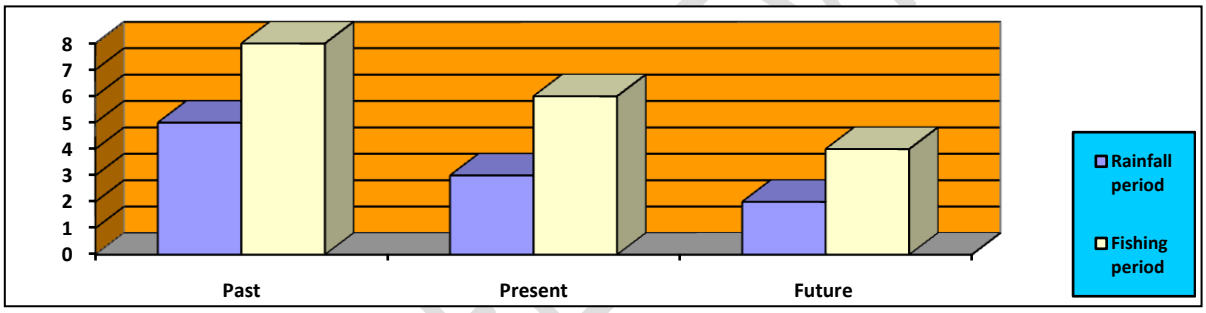


Fig 14: Fishing period vs Rainfall from the sea against Time scale in Nolia Sahi

Fisher communitiescommonly think that 25 types of marine fish are available, with a high market value. Presently the scale has been reduced to 12 types of species. They think on analyzing the trend, the commonly available numbers of species shall reduce to 8types in the coming decade which shall be an open threat to their livelihood.

Seasonality of fish/ dry fish availability with time *scale*

The community recognized several factors for the reduction of some of the species and the scale of the fishing such as the use of zero net, intensive fishing by trawlers and more predominately change of rainfall pattern, which has a direct impact on the fish breeding.

Table 7: Summary of various fish species availability in past, present and predicted for future

Time Scale	**Number of fish species**	**Availability of different fish species (Local names)**
Past (20 yrs. Back)	25 types	Kokoli (Dussumieria elopsooides), Large Prawn, (Penaeus Mondon),Bada Tumbuda, Bada Kabala, Black Prawn, Gulibinda, Gulibinda, Large Para fish, Singhi Kani, Meji, Pathara-mundi, Kara, Kumutimuna, Crab, Ksnagudia, Sabala, Nakhamachha, Gania, Bagada Prawn,

		Kab Chandi, Surangi, Disco Kabala, Chanara, Small Elisa, Samudra Kantala
Present	12 types	Large Kabala, Singhi Kani, Meji, Patahara-mundi, Kanagudda, Nahkamachha, Sabala, Disco Kabala,Bagada Chingudi, Samudra Kantala, Kara
Future (10 yrs. Later)	7 types	Large Kabala, Meji, Sabala, Disco kabala, Kanagudda, crab, Kara& Patharmundi

Ofcourse,the community understands that the species which are not available on the coast need community stewardship in the conservation and protection of mother fishes. The trend of fish availability can be represented graphically as below-

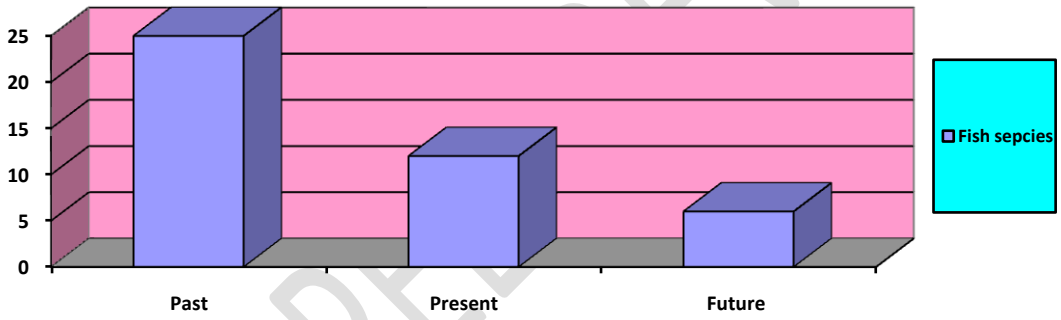


Fig 15: Fish Availability to the community with past, present and future trends at Nolia Sahi

Hazards: Community Perception, Coping Mechanisms and Preparedness

The Community identifies that Lake Tampara plays a crucial role in the reduction of the risk and losses that occurred during different hazards like flood and water logging over the years. They also pointed out it to be the buffer zone in managing the flood water and water logging issues. Since the ecosystem services they used to get from the lake have reduced with time scale, there is an increased threat to the community. Ofcourse, it was due to the geographical location of the village which is towards the downstream location of the Lake.

About 3 decades back, when the inlet and outlet to the Tampara Lake were functional they used to get less water logging. Whenever there is heavy rainfall the outlet is rejuvenated with fishes. The huge fish catch could escalate their income to double than present. The stakeholders of the lake could hoard and make dryfish, and renovate the outlet of the Lake is chocked. The villagers opined that the inlet and outlet to the Tampara Lake need to be dredged annually for smooth inflow and outflow to the lake.

Capacity profile and coping mechanism

In the community meetings questionaries are prepared and compiled from time to time and a capacity profile along with a coping mechanism has been prepared (Table 8)

Table 8: The capacity profile and the coping mechanism of the Nolia Sahi near Tampara Lake

Item	Present capacity profile		Coping Mechanism	
Mitigation	Pre-hazard	During Hazard	Pre-hazard	During Hazard
Forest	Deteriorated Casuriana jungle		Afforestation,Puccahome	
Individual Survivability				
Foods	Rice, Puffed and flattened rice stored for urgency	Take stored &relieffoodstuffs	Must store dry &nonperishable food	Most store prior
Water	Drinking water from tubewells	Drink stored water in bottles& pouches	Raised platform deep borewells to be set	Drink clean water stored in a clean pot
Fuel	Use fuelwood from Gram jungle	Not available as become wet	Store dry fuel or keep the gas cylinder full	Use cylinder and stove(Kerosine)
Sanitation	Use open-area defecation	Anywhere they like	Personal/community toilets	Community/ prefixed toilets
Shelter	No specific action	Shift to cyclone shelter during storm	Pucca houses on raised ground	More cyclone centers
Healthcare	No facilities	Need primary health centre	Training to village health worker for 1st-aid	Govt to provide in shelters
Mobility	Motorized scanty	Mobility through water and jungles	Need raised roads and motorized boats	Roads with boats for mobility
Earlywarning	No basics availability, Mikedeclared only	Available at shelters By Govt. Officials	Cyclone warning,alertsto Fishermen needed	Prewarning, TimelyGovt. alert needed
Livestock	Bovines absent	Not a problem	As nomadic no need	Not a problem
Community readiness				
Food	Nil	-	Rice products, dry fish	Processed foods use
Shelter	Nill	Cyclone shelter use	Willing all toshift CSh	All shelters in C.Sh
First-aid	Nil	Nil	Village workers to train	To keep in C.Sh.
Mobility	Nil	Bulanga CSh used	All other roads needed	Road to use
Earlywarning	Nil	Nil	Govt, electronic and local volunteers use	By local workers and Mike at CSh.
Firewood	Nearest Gram Jungle	Cooked food at CSh	Drywood, Kerosine, gas-filled cylinder to store	Relief source, stored dry wood
Drinking water	Store sweet or river water as GW is saline	Stored TW, riverwater, pouchat C.Sh	Raised platform deep borewells reaching sweet water needed	Boiled and later filtered water to use
CSh: Cyclone shelter; Govt.: Government GW: Groundwater				

The analysis clearly explained the existing capacity and practice of the community in the sphere of reducing risks in the village. At present, they have fewer mechanisms to cope with the hazards in terms of prevention and mitigation spheres. They are rather concentrating more on community preparedness and individual survivability spheres.

Knowledge and early warning have been enhanced over the period. They get information from various sources like block offices, radio and television more frequently, language problem hinders the information and knowledge of predisaster activities. They need some mechanism like translators to decode the impact at their level, more specifically on livelihood spheres. They use the local drum announcer to spread the cyclone and storm messages across the villages many times.

The analysis leads to discussions in different small groups based on gender and age group. The spheres of discussion mostly focused on the present practices of Community Readiness and Individual Survivability. The plan for food, water, shelter, first aid, sanitation, mobility,

fuel wood and livestock fodders were summarized again in the large group.

The second round of focus group discussions needs to be done on a time scale as in different spheres such as: i) pre-disaster period, ii) during a disaster and iii) post-disaster scenarios.The facilitation from different small groups was consolidated on the chart papers. Of course, it represents the community's view and perception of developing IRM-based intrusions.

Gender role during hazards and Risk changes

The status of women in the community was discussed in separate groups. Male members of the community also participated in these focus groups. Women in the villages are engaged in household activities without any fishing activities other than dry fishing (about 120 families) as a secondary occupation. The women's literacy rate is 30.5%. Women have a different societal status in comparison to the opposite gender. Women have less participation in the societal decision-making process and societal finance at the community including the family level. They havea low education status in comparison to men and thus a low capacity towards information regarding policy, lower mobility and other opportunities. Fishing crafts, gear and fishing activitiesare the men's work. women are there to only cook and do household activitiescollecting firewood and making dry fish.

Women'sresponsibility:

The women in the village do not participate in the primary livelihood sector of marine fishing since it has been a male-dominated occupation. The secondary occupation of the community is part ofthe primary occupation of the women which is 'dry fish making and selling'. This occupation depends solely on the catch. Therefore, the lowering of catch leads to increased scarcity in dry fish making. Since males do not take part in house management, the women's community are stressed. That shall affect family peace and cultivate unfair adaptation in livelihood mostly during the ban period though getting less financial help.

Table 9: The *Income source Vs. major expenditures in time scale* by the fishers (Nolia Sahi)

Month	Past (2000-2019)		Present (2020-2023)		Future (2023-2030)	
	Income	Expenditure	Income	Expenditure	Income	Expenditure
January	Fishing/dry fish making	Netrepair/ home/ health	Fishing/dry fish making	Net repair/ home/ health	Fishing/dry fish making	Net repair/ home/health
February	Fishing/dry fish-making	Celebration/ home/ health	Fishing/dry fish making	Celebration/ home/ health	Fishing/dry fish making	Celebrations/ home/health
March	Fishing/dry fish making	Celebrations/ home/ health	Fishing/dry fish-making	Celebration/ home/health	Shall marginalize Migrate/Wages	Celebrations/ home/health
April	Fishing/dry Fish making	Home/ Health	Fishing/dry fish making	Home/Health Firewood	Shall marginalize /migrate/Wages	Home/ Health
May	Fishing/dry fish making	Main health/ home expense	Fishing/dry fish making	Housing activities	Shall marginalize Migrate/Wages	Housing activities
June	Fishing/dry fish making	Celebrations/ home/ health	No earning	Housing activities	Shall marginalize Migrate/Wages	Health/Home sector
July	Fishing/dry fish making	No earning/ on Foods	No earning	Idle/Expd^{re} on Foods	Shall marginalize Migrate/Wages	Health/Home sector
August	Fishing/dry fish making	No earnings /on foods	Start Fishing	Idle/ spent on foods	Shall marginalize Migrate/Wages	Health/Home sector
Sept-ember	Fishing /dry Fish making	No earning/ Idle	Start Fishing	Home/ Health	Shall marginalize Migrate/Wages	Housing/ net repair
October	Fishing/dry fish making	Home/ Health	Start Fishing	Home/ Health	Shall marginalize Migrate/Wages	House/ boat/ net repair

Novem -ber	Fishing/dry fish making	Celebrations/ home/ health	No work/ net repair	Celebrations/ home/ health	Start Fishing, dry fish making	Celebrations/ home/health
Decem- ber	Fishing/dry fish making	Celebrations/ home/ health	No work/ net repair	Celebrations/ home/ health	Less Fishing/dry fish making	Celebrations/ home/health

The above analysis clearly shows that there is a lowering of income from the primary occupation, whereas expenses on diseases and modern living expenses have been raised over the period. The female members of the family are burdened with time and money to meet health, food, primary education, and societal expenses. Therefore it can be concluded that climate change has a greater impact in increasingthe social burden on women than past (Table 10).

Table 10: The income from livelihood and expenditure on disease duration scale)

Past (20 years back)		Present (at present)		Future (10 years later)	
Income: from primary livelihood	Expenses: on Disease duration	Income from primary livelihood	Expenses: on Disease period	Income from primary livelihood	Expenses: on Disease period
9 months	7 months	5 months	9 months	4 months	11 months

The decrease in income sources and increase in marginal expenses shall decelerate the fulfilling the

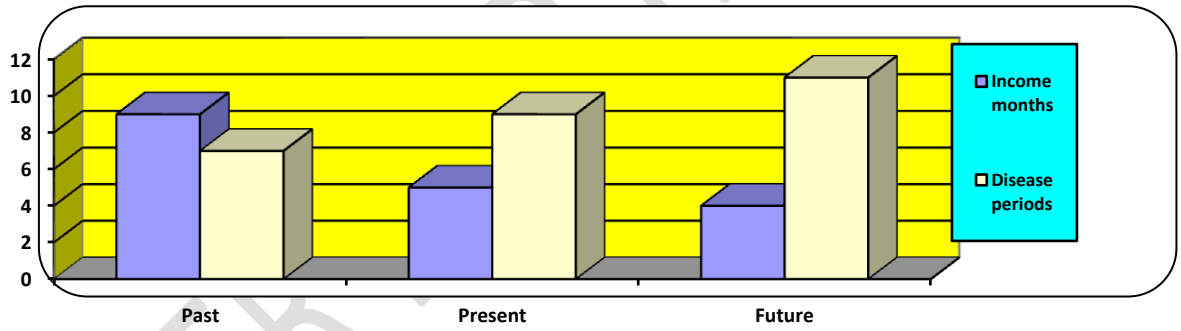


Fig 16: *Income from primary livelihood Vs. Expenses on diseases (periods) of Nolia Nuagaon)*

A participatory assessment on ***migration*** was facilitated. Migration and marginalization are noticed as an indicator of increased risk over the livelihood. Initially, the male of the family migrates seasonally to other areas in search of alternative income sources. But nowadays, there has been increased female migration from the same village. That means the strongest and most productive women members go out of the family for income, sometimes along with the male members and sometimes alone. This increased the risk to the women and the children..

Table 11: Migration trend in the community with time scale: in the proposed settlements

Parameters	Past (20 yrs. back)	Present	Future (10 years later)
Total number of families	180 families	240 families	280 families (projected)

Number of families with migration	40 families	120 families	160 families (projected)
% of families with migration	22%	50%	57%
% of women with migration	13 %	38%	50% (projected)
Migration periods	3 months	6 months	7 months

This can be graphically presented as below-

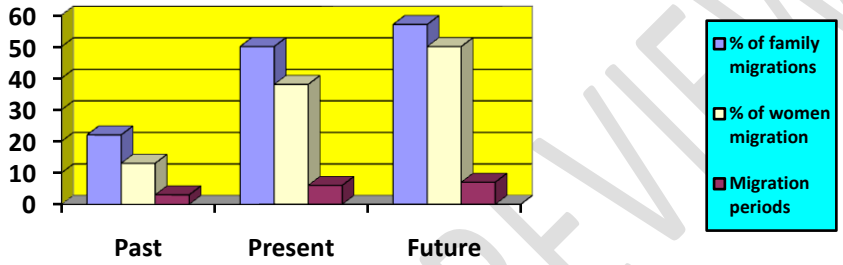


Fig 17Migration statistics against the time scale of both the Nolia Nuagaon

Discussion:

The availability of portable water forms shall be worsened in all sources making human life apocalyptic, (Shapiro et al., 2021[22]). The growing water crisis is worsening both as surface and groundwater sources, (UNESCO 2021[23]). The conservation and management of water have become futile or sluggish. The surging state portable water emergency is confronted by many developing countries including thickly populated countries like India. The sustainability of water has surged so high that no planning and management has been made either by government or private agencies. Still, the worst scenario shall be in coastal topography. The impacts of strandline shift, progradation/ or aggradation of the beach, deterioration of the ecosystem and the watershed hydrology with Salinity intrusion shall make the geomorphology fragile. Time demands have a sustainable ecosystem, so we should have a competent and scientific appraisal to achieve future water demand and ecosystem restoration through watershed development (WSD)*having*social, economic, political, and ecological entities, particularly along the Odisha coast, (Panda et al, 2020[24], Mishra et al, 2023[25]).

All the studies made above can be concluded that future income sources are reducing and of concern due to present climate change impacts, modernisation and population growth among the low-income fisher's community. Improper housing, WaSH facilities, and illiteracy have made them deprived of the facilities given by the federal institutions and Government and non-government institutions. Primary facilities like connectivity, livelihood support, education, Health, electricity and WASH facilities should be available to the fishermen's community uninterrupted to the villagers of Nolia Nuagaon. The facilities to be provided are"

1. Deep borewells with elevated platforms for safe drinking water with overhead Tank (SDG-6)
2. Food security and relief from the Government must be provided to each household as per SDG-2.
3. A community health unit, Asha workers and organizing health camps are essential (SDG-3)
4. The females of the community should have more SHG or mission Shakti for women's empowerment and theWomen Human Rights Defenders (WHRDs) as per SDG-5.
5. After each disaster and ban period the villagers must be assisted by relief like damaged fishing tools and houses. A disaster combating unit should be constituted within the community to serve the traumatised, vulnerable group efficiently.
6. Higher skilled education should be provided to the children of the financially weaker section freely as per SDG-4
7. Resilience processes for sustainable livelihood processes.
8. During a disaster, the community must be equipped with adequate food, healthcare, and sanitation facilities as relief.
9. Through afforestation, the Gramya Jungle should be retrieved to save the community from wind, erosion and devastation.
10. Connectivity should be improvedin the community to district HQ..
11. All families must be provided with a gas connection along with an uninterrupted electricity supply as per SDG-7. Functioning of an integrated solar power station with grids may be instituted and communities should get clean energy at a subsidised rate as per SDG-7.

The impact of the developed Tampara Lake ecosystem, the societal environment is going to deteriorate such as the running of the hotel industry, disposal of garbage, and dust-overloaded GHG gasses. overexploited catch of fish and the peaceful atmosphere in the fisher's community shall undergo societal differences. Like other coastal fisher communities in populous localities shall be full of slum and slum activities instead of a peaceful lifestyle.

Conclusion:

Fishing from the sea,the outlet of the Tampara and Rushikulya estuary is the main occupation that the community. Over the period the outlet is chocked, these brackish water fishes are unavailable for the community. The future prediction shows more vulnerability to sea fishing, due to OMFRA which prohibits fishing for several months. At the same time, the bigger boats and trawlers are other threats to the fishing.

The community mainly depends on the forest resources around their villages for several reasons like fuel wood, timbers etc. There has been notable depletion in the forest resources adjoining the village in the last decades. There are several causes behind this like use of space for house building, overuse of timber etc. But the villagers also acknowledge the fact the communities have not taken appropriate conservation and protection measures for this. Grasslands which were present in past have disappeared and been replaced by new thorny bushes which animals cannot graze upon. There is a need for exigent actions to be taken on behalf of the community to replenish the pre-existing forest, soil and water conditions.

The HVCA process followed by the ESSVA exercise helped the community to understand the IRM issues in a wider and more comprehensive way. They could become aware of the landscape approach to develop a supporting Ecosystem with all its services to the community. Based on this finding and analysis a joint Action Plan needs to be developed for both Bada and Sana Nolianuagaon. This needs to be accepted by the Gram Sabha and then included in the Gram Panchayat development plan (GPDP) plan for the village.

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