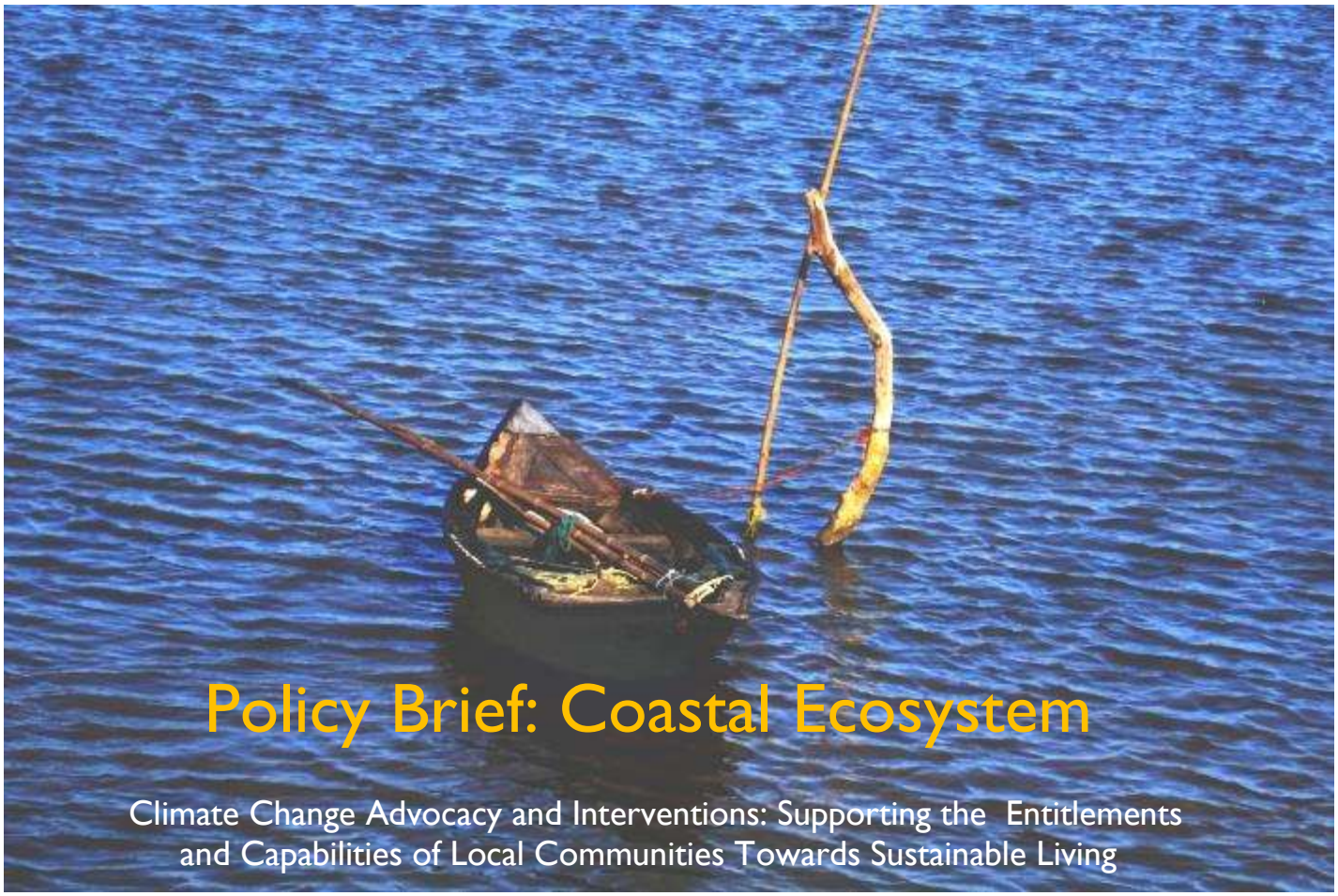

Policy Brief: Coastal Ecosystem

Climate Change Advocacy and Interventions: Supporting the Entitlements and Capabilities of Local Communities Towards Sustainable Living

This Policy Brief has been developed as part of INECC's engagement on Climate Change and Community Resilience that expected to develop eco system based policy briefs. The resilience framework posited through this policy brief has drawn from the realities of the micro ecosystem based experience and insights.

1. Executive Summary

Nearly 35% population of India live within 100 km of the country's coast line measuring 7517 km. The close to coast region is comprised of wide range of ecosystems - wetlands, mudflats, estuaries, islands, mangrove forests, marshes, lagoons, creeks, coral reefs, and sea grass beds, sandy and rocky beaches; close to coast community habitations, urban and industrial areas and so on.

The coastal region is one of the densely populated regions of the country and one of the most vulnerable due to the typical terrain, exposure to recurrent hazards; sensitivity of assets and practices, and relatively poor capacity of the community living in the coastal region as well as the infrastructure against the high intensity recurrent oceanic disasters.

The impacts of the global warming induced climate change, both rapid forming and slow onset, are comparatively more pronounced in the coastal region; would be more intense through the near and long future going by the projection relating to the climate change.

The Policy Brief primarily focuses on the area behind the shore line directly affected by day to day tidal influence up to 20 kilometres or more depending on the terrain; the ground zero of devastation of oceanic disturbances. The Brief is premised on the experience and observations of one community living close to the Bay of Bengal coast; how they have lived

through the typical dynamics of the close-to-coast regions and how they are poised to deal with the projected climate change. It is like 'crystal-gazing' into their reality to envisage the ways out to live through and grow with the stressors typical to near to coastal regions, especially relating to the climate change.

Few aspects that emerge strongly and demand serious attention are:

- In comparison to other ecosystems of the country, the disasters that strike the coastal region have been comparatively greater, frequent, humongous and challenging to the capacity of the community, government and the expert institutions as well;
- While the physical vulnerabilities are beyond capacity of the community living close to coastal region to address, the global warming induced impacts have been comparatively more pronounced in the coastal region, and there is high confidence (evidence) about the sea level rise and spike in other high intensity disasters with associated complications;
- Vast coastal regions are at risk because of inherent features of the coastal region, high exposure and sensitivity of major assets and livelihood practices to rapid forming and slow onset climate events; poor capacity of community, and poor benchmark of resilience building. Number of problems and issues without convincing solutions further the risk and complexities;
- Repeat of similar pattern of damage to assets and infrastructure due to inadequate transformative change in design and construction standards, at least against the known benchmark of worst disasters;
- Unabated pollution, absence of focus on sustaining inter-ecosystem services have resulted in adverse impact on the fragile coastal ecosystems;
- Inadequate scope and system for participation of close to coast community in resilience building process - protection and management of mangroves, embankments, plantations, sand dunes, fish resources, and other resources and systems of importance to resilience building;
- The situation demands urgency, focus, time and target bound programme matching to the spike in disaster events and the enormity of projected impact to reach out to the most vulnerable communities

'Not all storms come to disrupt life, some come to clear our path' towards resilient sustainable 'new normal'.

2. Context

Nearly 35% of the population of India live within 100 km of its coastline. The close to coast region of India assumes special importance because of high productivity of wide range of coastal ecosystems - wetlands, mudflats, estuaries, islands, mangrove forests, marshes, lagoons , creeks, coral reefs, sea grass beds, sandy and rocky beaches, etc. It is also one of the busiest happening places with concentration of population, urban areas including major cities; exploitation of varieties of natural resources, wide range of industrial and recreational activities.

Close to coast region of India has been in focus over the recent past owing to phenomenal increase in incidence of disasters of oceanic origin and the recurrent damage of enormous

proportion inflicted to livelihood and infrastructure. Spike in rapid forming and slow onset climate events attributed to the climate change induced by global warming, and the projections of imminent adverse scenario due to the same add to the complexities surrounding the coast.

The communities living close to coast region, the ground zero of destruction of recurrent high intensity disasters, are especially prone to risk due to their geographical location and host of other factors - livelihood practices sensitive to ecosystem and climate services, poor socio economic status, housing and living environment and other typical constraints inherent to the close coast region. The communities living in the close to coast region would be the ones to face the brunt of sea level rise and other projected impacts due to the global warming.

The Policy Brief is premised on the experience and observations of one community living close to the Bay of Bengal coast; how they have lived through the typical dynamics of the close-to-coast regions and how they are poised to deal with the projected impacts. It is like 'crystal-gazing' into their reality to gain insight regarding the possible ways out to build resilience, grow and have sustainable livelihood in the midst of the global warming induced climate change.

3. The coastal region of India and vulnerability

3.1. Coastal region and diversity

'Coast', 'coastal', 'coastal zone', coastal tract', 'costal States', 'coastal districts', 'coastal blocks' and other similar expressions have few things in common; their boundaries touch the coast and they are influenced, though differentially, by the dynamics of events that happen along the coast. The Policy Brief primarily focuses on the close to coast region, the area behind the shore line, say up to 20 kilometres or more depending on the terrain that directly come under day to day tidal influence.

Overview of the coastal region in general would help to place the community observation, on which the Policy Brief is premised, in perspective.

Estimates show that the 'coast line' of the world is 356,000 km and the 'coastal area' covers more than 10% of the earth's surface. Because of the economic benefits that accrue from 'coastal region' about 40% of the world population live within 100 km of the coast – nearly 10% of them reside in low elevation coastal zone.

India has a coast line of 7516km, including the islands. The Mainland coast line of 5422 km comes under nine states - Gujarat, Maharashtra, Goa, Karnataka, Kerala, Tamil Nadu, Andhra Pradesh, Odisha, West Bengal and two Union Territories (UT) Daman & Diu and Puducherry, and the rest are under two Island UTs- Andaman & Nicobar Islands and Lakshadweep Islands. There are 66 coastal districts in mainland India with 14% of the total population. The coastline is punctuated with around 100 rivers, including major and medium ones discharging into sea.

Open coast and eroding sand dunes: coast near to Palasa, Andhra Pradesh

The east and west coast of India have widely varying profile. The Mainland east coast stretching about 3000 km, from Sundarbans in West Bengal to Kanyakumari in Tamil Nadu, is characterised with well-developed river delta systems with vast coastal plains and estuaries. The west coast is relatively straight in comparison to the east coast; characterized by a number of tidal creeks, and most prominently, the Western Ghats that run almost parallel to the west coast; acts as a major water divide between the east flowing Godavari, Krishna and Cauvery river systems and the short stretched west flowing minor rivers.

Both the coasts have monsoon type rainfall pattern, restricted to two seasons in a year. The southwest monsoon, active from June to September, contributes the bulk of the annual rainfall along the east and west coasts, except in the coastal areas of Tamil Nadu and southern coast of Andhra Pradesh, where the bulk of the rainfall is from northeast monsoon. The annual normal rainfall along the west coast ranges from 300 mm (north& northwest), to 2500 mm (south), while in the eastern coastal tract, it is generally in the range of 1000 to 1500 mm except in some areas of Andhra Pradesh and Tamil Nadu.

Major coastal eco systems include coastal wetlands (43230 sq km), major estuaries (97), major lagoons (34), mangroves (6740 sq km, 31 major locations, actual cover 4921 sq), nearly 128 marine Protected Areas (spread over 6271 sq km) - the Marine National Parks, Marine and Wildlife Sanctuaries, Marine Biosphere Reserves, Ramsar Coastal Wetlands, Tiger Reserve (Sundarbans), the Coral Reefs of Lakshadweep, Mangrove Notified Forests and National Parks.

India has an Exclusive Economic Zone (EEZ) of about 2.37 million square km of sea along the coast line (from 12 to 200 nautical mile) having exclusive legal right to utilize all living

and non-living resources. The EEZ goes through fishing ban of 61 days - from15th April in the east coast and from 1st June in the west coast in order to help sustain the fish resources. Over and above, the States decide their own fishing ban period applicable to different fishing vessels within their territorial waters (0 to 12 nautical miles).There are also fishing bans related to nestling period of vulnerable species (Olive Ridley sea turtle, for example)in specific estuarine and offshore regions. There are 3,288 marine fishing villages along the coastline with marine fisher population of about 4 million; 61% of the fisher families belong to Below the Poverty Line (BPL) category.

3.2. Vulnerability of the coastal region

The close to coast region including the coastal ecosystems, which are highly dynamic with erosion and accretion by nature, are at present vulnerable to host of climatic and non-climatic factors. The tropical cyclones and sea surges of varying intensity are common for the coastal States. Especially, four States along the east coast - Odisha, West Bengal, Andhra Pradesh, and Tamil Nadu are among the most affected with severe storms in cycle of 4 to 4.8 years. The east coast, compared to the west coast, is more prone to cyclones. An analysis of the frequencies of cyclones during 1891-2000 shows that nearly 308 cyclones (including 103 severe) affected the east coast and 48 crossed the west coast (including 24 severe).

The tsunami of December 2004 was the new addition to the list of vulnerability (caused destruction in coastal areas of 15 countries) that surprised and shook up the coastal tract of India and created havoc especially in Andaman and Nicobar Islands, Tamil Nadu and Andhra Pradesh with more than18,000 deaths.

Assessments reveal that near to one third of the population are vulnerable to cyclone related hazards. The coastal region up to about 20 km inland (depending on the terrain) with low-lying areas and gentle gradients, are highly vulnerable to storm surges, tsunamis and inland flooding. Studies show that between1950-2015, tropical storms (92) caused 50,505 human deaths, affected 2027,158,946 people with a damage estimated at INR 1,16,585 crore. As per the National Disaster Management Authority (NDMA) 5,700 km, out of the 7,516 km long coastline is prone to cyclones and tsunamis.

Coastal ecosystems are adversely affected by climatic as well as non-climatic factors. For instance, the mangroves forests are under threat due to number of factors: reduction of fresh water flow downstream of rivers due to construction activities including dams at up streams (that result in reduction of flow to mangroves swamps), obstruction of tidal water flow and loss of habitat due to industrial activities, urbanization, encroachment for fish farming, and so on.

Increase in temperature, rising sea level, spike in the frequency of tropical storms attributed to climate change, pose serious threat to the mangroves as well as other fragile coastal ecosystems. Observations reveal that as a consequence of sea level rise two islands in Indian Sundarbans - Suparibhanga and Lohacharra, have submerged and a dozen of other islands are also threatened of submergence. It is observed that hyper salinity and other associated factors such as increasing temperature, and poor flushing of mangrove soil by tidal waters adversely affect the mangroves at Pichavaram, Tamil Nadu.

Pollution of coastal waters is one of the major threats to the vital coastal ecosystems. One estimate reveals that coastal states of India release 33215MLD (million litre per day) sewage to the sea; of which only about 38% is treated. Increasing levels of organic and inorganic pollution in the coastal water over the years threaten to affect the dissolved oxygen and microbial concentration levels, which are the two important indicators of health of water. Various studies show dissolved oxygen levels are much lower than the recommended level (5 mgl or more for the ecologically sensitive coastal area and beach tourism) at many locations impacting larvae and juveniles of fish and other marine species.

High exposure, poor capacity and other typical geographical limitations further accentuate the vulnerability of inhabitants living in close to coast region, especially influenced by day to day tidal cycle. Greater percentages of families are below the 'poverty line', and live in kutcha houses; considerable percentages of habitations are below sea level. Majority of the families pursue highly climate sensitive livelihood practices; struggle with livelihood resource depletion and host of other problems typical to the close to coast region - soil salinity, absence of irrigation, water logging due to run off congestion, saline intrusion due to absence or inadequate protection system, habitat destruction and so many other existential problems. Recurrent cyclones, flooding, impact of slow onset climate variability in combination with poor socio-economic benchmark, seldom allow close to coast community a few years of breathing space to grow steadily. Going by the range of projections most of the inhabitants of the region are like sitting ducks to the imminent impacts induced by the global warming.

Climate change projections for coastal region of India

The Special Report on Global Warming of 1.5 °C published by the Intergovernmental Panel on Climate Change (IPCC) on 8 October 2018 observes that meeting a 1.5°C target is possible but would require "deep emissions reductions" and "rapid, far-reaching and unprecedented changes in all aspects of society." The report finds that "limiting global warming to 1.5°C compared with 2°C would reduce challenging impacts on ecosystems, human health and well-being" and that a 2°C temperature increase would exacerbate extreme weather, rising sea levels and diminishing Arctic sea ice, coral bleaching, and loss of ecosystems, among other impacts. The report further observes that, for global warming to be limited to 1.5°C, "Global net human-caused emissions of carbon dioxide (CO2) would need to fall by about 45 percent from 2010 levels by 2030, reaching 'net zero' around 2050." The reduction of emissions by 2030 and its associated changes and challenges are enormous.

The global mean sea level, relative to 1986-2005 is projected to rise by 0.26 to 0.77 m by 2100 for 1.5°C global warming. The sea level rise will continue beyond 2100 even if global warming is limited to 1.5 °C. Global warming of 1.5°C is predicted to have humongous impact on coastal ecosystems including decline in catch for marine fisheries of about 1.5 or 3 million tonnes; coral reefs are projected to decline by a further 70–90% at 1.5°C.

Downscaled projections for the coastal region of India are still not available in public domain. However, various projections reveal 'sea level rise' and flooding of low-lying areas along the coast throughout the 21st century and beyond. There are wide range of projections (rise by 10-15 cm by 2050) and imminent scenarios. For example, sea level rises

by 0.59 m would submerge 565 square km along Andhra Pradesh coast, with an additional area of about 1233 square km coming under the new intertidal zone displacing about 1.29 million people mainly hut-dwelling fishing communities who live in 282 villages spread over nine coastal districts of Andhra Pradesh (2001 Census), with possibility of storm surges reaching further inland (Unnikrishnan et al 2006). Projections include flooding of coastal cities like Kolkata, Mumbai by 2070s; massive displacement of people from specific low lying areas, for instance 70,000 people will be displaced from the Sundarbans by 2030.

There are projections about overall 10-12 percent increase of rainfall in the country with increase in intensive rainfall events and increase in annual temperature 3-5degree Celsius by end of the 21st century.

Other projections relevant to India's coastal region include:

- Increased number of hot, humid summer days, warm and short winter;
- More number of very heavy rainy days (>125 mm per day)and prolonged dry spell;
- Increase in number of low intensity low pressures at the Bay of Bengal;
- Increase in number of more intense tropical cyclones with larger peak wind speeds and heavier rainfall.

4. Vulnerability and resilience building: Community experience and observation

The Brief primarily draws upon the insights from close to Bay of Bengal coastal community – cluster of 9 villages with population near to 25000 under two contiguously located Panchayats; Jamboo and Suniti in Mahakalapada block of Kendrapada district, Odisha.

The habitations and the surrounding area, located within few meters to 2 km distance from sea, are below the sea level - 3-4' below the high tide level; during low pressure the area remains 6'-8' below the inflated tidal water bodies. The area, most of the habitations and agricultural land, are encircled saline protection embankments (mostly earthen) with sluice gates at different points to regulate inlet of tidal water and outlet from the protected area. Most villages have mangroves forests at close proximity.

The community has poor benchmark with socio-economic status - 40% families are landless, 60% of land holding families have up to 2 acres of land; their main sources of livelihood – small scale farming and/or fishing in tidal water bodies and daily wage earning;15% families have one or more persons on outmigration; families below poverty line-70%; about 20% families have food security from own production; 60% families have annual income up to Rs.24000; more than 80% families live in kutcha houses.

The volume of rain at the district level over the last 20 years (1998- 2017) varied from 874mm to 2000mm+ (1500 + to 2000+mm in 55% years)

Jamboo and Suniti Panchayat, Mahakalapada, Odisha at the edge of Bay of Bengal

Rapid forming extreme climate events as well as slow onset ones have direct bearing on the livelihood of the community, which to a large extent is dependent on local natural resources and highly climate sensitive. The following is a brief account of community experience and observation:

- 6 major cyclones and sea surges over the last 5 decades (since 1967) involving more than 700 human death and wide spread damage to livestock, houses and properties; including major crop loss in 55% years.

- Phenomenal increase in number of low-pressure events throughout the year, in some years more than 15 times. Frequent low-pressures trigger number of problems:

    - Weakening of earthen 'saline protection embankment' that result in breach;
    - Low pressure, often accompanied with incessant rain, trigger water logging (drainage of rain water from the protected area below the sea level is not possible as tidal water bodies remain in spate under the impact)that affects standing crops; backyard ponds with fish cultivation overflow;
    - Intrusion of saline water in areas not protected by saline protection embankments and because of damaged/malfunctioning sluice gates – these recurrently affect standing crops, and create problem of soil salinity;
    - Reduction in fishing days- traditional fishing families are unable to fish at least 3 days per depression (tidal water bodies remain in spate making it impossible to operate the traditional fishing gears).

- Local climate variability such as increase in average temperature throughout the year; change in wind pattern at coast; highly uncertain rainfall pattern – late monsoon, early exit, extreme deficit and excess rainfall; long dry spells, etc., cause a variety of existential problems; few examples:

    - The region is rainfed; additionally, farmers depend on rain to get rid of saline effect; late rain delays farming operation;
    - Rainfall variability trigger number of practical problems for fishing related activities: late rainfall means late flow of fresh water to tidal water bodies that

affects catch of certain preferred varieties; local fishers believe that increase in surface water temperature cause frequent change in wind direction that in turn induce increased inflow of saline water from sea to tidal water bodies, which affect movement of economically significant fish variety; combination of increase in surface water temperature and change in wind direction trigger 'swing wave', which create problems for casting traditional fishing gears, also weaken the earthen embankments;

- Increase in intense and continuous days of rainfall create problem for fisher families making dry fish;
- Problem for emergency irrigation in rainfall deficit years (harvesting rainfall in surface water bodies is the major source of irrigation as ground water below few feet is saline in most of the area); untimely rain in December, January has become frequent, it adversely affects the standing crop.

- High exposure and poor capacity are major limiting factors in resilience building process.

  - Most of the habitations within the protected saline embankments are 3-4' below the normal high tide level and 6-8' during the time of low pressure; hence everything inside get easily affected in the event of storm, cyclone, sea surge and breach in saline embankment; water logging due to intense rain during low-pressure;

  - Most families (80 %+) continue to live in kutcha houses –wattle and mud daub wall with paddy straw thatched roof, in low lying areas, despite multiple cyclones in past; easily affected with water logging, storms and cyclones of different intensity;

Saline water intrusion to habitation, agricultural land during springtides in May –June due to absence of protection embankments, poor design/malfunction of sluice gates (Jambu-Suniti, Mahakalapada, Kendrapada district, Odisha)

- Going by community observation, the cluster of villages have saline protection embankment of about 30 km length; except about 4 km, the rest is earthen(clay and sandy soil, mostly without stone packing) embankment. The saline embankments are vulnerable due to number of factors – embankments made of soil with varying height, width; susceptible to tidal overlapping and breach at number of points. Considerable portion of agricultural land and some habitations regularly face inundation due to absence of protection embankments.

- Malfunctioning of sluice gates adds to their plight – there are about 30 sluice gates placed in different points of the saline embankments to regulate tidal water. Saline water intrusion has become a regular feature even in the protected area due to number of factors: malfunction of sluice gates due to poor design and construction, improper site selection and not matching to the emergent situation – 'swing wave', phenomenal increase in low pressure, storms and cyclones;

- Poor socio- economic benchmark, partly due to recurrent loss of livelihood due to rapid and slow onset climate events: 70% 'below poverty line' families; 80% families have kutcha houses; only about 20 % families have food security from their own source production and more than 60% families have annual income up to Rs. 24,000;

- Host of other limiting factors behind the poor capacity of the community include: inherent issue of soil and ground water salinity at shallow depth, absence of irrigation facility, hence farming is largely limited to one crop- kharif paddy and very little marketable produce from land-based farming. The traditional fisher families of the area have a very small window period of fishing due to fishing ban - eight months at a stretch, beginning of November to end June, including nestling period of Olive Ridley sea turtles and the fish breeding season in estuarine as well as offshore region. No concerted initiatives to support alternative livelihood other than consolidated compensation of Rs.7, 500 to registered fishers against the ban period.

Community observation on initiatives for risk reduction and capacity building

The cluster of villages experienced high intensity cyclones in the years 1967, 1971, 1982, 1999, 2013 and 2014 (till the appraisal was made during 2017-18); there was intense flood in 2000 , and there was impact of tsunami of 2004 (tidal water bodies remained inflated as during low pressure). Community traced the improvements relating to risk reduction and capacity building over the years; their observations in brief:

- 1967 cyclone- (sea surge, human deaths, few habitations got washed away) almost all houses had low level plinth; there was no saline protection embankment - only clay ridges by farmers to protect agriculture land from routine tidal inundation; not a single pucca house; there were couple of open and active creeks inside the habitation area; people were drinking from water holes, open wells, back yard ponds;

- 1971 cyclone- (sea surge, human deaths – near to 700 including 1967, few habitations got washed away) almost all houses had same low level plinths; few years after the cyclone government started making earthen saline protection embankments close to mangroves forest fringe aligning to the ridges earlier made by the farmers; sluice gates

were constructed at few places. There was significant depletion of mangroves due to erosion of mudflats and felling for household requirement including reconstruction of houses; none of the families had pucca a house; open and active creeks inside the habitation area were still there; people continued drinking from water holes, open wells, back yard ponds.

- 1982 cyclone- (sea surge, 50 deaths, none of the habitations got washed away) in the meantime families had remodelled their houses with raised plinth, about 4'from ground level of the habitation and planted trees in the homestead for protection; more areas covered with saline protection embankments; none of the families still do not have pucca house but few schools had pucca buildings; most active creeks either got closed or regulated with sluice gates; most habitations had few deep tube wells fitted with hand pumps for drinking water; mangroves forest further depleted due to felling for household use including house construction.

- 1999 Super cyclone - (back water, 2 deaths, none of the habitations got washed away) in the meantime families had further reinforced their houses with raised plinth, soil filling of surrounding homesteads – by default the outcome of that process was small backyard ponds in most families;1%families had pucca houses through own initiative; 3 schools had pucca buildings and one cyclone shelter had come up in 1996; saline embankments had been further strengthened – more area covered, height raised, stone packing at sensitive places; all active creeks either got closed or regulated with sluice gates; almost all habitations had deep tube wells fitted with hand pumps for drinking water.

  There was an attempt for creek irrigation around 2006, but the masonry structure got washed away in the water current of the creek before it was commissioned.

State of saline protection embankment in some pockets in normal times: Batighar area, Mahakalapada, Kendrapada district

- 2013& 2014 - Cyclone Phailin & Hudhud- (no sea surge, no deaths, none of the habitations got washed away) most families took shelter in the cyclone centres (increased to 5), school buildings (increased to 5) and private pucca buildings – in the meantime about 10% families had pucca buildings, mostly through government support.

Other significant improvements relating to disaster risk reduction and resilience building through government and non-government initiative by 2018 include: demolition of about 700 acres of encroached prawn fishing ponds inside most sensitive sea side mangroves area by the Forest Department, already mangroves have reclaimed the area with luxuriant growth; some portion of the saline embankment further strengthened with stone packing and made into all-weather road; Disaster Mitigation Task forces with a team of 30 members each (attached to cyclone shelters) trained in different skills of disaster management; completed and ongoing State and Central government sponsored pucca housing scheme for BPL families, construction of toilets, construction of all-weather internal connecting roads linking the cyclone shelters.

How safe do they feel against the emergent scenario linked to climate change?

The community had little idea regarding the imminent impact induced by climate change or the projections concerning the coast. So they were requested to respond with their assessment of their vulnerability against the experienced and known worst disasters of recent past, say the super cyclone of 1999 with wind speed up to 300 kph, sea surge of 5meters and intense rainfall for more than 30 hours. Response of the community was quite interesting:

- There would be no or very low human casualty, as there has been significant improvement in response to disaster warning (thanks to community level Disaster Task Force); people would take shelter in multiple cyclone shelters and number of private and school buildings (which was not the case 20 years back);
- They were doubtful regarding the resilience of the earthen saline protection embankment in preventing sea surge - they said that there would be breach and failure of sluice gates, hence habitation area and agricultural land will be inundated;
- Almost 80% houses are still kutcha and good number of them are located in relatively more low-lying area, a good percentage of them will be badly damaged;
- People are now better prepared at the family level thanks to the awareness and community preparedness created through the cyclone shelter related activities- there would be comparatively less damage to food grains for instance – a good percentage of families have developed separate storage bin on raised platform with waterproofing facilities; they do a variety of reinforcing and safe keeping of valuables post cyclone warning;
- There would be huge damage to electric transmission system, sluice system, culverts and embankments as there has not been any change in their design to face disasters of this scale.

Apart from the problems shared earlier, the perceived contributing factors to their vulnerability in future include: sand spit forming at the river mouth that has considerably reduced the depth; rise in the level of sea water (they compared with the situation around 1971, when they managed to protect their agricultural land from tidal water just with clay ridge); fast depletion of mangroves from the mudflats of creeks along the villages.

The community also shared their observations from the neighbouring area that they perceive as contributing to vulnerability of those areas: massive river bank erosion in villages near to coast region of Baitarini river in neighbouring Bhadrakh district; massive sea shore erosion threatening number of villages just few kilometres away in neighbouring Rajanagar block (where government and expert institutes have been trying different methods over the last decade to address the problem, the last being 'geo tube sea wall'); erosion of sand dunes in neighbouring Ramanagar panchayat (after the villagers cleared the screw-pine plants) exposing the villages along Mahanadi river mouth to cyclone and sea surge).

The community was briefed about the projections relating to global warming and climate change induced impacts concerning the coastal region (sea level rise, increase in incidence of cyclones, local climate variability, etc.) and requested to respond to what they think would make them feel safe in general, what would make the families to live with resilient livelihood in the midst of all the projected impacts, and what roles they see for themselves. The community's response was quite insightful:

- What topped their list of priority was mitigation of physical vulnerability - resilient saline protection embankments and the sluices that provide protection against the impact of increased incidence of low pressure, swing waves as well as impact of high intensity cyclones and surges; rise of water level in tidal water bodies;
- Other aspects that were given importance included: resilient houses (pucca, plinth above the level of water logging, safe grain storage) and other public infrastructure (buildings, connecting road, drinking water, electric transmission, etc.) in the area to withstand at least the known intensity of cyclones, seas surges, water logging; more number of cyclone shelters to reduce crowding; facilities for rain water harvesting, creek based irrigation facility (to deal with groundwater salinity, potable drinking water); new technology to improve production; alternative livelihood as the fish resources in local tidal water bodies are not adequate to support the increasing population; adequate compensation and support for alternative livelihood activity to deal with the recurrent loss due to recurrent disaster and climate variability, multiple ban on fishing in estuarine and offshore region;
- They cited issues that limitation in vulnerable families accessing the resilience building opportunities: the 'queue' system is cited as a major problem, for instance the pucca housing-allocation for limited families comes to the Block, and the Block distributes among the Panchayats, this is a slow process and no one knows when all the families would be covered, there is no priority for vulnerable areas. Same process for all the routine programmes, for instance the fisher families that lose livelihood during long ban period do not get priority in accessing livelihood enhancement schemes.

It is important to note that the community, though in general discussed during course of the interaction, some aspects did not appear in their list of priority; for instance, protection of mangroves, insurance cover, community role or participation in resilience building process.

5. Near to coast community, climate change and sustainable development

Going by the projections regarding the future scenario, it is loud and clear that the impact of global warming would be more pronounced through 2030s and beyond 2100, and the coastal ecosystem would be the ground zero of devastating impact owing to sea level rise; rise in intensity of cyclones, temperature, rainfall and the associated problems.

Though the projections down to the 'local-region' are not very clear so far, recent spike in frequency and intensity of oceanic disasters; specific cases and observation of sea level rise and submergence; impact of slow onset climate events and host of other experiential insight are clear signs of the shape of things imminent in near future.

Broad observation on close to coast region

The observation of the case of the community in point, finds resonance with experience, issues, findings, insights from other close to coast region of the country; the salient points include the following:

- In comparison to other ecosystems of the country, the disasters that strike the coastal region have been comparatively greater, frequent, humongous and challenging to the capacity of the community, government and the expert institutions as well. Especially, the physical vulnerabilities are beyond capacity of the community of the near to coast region to address;
- Global warming induced impacts have been comparatively more pronounced in the coastal region and there is high confidence about the sea level rise and spike in other high intensity disasters with associated complications
- Because of inherent features of the coastal region– estuaries, areas with gentle gradient, low lying areas, areas below sea level, etc., vast coastal areas are at risk;
- Extensive coastal tracts are also at riskdue to high exposure (close proximity of habitations, installations, industries, etc.), sensitivity of major assets and livelihood practices to rapid forming and slow onset climate events; poor capacity (socio economic benchmark, housing, typical close to coast limitations in livelihood resources, etc.)of community living close to coast;

..

Instance of vulnerability of houses in low lying areas even to normal water logging...

- Number of problems and issues – recent spike in cases of coast erosions; massive riverbank erosion in tidal region; vast open coast bereft of trees and vegetations and so on - without convincing solutions further the risk and complexities;
- Coastal ecosystems with livelihood supportive and protective abilities are getting depleted and degraded (in a time when their services are most needed) - mangroves, mudflats, sand dunes, estuarine and marine fish resources and other such coastal ecosystems;
- Repeat of similar pattern of damage to assets and infrastructure due to inadequate transformative change in design and construction standards at least against the known benchmark of worst disasters (embankment, bridges, culverts, roads, houses, drainage, electric transmission, and other such infrastructure);
- Lack of concerted initiative to address pollution of estuarine and offshore region, and absence of focus to sustain inter-ecosystem services, have resulted in adverse impact of estuarine and marine eco system – discharge of untreated effluents to sea, siltation of river mouths, formation of sandbars and spits; inadequate water flow to downstream river systems and so on;
- Inadequate scope and system for participation of close to coast community in resilience building process - protection and management of mangroves, embankments, plantations, sand dunes, fish resources, and other resources and systems of importance to resilience building;
- Lack of urgency, focus, time and target bound programme, matching to the spike in disaster events and the enormity of projected impact induced by global warming, to reach out to the most vulnerable communities, to mitigate risk, build resilience and pursue sustainable livelihood in the midst of climate change.

Opportunity

The following are few potential opportunities, picked up at random from various studies, articles and observations, to help enhance community capabilities towards resilient and sustainable living:

- Relatively effective models of coast specific disaster response, management and risk minimization, for example, Odisha;
- Presence of mangrove forests and swamps at strategic locations in varying extent, density and species diversity in the coastal states and the UTs with potential for regeneration. Mangrove forests and wetlands have on many an occasion proved their potential act as barrier reducing the impact of cyclones, sea surges, salt water intrusion (from Bhitarkanika region in Odisha –multiple cyclone events- to Pichavaram in Tamilnadu -Tsunami 2004). Mangroves play important role in nurturing the estuarine and offshore fish population (working as huge organic hatchery and highly productive marine food chains).Mangrove forests (15 times more capacity in carbon sequestration than tropical terrestrial forests) have potential to play a major role in carbon cycle in removing CO_2 from the atmosphere and storing it as carbon in plant materials and sequester large amounts of carbon below ground;
- Continuous mass of potential common resources for providing protection as well as supporting livelihood (estuaries, mangroves, sand dunes, swamps, lagoons, wetlands beaches, rocky formations, etc.);
- A variety of species including plants those survive and grow well in hostile conditions (saline, brackish and water logged condition, sand dunes) with capacity to fight back, regenerate and support livelihood.

Coast, Community, Climate Change, Resilience building and sustainable development

There has been significant development in disaster management architecture in the country over the recent past, especially following the enactment of Disaster Management Act 2005. A number of institutional mechanisms are in place across the country from National, State, District, Block, and in some cases up to the community levels (in form of Disaster Management Task Force or similar). The conceptual policy and programme directions also come from a number of processes such as National Action Plan for Climate Change (NAPCC, June 2008) and State Action for Climate Change (SAPCC), and other such processes.

The Government of India is strongly committed to the Sustainable Development Goals (SDG). A number of SDG goals are relevant to the wellbeing and sustainable development of the near to coast communities, including the overarching goal - 'put people first' and to ensuring that 'no one is left behind'. SDG 14 says ' Conserve and sustainably use the oceans, seas and marine resources for sustainable development'. Sustainable living and development of the close to coast communities are possible only when the ecosystems they depend upon are free from risk and resilient systems all around.

Although coast specific disaster response and management have become more organised in comparison to what it used to be about two decades back, there has not been a significant change towards resilience building to coast specific hazards in a long-term basis focusing on

the capacity building of the community, livelihood, infrastructure, resources, and ecosystems. Slow onset impact induced by the climate changes that act as continuous limiting factor to poor capacity of close to coast community has not been focussed so far.

The projections indicate that coastal ecosystems including the near to coast regions are going to face a long-term change, shift towards a 'new normal'. The emergent situation entails number of shifts in approach and focus; beyond minimizing effect of disaster to risk reduction and resilience building of the coastal ecosystems; a shift towards transformative actions. Simply put, reducing vulnerability and exposure to present climate variability-how individuals, groups and natural systems can prepare for and respond to changes in climate; and adapt and build resilience.

Going by the insight of the case of the community in point, risk reduction and capacity building in a number of aspects, in reference to known disaster scenario, can only converge to resilience. An approach that has scope for integration of inter-related aspects can only prepare the close to coast community for resilient sustainable livelihood in face of recurrent disasters -mitigation of risk (Disaster Risk Reduction), making best out of the circumstances by adapting to the situation (Climate Change Adaptation), the need for continuing with development despite the impact of climate change (Sustainable Development), out of box transformative actions (not to repeat the pattern of adverse impacts) and resilient pathway (not adding new stress, short and long-term co benefits of mitigating the root cause of the climate change in routine risk reduction, resilience building activities to the extent possible).Post-2015 Sendai Framework highlights the key role of ecosystems for DRR; healthy ecosystems can play a key role in hazard mitigation and can even prevent hazards from occurring.

Village at lower elevation with riverbank erosion, close to mouth region of Baitarini river (Bhadrakh district, Odisha)

6. Way forward

The realities at close to coast region and the imminent scenario in near and distant future entails that the policy and action focused on community resilience building and sustainable livelihood give attention to the following.

i) Special focus on the close to coast ecosystems including the communities in National Action Plan on Climate Change (NAPCC) and the SAPCCs considering the spike in frequency, intensity of coast specific hazards, enormity of impact and the projections with high confidence;

ii) Capacity building and community level micro planning as the basis for resilient and sustainable livelihood in face of recurrent disasters with consideration to the following aspects:

- Identification of vulnerability, barriers in pursuing livelihood, opportunities in reference to the impact of local rapid forming and slow onset climate events; good practices, opportunities to help live and grow sustainably with the 'new normal' induced by climate change;
- Identification of scope to integrate DRR and CCA at community level interventions;
- Exploring scope of participation of community in resilience building including management of infrastructures (for example protection embankments, sluices) and micro ecosystems (for example, mangroves, shelterbelt, sand dune; estuarine and marine fish diversity);
- Accessing and maximising the use of entitlements and convergence potential for resilience building at family and community level - housing, compensation, insurance, expanding means of livelihood, etc;
- Education and awareness at schools regarding climate change, induced impact, scope for resilience building and sustainable development; inculcating life skills (relevant to the micro eco systems);
- Family level resilience building integrated to ICDS, ASHA (disaster smart living environment, mother and child care, hygiene, sanitation, drudgery reduction)
- Integration of DRR-CCA aspects in PRI system (Gramsabha- Pallisabha)

iii) Inclusion of DRR, CCA and sustainable development approach in micro region context in all sector development activities, State and Central, being implemented in the areas of improved housing, irrigation, employment generation through MGNREGA; livelihood missions to minimise economic vulnerability as well as post disaster rehabilitation; rural road connectivity programmes; health, mother and child care programmes; animal health care programmes; education programmes; women empowerment; programmes for risk transfer; afforestation; strengthening of embankments, etc. Precaution for not creating new risks to sensitive, fragile ecosystem (ground water depletion in areas prone to salinity, exposure, habitat destruction of mangroves, and over exploitation of estuarine and marine for example);

iv) Developing risk reduction (and transformative) parameters in designs and execution of structural activities- construction of cyclone shelters, construction of cyclone resistant buildings, road links, culverts, bridges, canals, drains, saline embankments, school buildings, surface water harvesting, communication and power transmission networks etc., with due consideration to analysis of disaster history and projections as well as the worst case scenario.

v) Realistic assessment of shelter need– community and private with (to reduce over crowing) facilities for women and children. Resilient house design with shelter for livestock, safe keeping of grains (in case of private housing state supported or self-initiative); safe keeping of boats and other important assets, in reference to the known vulnerability benchmark should be part of the overall shelter strategy.

vi).Transformative model / action to address the longstanding issues that influence the impact of climate change induced disasters:

- To maintain flow of water in the rivers downstream up to the estuarine region to ensure growth of mangroves, seasonal migration and breeding of important fish species; help address the problem of sedimentation, formation of sandbars, spits;
- Reinforcement and rejuvenation of protective and live supportive ecosystems along the coast: effective shelter belt plantation; protection of beach and sand dune ecosystem with appropriate plant diversity; regeneration of mangroves at the estuarine regions as well as inland creeks having mudflats and influenced by tidal action (recognising multifaceted ecosystem role - risk reduction, livelihood support, carbon sequestration);
- Focused action to stop release of untreated effluents to sea and estuarine region;
- Piloting and popularising gainful alternative use of brackish water and soil;
- Introduction of innovative technology mix, livelihood options to help make best in environment of typical coast specific limitation (sandy, brackish soil, scarcity of fresh surface and ground water; salinity; limitation of surface irrigation, wind and stormy environment, water logging, etc.); alternative energy to reduce stress on fragile ecosystem, take care of frequent down period owing to storms;
- Effective and eco-friendly means and ways to address shore erosion and riverbank erosion at estuarine region;
- Coast specific insurance package.

vii) Special coast specific attention

- Downscaling of climate change related projections and micro-level vulnerability assessment;
- Sense of urgency aligned to the increasing frequency, intensity of disaster and high confidence projections;
- Time and target bound action to mitigate physical vulnerability; reach out to most vulnerable families with resilient housing and living environment;
- Policies and programmes aligned as per assessment of local impacts, trends, scenario building to risks associated with the sea level rise, frequency and intensity of rapid forming and slow onset climate events; existing good coping and adaptation practices;
- Assessment of impact on fishers where they face multiple bans stretching to long period (breeding of endangered species and fish breeding) and provide alternative livelihood..

State of tidal water bodies at a ferry ghat prior to Cyclone Phailin, 2013 (Jamboo, Mahakalapada, Kendrapda, Odisha). Huge challenge to rise to the adage 'Not all storms come to disrupt life, some come to clear our path'.

References:

- Resilience and Vulnerability Working Group II: Impacts, Adaptation and Vulnerability/ Chapter 6. Coastal zones and Marine Eco systems-http://www.ipcc.ch/ipccreports/tar/wg2/index.php?idp=301
- Climate resilient pathway Climate-Resilient Pathways: Adaptation, Mitigation, and Sustainable Development Chapter 20/https://www.ipcc.ch/pdf/assessment-report/ar5/wg2/WGIIAR5-Chap20_FINAL.pdf
- Facts and arguments derived from the Vulnerability Profile of India by National Disaster Management Authority available at http://ndma.gov.in/en/vulnerability-profile.html
- State Profile of Odisha by National Institute of Disaster Management, National Disaster Risk Reduction Portal (pp- 10-14) available at http://nidm.gov.in/pdf/dp/Odisha.pdf
- Ravindranth D, Chaturvedi R.K and Dr.Kattumuri R- Mainstreaming Adaptation to Climate Change in Indian, Policy Planning available at http://www.lse.ac.uk/asiaResearchCentre/_files/ChaturvediKattumuriRavindranath.pdf
- Odisha State Action Plan on Climate Change http://odisha.gov.in/forest_environment/ActionPlan/CCAP%20ORISSA%20FINAL-1.pdf/pn-41-42
- Mainstreaming Disaster Risk Reduction and Climate Change Adaptation ICAR-CPCRI http://www.icar.org.in/en/node/9326
- Benefits of Shelterbelt Plantation in Saline Coastal Tracts of Gujarat Parul Gupta1, Anupma Sharma2, Namita Joshi1Department of Environmental Sciences, Kanya Gurukul Mahavidyalaya, Gurukula Kangri Vishwavidyalaya, Haridwar, Uttarakhand, 249404, India
- Briefing Note, Climate Change and Disaster Risk Reduction, 200 http :// www.unisdr.org/ files/4146_ClimateChangeDRR.pdf
- Vulnerability Profile of India by National Disaster Management Authority available at http://ndma.gov.in/en/vulnerability-profile.html
- State Profile of Odisha by National Institute of Disaster Management, National Disaster Risk Reduction Portal (pp- 10-14) available at http://nidm.gov.in/pdf/dp/Odisha.pdf
- Source: https://www.wmo.int/pages/themes/climate/climate_projections.php
- Gupta, A.K., Katyal, S., Chopde, S., Wajih, S.A., and Kumar, A. (2016). Climate-Smart District Disaster Management Plan as Effective Tool for Implementing State Action Plan on Climate Change: Lessons from three states in India. Policy Brief. GEAG India and ISET Colorado USA (India Office), published under project supported by CDKN.
- K. Kathiresan Mangrove forests of India K. Kathiresan / https://www.currentscience.ac.in/Volumes/114/05/0976.pdf
- Sahu SC, Suresh H, Murthy IK and Ravindranath NH/Mangrove Area Assessment in India: Implications of Loss of Mangroves
- http://ndmindia.nic.in/NPDM- 101209.pdf
- https://pmayg.nic.in/netiay/English_Book_Final.pdf
- Data base on coastal states of India; Centre for Coastal Zone Management and Coastal Shelter ; Hosted by Institute for Ocean Management, Anna University Chennai, Sponsored by Ministry of Environment, Forests & Climate Change, Govt of India

Research & Input: Sanjay Khatua, Freelancer-Developmental Research & Communication; Director (Hon), DHARA; email:sriskk@gmail.com
Pix: Sanjay Khatua