



Coastal Community Resilience And Its Significance In Disaster Risk Reduction And Mitigation

Exploring Risk Perceptions, Coping Mechanisms and Adaptation Strategies: Insights from Chellanam Panchayat, Kerala, India

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Abstract: Climate change is ubiquitous and it has been incrementally increasing in the past decades. The impact of climate change varies from place to place and over time. It ranges from an increase or decrease in average temperature to significant damage to the built environment or a partial or complete disruption of social, economic, and environmental systems. It is a fact that these cannot be prevented and can only be managed to minimize loss of life, property and other related consequences. Coastal areas are highly susceptible to climate change majorly sea level rise, storm surges, soil erosion, coastal flooding etc. that poses significant threat to physical, social, economic and environmental aspects of coastal communities. Comprehensive and long-term strategies for disaster management and climate risk adaptation are required instantly, wherein community resilience becomes a perfect synthesis of a dual-pronged approach. Current disaster policies are short-term focused and ignore the long-term benefits of building resilient communities. Here the authors have tried to explain the significance of resilient communities in disaster reduction and adaptation by delving into the conjectural knowledge of resilience and allege that resilience has to be an integral part of climate change adaptation and disaster risk reduction. The authors have attempted to analyze the inherent resilience of Chellanam, a coastal panchayat of Ernakulum District in Kerala, South India which is one among the worst-hit soil erosion coast of India, taking into account its disaster profile, risks and subsequent recent initiatives that lets the community evolve and plough on.

Index Terms - Resilience, Disaster resilience, Coastal community resilience, Disaster risk reduction, Adaptation and mitigation.

I. INTRODUCTION

Risk is the likeliness of a hazard becoming a disaster. Analyzing the well-established equation of disaster risk, $R = H \times V - C$, (where R is the risk, H is the hazard, V is vulnerability and C is the capacity), it is clear that vulnerability is the major component that decides the impact of disaster risk. Resilience emanates from vulnerability. In the wake of natural disasters, resilience is used as a strategy to overcome vulnerabilities (Graveline & Germain, 2022). India shares only 7.4 percentage of geographical area of Asia, yet accounts for 24 percentage of deaths due to disasters owing to the size of its vulnerable population. It is said that more than 85% of the country is under the risk of one or more hazards (Sharma, Nandakumar, & Aswinikumar, 2017). The 7516 km stretch of India's coast hosts the most vulnerable population due to its varied climatic zones, vast geographic diversity, exposure to climate change risks and the rapidly increasing urbanization that intensifies climate change and brings uneven outcomes to disaster impacts. Thus, the proactive and positive

method to address vulnerability is by increasing the resilience and lamentably resilience is acknowledged only after a disaster.

Resilience is existent in all communities, particularly which are indigenous or close to nature as apparent in coastal communities, wherein the inherent resilience the community hold determines their strength. But this resilience can no longer be taken for granted and is now in a situation where it has to be actively managed and governed as the vulnerability of the population has become multifold and climate change has become the greatest threat as it increases the hazards in both frequency and intensity. Therefore, investing in resilience is a challenge entailing different management regimes ranging from local community to global (Cutter, 2013).

II. DEFINING RESILIENCE, DISASTER RESILIENCE, URBAN RESILIENCE, COMMUNITY RESILIENCE AND COASTAL COMMUNITY RESILIENCE

2.1 Resilience

Resilience is an overarching, relatively complex concept that has been unfolded to a great extent and has been extensively discussed in the academia (Graveline & Germain, 2022). It is difficult to find a common understanding or definition of resilience in literature (Schipper & Langston, 2015), (Cheek & Chumtina, 2022) as it is getting constantly redefined hence becoming difficult to operationalize (Bene, Newsham, Davies, Ulrichs, & Godfrey, 2014).

Tracing the history of the term 'Resilience', it was first used scientifically by Francis Bacon, in the year 1625 in a compendium of Natural History. The term referred to the strength to recover from adversity since 1839 (Graveline & Germain, 2022). Though the concept was used in Ecology & Psychology from 1950s, it became popular after it was put forward by ecologist Holling in a seminal paper in 1973. There were three apparent schools of thought in resilience. First is the Socio ecological resilience rooted in ecology. Second is the sustainable livelihood approach in 1990's and the third being disaster focused approach since the year 2000 (Schipper & Langston, 2015). The line dividing resilience as an application, measurement or state of being is very fuzzy.

Resilience is the ability to recover by means of its own resources. It is ensuring continued well-being. According to UNDP report Resilience is "a transformative process of strengthening the capacity of individuals, communities, institutions and countries to anticipate, prevent, recover from and transform in the aftermath of shocks, stresses and change".

2.2 Disaster Resilience

It was after three decades of its inception, the concept of 'Disaster resilience' became popular emerging globally as a disaster risk management and mitigation paradigm, especially after hurricane Katrina in 2005 (Cariolet, Vuillet, & Diab, 2019). Disaster resilience is the capacity of a structure, organization or community to self-organize, learn, avert, change, adapt or transform from the disaster impacts, remaining malleable and assuring to reinstate or refine its identity, structure and functions (Adikutlu, 2019) & (Cheek & Chumtina, 2022).

2.3 Urban Resilience

The term urban resilience was originally defined by 'Resilience alliance' in 2007 which binds four specific genres of resilience, namely metabolic flows (ability to sustain well-being of the society), governance network (learning capability and adapting urban challenges), social dynamics (ability to be inclusive and equitable) and built environment (maintaining spatial relations and connections in urban landscape) (Adikutlu, 2019).

2.4 Community Resilience

Urban resilience when referred at community level is called community resilience and resilience by itself is often community oriented attributable to its local scale. Quite a few powerful tools for reducing impacts of uncertainties are found at this scale. Consequences are perceived instantly and intensely at local level and the first responders are the local actors. Moreover, it is at local level the community works best towards the complex zestful congregation of social, economic and natural environment, that is distinct to that community and deals effectively in managing risks and vulnerabilities (Graveline & Germain, 2022). In community resilience, social component becomes an important priority (Cariolet, Vuillet, & Diab, 2019). Social learning and Social Capital become the two fundamental notions of community resilience.

2.5 Coastal Community Resilience

The capability of the coastal ecosystem to resuscitate after disasters and perpetuate services for human livelihood refers to coastal community resilience. More adaptive reciprocations will be required in coastal zones to deal with a surfeit of hazards related to global environmental changes and coastal zones have to be transformed to become more resilient. Social memory (the reservoir of practices, knowledge and values), social learning (diversity of adaptations), strong social cohesion, staunch local leadership, mechanism for collective action are major factors that enhance coastal community resilience (Adger, Hughes, Folke, Carpenter, & Rockstorm, 2005).

III. CHARACTERISTICS AND DIMENSIONS OF RESILIENCE

The major characteristic of resilience is its multi scalar or cross scalar nature which rests on a range of existing capacity levels of social, economic, environmental, infrastructure and institutional dimensions ranging from individual to macro system (Bene, Newsham, Davies, Ulrichs, & Godfrey, 2014). According to IRGC (International Risk Governance Council) resource guide on resilience, focus has to be given on 'stresses' within a community as these accumulated can create multiple impacts even before the catastrophe (Flax, Armstrong, & Yee, 2016). Hence resilience efforts help any community/ City to perform better in spite of their diverse geography, culture and risks they are exposed to. Susan L Cutter has re-conceptualized resilience as bouncing forward than bouncing back (Cutter, 2013).

Time scale is an important characteristic of resilience. The efficiency of resilience is weighed by the speed with which the resistance to disturbance, short term coping ability or long-term adaptation ability helps the system to return back to equilibrium (Davoudi, 2012). A resilient community absorbs impacts in short term and in long term it increases its capacity for learning by self-organizing (Sharifi & Yamagata, 2014). It has become a measurable indicator of progress (Bene, Newsham, Davies, Ulrichs, & Godfrey, 2014).

The general attributes that a resilience system should possess have been broadly classified to three groups- State, Response & Dynamism (Gelantini & Tezer, 2018). i) State includes those attributes that makes a system resilient which includes- Robustness (Rb), Redundancy (Rd), Reflectivity (Rf), Flexibility (Fx), comprehensiveness, self-reliance. I) Response group refers to actions oriented to attain resilience state namely Rapidity (Rp), Cope/Resist, Recover, Adapt, transform etc. iii) the third group includes attributes that are generated against unexpected changes. Those are Resourcefulness (Rs), Inclusivity (Ic), & Integration (It), Networks, Self-learning, Memory etc. These attributes needs to be quantified around different dimensions namely social, economic, technical, organizational (Cariolet, Vuillet, & Diab, 2019) and environmental and have to be applied either in pre-disaster phase, during the disaster phase or in the post-disaster phase, to be able to build up a resilient system based on sustainable strategies (Al-Humaiqani & Al-Ghamdi, 2022)

IV. PROCESS OF RESILIENCE

Since 1960, there had been a proliferation of initiatives focused on the concept of resilience happening at global, regional and national level. It later became a prominent concept on the development agenda which is evident from the growing number of organizations. E.g. 'Making cities resilient campaign' of UNISDR 2010, UN Habitat's City Resilience Profiling Program 2018, The World Bank GFDRR's Resilient City Program 2006, Arup & Rockefeller Foundation's City Resilience Index 2013, Rockefeller Foundation's 100 Resilient Cities 2013 etc. are some of them (Cheek & Chumtina, 2022). World Bank places resilience as par with equity and economic opportunity (Bene, Newsham, Davies, Ulrichs, & Godfrey, 2014). The Sendai Framework for Disaster risk reduction (SFDRR) 2015-2020, was formulated intending to make communities disaster resilient by reflecting on past disasters. It seeks development to be risk sensitive, emphasizing the significance of associating disaster preparedness to Sustainable development goals.

Resilience results from the absorptive, adaptive and transformative capacities of the system and interventions are required to strengthen these capacities that can either be short term or long term. Short term interventions are for reducing the impact of vulnerability whereas long term interventions address the structural causes of vulnerability (Adikutlu, 2019) that generates varied results-persistence, incremental adjustment and transformational responses depending on the intensities of change or shock. (Bene, Newsham, Davies, Ulrichs, & Godfrey, 2014). When the protective or absorptive capacity is transcended, the community will practice promotive or adaptive capacity wherein people make adjustments to continue functioning. These may be adopting new techniques, diversifying livelihoods, accomplishing new social network etc., involving multiple groups at multiple levels on a continuous basis knowingly or unknowingly. Adaptation is a continuous incremental process, though adaptation at one level mostly reduces the adaptation at another. Societies may

not be even aware of how they adapt to changes as people generally do not adapt to one particular stressor, but to a general mix of changes. When enormous changes occur instantaneously or in due course of time, the capability of the system to adapt gets exceeded and transformation of community's basic structure and functions takes place. The ability to create a new system is referred to as transformability which involves a new way of living and doing things (Ijiomah, 2018). The implications associated with these are more challenging. According to Bene (2014), 'It is more costly to transform a system, than to maintain it or to rebuild it as it was' (Bene, Newsham, Davies, Ulrichs, & Godfrey, 2014).

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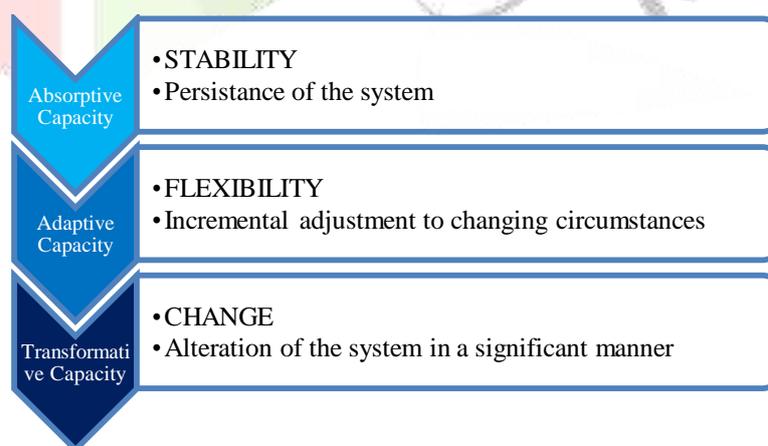


Fig 1 Process of Resilience

V. CONCEPT OF RESILIENCE IN THE CONTEXT OF DISASTER REDUCTION AND MITIGATION

After a disaster or shock, the socio cultural norms and traditions that hold the communities together gets partially or fully damaged apart from the economic decline and environmental decay. Communities always strive to bring in a sense of regularity or equilibrium back and also attempts to recover better and stronger

(Schreurs, 2021). A resilient community is formed when social, economic, environmental, infrastructure and institutional components are integrated and are mutually supportive (Cutter, 2013).

Resilience in the context of disasters is not only the preferred end result, but also the process leading to the preferred end result (Cheek & Chumtina, 2022). This requires an integrated and holistic management program that comprises of two sets of knowledge that plays a major role in the context of disaster. Firstly, any activity to lessen disaster risk and expand resilience is based on the knowledge of hazards and vulnerability of that area like assessment of risks, mapping of hazards, risk awareness and educational activities, urban planning, contingency planning, retrofitting etc. The second set of knowledge ison ‘accumulated resilience’ or ‘inherent resilience’, those which are not directly related to disaster. These include the built environment, social capital, community engagement, the inherent capabilities of preparing, adapting and recovering, good governance, policies, leadership etc (Adikutlu, 2019).

In the context of disasters, the four phases any community goes through over time are Pre disaster, Disaster, Restoration and long term recovery. When a disaster strikes a less resilient community, it takes more time to restore and the status of recovery will also be lesser than a resilient community. When a community develops its own strategies to prevent, mitigate, recover and prepare for disasters, it becomes a disaster resilient community. Such communities are able to tolerate and overcome damages from a disastrous event significantly without external assistance by following certain pathways that institute a culture of resilience knowingly or unknowingly. Hence it is of utmost importance that we build adequate coping and adaptive strategies that largely contributes to the capacity of the system to redeem from disasters (Al-Humaiqani & Al-Ghamdi, 2022).

VI. LINKING COASTAL RESILIENT COMMUNITIES TO DISASTER RISK REDUCTION/MITIGATION

The coastal towns and cities of the world has always been the hub and control centres of trade and commerce since centuries all over the world. More than 40% of world population resides within 100 kms of coastline and 50% are likely to do so in 2030, owing to the diversity of resources and opportunities these offer (Adger, Hughes, Folke, Carpenter, & Rockstorm, 2005), (Almutairi, Mourshed, & Ameen, 2020). Coastal cities and towns, especially in developing countries strives to manage two major kind of issues. One is the untimely or unexpected disasters and the other is the degeneration of coastal ecosystem, both leading to indefensible coastal communities (Oktari, Comfort, Syamsidik, & Dwitama, 2020) creating ripple effects, aggravating all the accumulated stresses existing in the community. The only viable solution is to devise measures to facilitate coastal resilience.

Coastal community resilience is an ever evolving holistic sculpt embedding coastal management, disaster management and community development (Rubinoff & Courtney, 2008). Disaster risk reduction and management is short term compared to strengthening defences against climate change and managing the coast. Building a cohesive and inclusive community is also a long term concern of a coastal resilient community.

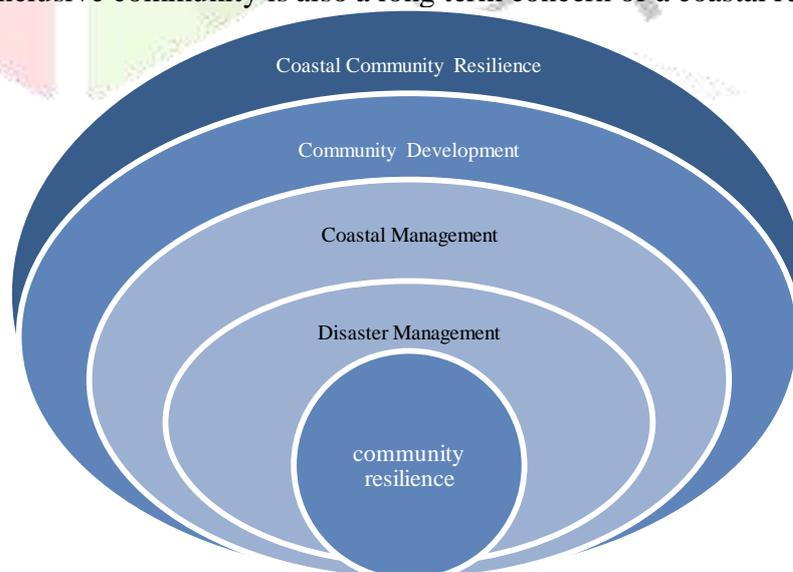


Fig 2 Concept of Coastal Community Resilience

VII STUDY AREA- CHELLANAMPANCHAYATH, KERALA

Chellanam Panchayath of Ernakulam District, Kerala, India, occupies a strategic position as a narrow strip of 19.37sqkm land, that lies 18km south of Cochin port sandwiched between Arabian sea in west and Vembanad Lake in the east. It has a coastal stretch of 16.5 km with population density of 1838person per sqkm which is 2.24 times the density of Kerala and 1.8 times the density of Ernakulum District. The width of the study area varies from 150m to 1800m. As per 2011 census the total population of the panchayat is 14928 with 3436 households spread across 21 wards, fostering close knit neighborhood bonds. Chellanam benefits from close proximity to Kochi by facilitating seamless travel and fostering economic exchanges.

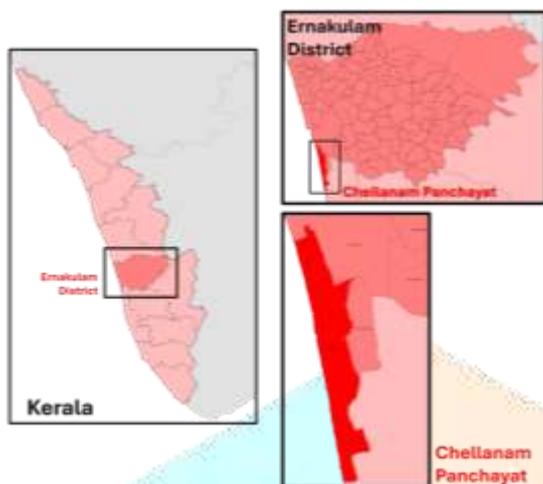


Fig 3: Location map showing Chellanam Panchayat, *Source - Survey of India & Open Street Maps, Generated in GIS*

VIII DISASTER PROFILE AND ISSUES OF CHELLANAM

The region experiences a tropical climate typical of coastal regions of Kerala. Chellanam becomes most vulnerable in the south west monsoon months (June to August) when the waves breach the damaged sea wall and inundate the whole village. It is highly susceptible to tropical cyclones that fetch strong winds, downpours and storm surges posing risk to local people and infrastructure has become a norm. Tracing the time line of disasters are severe sea surge in 1930, major flood in 1966, severe hail storm in 1968. The height of the sea wall was increased using giant boulders in 1978-1983, which crumbled after 20 years. The Tsunami and Tautkae that occurred in 2017 and 2021 respectively was devastating in 6kms, critically affecting the stretches of Companypady, Bazar, Chalakadavu, Kannamaly and Cheriya Kadavu, and displacing the rubbles of sea wall 20-50m. The major floods in Kerala in 2018 and 2019 did not record considerable damage to the community. It is said that the construction of Cochin port in 1928 towards 17 km north of Chellanam, sowed the seeds of erosion. Normally high energy waves moves sand and sediments from North to South in Monsoon and the eroded sediments are brought back by low energy waves vice versa during other seasons. This cyclical process of erosion and accretion is disrupted by more than 16m depth shipping channel maintained by regular dredging. Chellanam local body got its first sea wall in the year 1967-68. Ten years later Kerala Government identified the Chellanam coastal stretch as erosion prone and between 1978 and 1983, the height of the sea wall was increased considerably using large boulders. Over the years due to lack of maintenance the sea wall either crumbled or reduced in size. After 20 years the big boulders reduced to small stones and were washed ashore no longer protecting the coast.

The unscientific construction of harbors and ports are inferred as the reasons for soil erosion. The construction of harbor at Chellanam coast in 2010 has said to aggravate the issue of coastal erosion as it obstructed the natural movement of sand and sediments. The report of National Centre for Coastal Research, which mapped the changes along Indian coast from 1990 to 2016 reveals that Kerala is the third most vulnerable coast to soil erosion after W Bengal and Puducherry.

The 10 km stretch Vijayanthodu canal extending from South Chellanam to Kannamaly-Puthenthodu, the major potential of the place, that was built artificially as an outlet for storm water and transportation facilities no longer serves its purpose as it is now under ecological threat and water quality issues. The salt water intruded water body where in 'ekkal' (silt) and organic matter accumulated at the bottom (once the major transportation channel for vegetables and pokkali rice to the markets in Kochi) has become a threat for inundation during monsoon also bereaving the 7.4 percentage of the inland fishers in the study area.

(Panchayat level statistics, 2011). The reduced depth of lake resulted in increased water temperature leading to changes in aquatic ecosystem impacting the local occupation and economy. An interim report published by Kerala University of Fisheries and Ocean Studies (KUFOS) in the year 2021, where in status of drainage network in Chellanam during 1968 and 2001 was studied, reveals that interconnections of Sea and Vembanad lake (pozhi) has been lost. The entire population of Chellanam are dependent on municipal water supply for household purposes.

IX ABSORPTION, ADAPTATION & TRANSFORMATION CAPACITY; EVIDENCES OF RESILIENCE IN CHELLANAM PANCHAYAT

The functioning of the system in spite of the drastic physical changes and immense environmental damage is the evidence of inherent resilience of the community wherein continuous adjustments were made by the people by adopting new techniques, diversifying livelihoods, accomplishing new social networks etc, on a continuous basis knowingly or unknowingly. This is evident tracing the history of Chellanam though specific historical records are limited.

9.1 Absorption

Chellanam was primarily a fishing village and its economy was dependent on traditional fishing practices, coir manufacturing and farming. Though fishing is still considered as the major occupation, people also earn a living working as masons, carpenters, domestic helpers and construction labourers as fish draught has been a major concern that affected the social and economic capital of fishermen community in the recent years. The people in Chellanam have abandoned farming due to salt water intrusion in the backwaters.

9.2 Adaptation

It is very surprising to know that the large swathes of sandy beach that separated the sea and village was more than 3km. Evidences of this can be traced from the history of 2 well known churches that were fairly documented by the church authorities. 'Our lady of health' church built in 9th C, situated at Saudi and St. Michaels Church at Manassery (both comes under Kochi corporation now) has been rebuilt 3 to 5 times respectively due to coastal erosion and is now lying 3 to 3.5 kms east of its original location. The distance between the high tide line and houses have alarmingly reduced to 50m, which used to be 250 to 300m two decades back. Every monsoon, the fishermen are forced to take refuge in nearby schools and community halls, which lacks proper sanitary facilities, sleeping and cooking areas.

Lack of availability of land area particularly government land, for neither further development nor rehabilitation is a major constraint. The current land use pattern reveals that 41% of the land area constitutes low lying pokkali farms and shrimp farms, 29% of land area constitutes water bodies and as little as 30% of the total land area is only available for development activities. The houses partially or fully damaged along the coast are being reconstructed in the same location with a basement height of 1.5 to 2m height considering the storm surges and sea level rise. There is absolutely no recreational space, theatre, shopping malls etc. in the local body, except for a floating turf in northern part of Chellanam.



Fig 4: Floating turf at Chellanam Panchayat

9.3 Transformation

The first road was commissioned in Chellanam in the year 1968 making it a part of Kochi region. This brought about dramatic changes- diversifying livelihood, accomplishing and expanding their social networks. The 20.23 acre Chellanam harbor, commissioned in the year 2021, is one of the finest picturesque harbor and a major fishing centre of Kochi. 220 motorized boats and 25 'valloms' that operates in this harbor has brought multitude of changes in the economic and social sector. This encouraged expanding the fishing sector by modernizing it and is now dominated by people outside Chellanam. The 'tharakan system' (traditional practice where the middle men owned the boats and controlled the marketing of the fishing industry) still prevails with a clear socio economic divide.

The latest development includes sea wall made of concrete tetrapods and chain of T shaped groynes (low barriers structures built from the coast into the sea) for coastal protection that commenced in the year 2022. The first phase of it has been completed spending 320 crores, which is a 7.32km stretch from Chellanam harbor to Puthenthode marking a major transformation of the area.

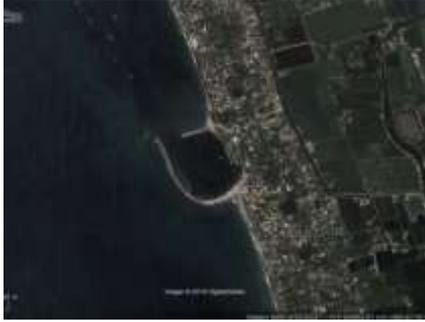


Fig 5: Figure showing Chellanamharbour in map,
(Source: <http://www.hed.kerala.gov.in/index.php/chellanam>)

X DISCUSSION

Graveline and Germain suggests that the concept of resilience focuses on three complimentary dimensions- 'Bounce Back', 'Build Back Better' and 'Bounce Forward' (Graveline & Germain, 2022). Though all popular definitions of resilience talks about retaining the same identity, structure and functioning, Kelman et al argues that changes in a society are ubiquitous and 'Bouncing Back' might never be feasible and further maintaining the same identity and function is simply returning to its vulnerable condition (Kelman, Gaillard, & Mercer, 2015). In the case of Chellanam, 'Bounce Forward' concept is discerned wherein the tetrapod seawalls have introduced an absolutely new dimension to tourism sector, the first of its kind in the State.

The irony of the recent tetrapod seawall construction stretching from Chellanam harbor to Puthenthode, anticipating tourism development has put people to dilemma, though land values has increased considerably. Though the Government has spent 320 crores of rupees on tetrapod sea walls, further efforts have to be taken to attract next generation of young people to invest in this area as there are absolutely no tourist infrastructure available to convert it to a safe, resilient, sustainable area.

Strategic location near Kochi and the proximity of the tourist village Kumbalangi, with efficient public transportation and connectivity adds to the strength of the community. Strategies are required to attract tourists to the tetrapod sea wall, picturesque harbor and the scenic beaches for which a holistic vision towards development of study area is required.

Regarding social dimension, strong community sentiments and communal harmony is the major strength of any community that accentuates community resilience, so is in Chellanam. The complimentary efforts from local self government, Church authorities, NGO's (namely 'Chellanam Kochi Janakeeyavedi', 'Core Chellanam'), strong local leaders and common people have contributed to the resilience of Chellanam in spite of the aggravated coastal issues.

Encouraging public-private cooperation in risk management and estimating disaster losses, establishing a baseline resilience for cities/ nations and measuring its effectiveness and progress, building strong local capacity and supporting it financially are the major strategies put forward by Cutter L Susan (Cutter, 2013).

XI CONCLUSION

Every community is unique with its own complex physical and social structure. Hence strategies are developed to improve resilience based on the strengths and challenges of the interconnectedness of social, economic, physical, environmental and institutional dimensions. Resilience theory has been applied to Chellanam panchayat to understand how the community has adapted, transformed and built resilience examining the above dimensions.

The best time to build resilience in a community is when it is being planned or major structural changes are being made. Ideally government policies for coastal zone management have to balance economic development with preservation of coastal habitat and environment. Prioritizing the high risk of damage along the coast, a humongous investment on tetrapod seawall has been initiated that would effectuate tremendous impact on other sectors in future. Hence this would be the ideal time to look into measures to enhance resilience of the community though the history of the village reveals its resilience, adaptability and community spirit of its people.

Rehabilitation and reconstruction are the commonly used interventions after a disaster. Even in the absence of disaster, enhancing resilience has its benefits in facilitating social capital and serving community challenges. A well-informed and prepared community with sound knowledge and awareness of disasters not only causes less damage to the community but also helps in imparting a better, livable, sustainable, and resilient community in the future.

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