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Planning For Resilience: Examining Gaps in Cyclone Preparedness and Impacts on Marginalized Communities in India's East coast cities

Pravash Ranjan Rout[1], Ar. Mahima Thussu[2]

[1] M.U.R.P Student, Faculty of Architecture & Planning AKTU, Lucknow, India
[2] Assistant Professor, Faculty of Architecture & Planning AKTU, Lucknow, India

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Abstract - Cyclones and associated storm surges pose a major threat to coastal communities in India, especially along the Bay of Bengal where their intensity is higher. This paper examines cyclone resilience planning in four coastal cities - Visakhapatnam, Puri, Rameshwaram, and Velankanni. A multi-dimensional analysis is undertaken to focus on disaster preparedness, tourism economy contributions, socio-economic inclusion, and sustainability principles. The key objective is to study the integration of cyclone resilience with equitable, tourism-based development to strengthen vulnerable communities through conceptual modeling.

The research methodology employs a mixed methods approach combining literature review, secondary data analysis of resilience infrastructure and tourism statistics, and conceptual model development. Findings highlight continued infrastructure and preparedness gaps alongside persisting socio-economic disparities limiting resilience access for marginalized groups. While progress is visible on early warnings, shelters, and evacuations, constraints exist regarding storm-proofing of amenities, customized enterprise support, secure housing, and risk financing tools.

The study concludes that resilient, sustainable outcomes require planning processes that engage tourism-dependent communities through bottom-up participation. Coupled with hazard-resilient land use standards, customized livelihood protection schemes, resilient affordable housing programs, and coherent governance; tourism-centric coastal cities can enhance capacities to absorb cyclone impacts and enable inclusive rebuilding.

***Key Words*:** Cyclone resilience, Coastal city planning, Socio-economic vulnerabilities, Tourism economies

1. Introduction

Extreme weather events like cyclones, storm surges, and floods pose major challenges to the sustainable development, resilience and climate adaptation capacities of coastal cities in developing nations. With over 250 million inhabitants, Indian coastal urban centers have witnessed amplified threats from intensifying cyclones, economic damages and loss of lives (Revi et al, 2022). Impacts disproportionately affect marginalized communities like fishing settlements and religious tourism-based economies shaped by socio-economic disparities. Integrating cyclone resilience with tourism-centric growth necessitates planning processes addressing these multi-dimensional concerns.

This paper undertakes conceptual modeling examining interactions between cyclone risk preparedness, tourism contributions, and socio-economic inclusion across coastal cities. The analysis focuses on religious tourism destinations along Bay of Bengal facing cyclone hazards like Visakhapatnam, Puri, Rameshwaram and Velankanni. Adopting a mixed methods approach, the "cyclone resilience" planning status is assessed through preparedness components like early warnings, shelters, and land use adaptations. Coastal city planning interactions with storm surge risks are studied by analyzing exposed populations and protective ecosystems. The tourism economy footprint is mapped through secondary statistics on visitor arrivals, infrastructure investments, and disaster impacts. Socio-economic vulnerabilities among informal workers, vendors or fishing communities are highlighted using census data analytics and policy document reviews.

Sustainable development necessitates participatory planning allying hazard mitigation with secure livelihoods, affordable housing, and social protection priorities of tourism-reliant populations. Outcomes showcase continued gaps in climate-proofing critical amenities, housing programs for low-income groups and small enterprise support schemes. Integrated planning processes allying cyclone mitigation with secure livelihoods, resilient affordable housing, and social protection priorities of tourism-dependent communities through their participation.

2. Background

Coastal cities exemplify the frontlines of climate change hazards with over 440 million people concentrated in low-lying areas facing amplified threats (MoEFCC, 2019). Studies project greater human settlement in these regions with nearly 40% of India's population set to inhabit coastal centers by 2025, equivalent to 500 million people (Masruroh et al, 2022; Revi et al, 2022). Density spikes converging with rising sea levels and tropical cyclone intensity, translated to a tripling of extreme weather event frequency over North Indian Ocean sub-basins since 1970 (UNDRR GAR, 2022).

Urban hubs along the Bay of Bengal like Visakhapatnam or Puri face further amplified onslaughts from cyclones and storm surges which have intensified by 18% per decade (Revi et al, 2022). Post-disaster evidence showcases prolonged devastation and economic impact totaling US$87 billion in climate-induced losses for India from 1998 to 2018, severely

hindering sustainable development goals for marginalized coastal communities (UNDRR GAR, 2022). Fishing settlements and religious tourism-based economies exemplify socioeconomic disparities exacerbating uneven access, with over 40% of fisherfolk subsistence or trafficking risk (Bhatt et al, 2022).

Their vulnerability necessitates "comprehensive risk assessment and multi-hazard early warning systems" able to resolve cyclone detection challenges, alongside "substantial risk reduction and risk transfer measures" as per the Sendai Framework priority areas (UNDRR, 2015). Integrated frameworks balancing cyclone resilience alongside sustainable rebuilding of inequitable tourism economies could illuminate inclusive planning directions for coastal cities globally facing analogous scenarios.

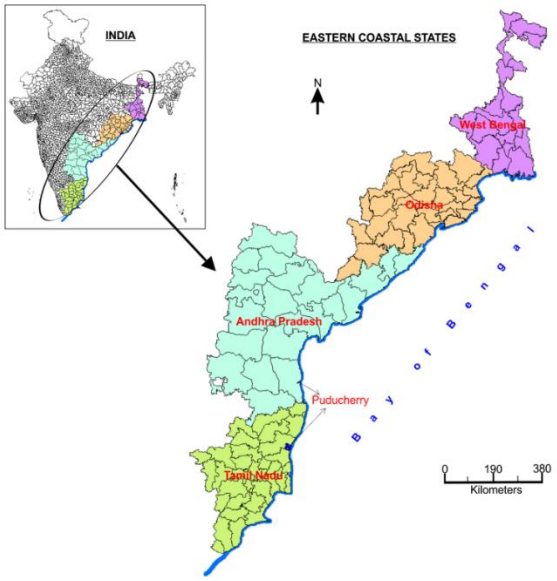

Figure 1 Vulnerable eastern coastal states

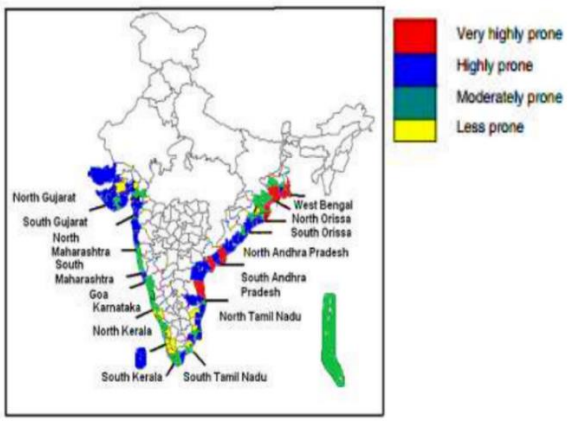

Fig.1: Cyclone hazard prone districts of India based on frequency of total cyclones, total severe cyclones, actual/estimated maximum wind strength, PMSS associated with the cyclones and PMP for all districts

Figure 2 Proneness to cyclone across coastal states of India

The term 'Cyclone' is used globally to cover tropical weather systems, in which winds equal or exceed the minimum of 34 knot (62 kmph) (Mohapatra 2015). 80% of the cyclones affected in India made its history in the eastern coast alone (Fitchett and Grab 2014)

East coast of India is experienced nearly 308 cyclones affected in the east coast between 1891 and 2000; among them, 103 cyclones were severe (Rao et al. 2007; Mohapatra 2015; Suchitra 2015)

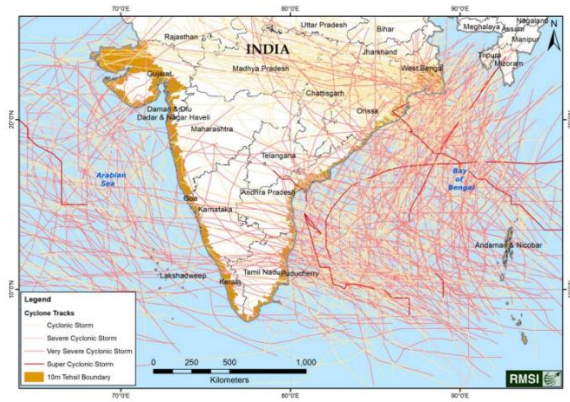

Figure 1-1: States'/UTs' coastal Talukas with land area falling up to the 10 m MSL limit along with cyclone tracks

Figure 3 States coastal areas falling up to 10m MSL limit along with cyclone tracks

State	Districts	No. of severe Cyclones	Total No. of Cyclones	Wind Speed in knots	PMSS in metres	PMP in cm
West Bengal	South 24-Parganas	16	29	115	12	52
	Medinipur	10	22	115	13	56
Orissa	Balasore	5	28	75	11	60
	Puri	6	17	140	8.5	60
	Bhadrak	4	17	65	9.5	60
	Jagatsinghpur	4	17	140	6.5	60
	Ganjam	5	11	100	4	48
	Kendrapara	1	6	140	4	60
	Khordha	0	4	100	4	52
Andhra Pradesh	Nellore	8	18	110	4.5	60
	East Godavari	4	17	125	4.5	52
	Srikakulam	5	12	100	4	56
	Guntur	0	0	127	7.5	56
	Visakhapatnam	4	8	125	4	52
	Krishna	5	12	127	5.5	56
	West Godavari	3	6	127	5	52
	Prakasam	3	5	115	6	52
	Vizianagaram	1	3	94	4	52
Tamil Nadu	Pudukkottai	1	1	55	7	52
	Kanchipuram	8	13	55	3.5	68
	Cuddalore	4	6	90	3.5	68
	Tiruvarur	3	6	90	5.5	60
	Nagappattinam	3	10	90	4.5	68

Figure 4 Cyclone parameters under eastern coastal cities

The Bay of Bengal witnesses cyclones both pre-monsoon as well as post-monsoon. The average temperature in the Bay of Bengal around the year is high - about 28 degrees. The lack of a landmass in the basin propels the cyclone to move towards the Indian coastline.

1. *Vulnerability (acc. To NULM)*

Under the National Urban Livelihoods Mission (NULM) in India, Vulnerability refers to a condition or state of being susceptible to risks, shocks, or adverse events that could significantly impact an individual or community's socio-economic well-being, especially in urban areas.

2. *Disaster Resilience (acc. to UNDRR)*

The ability of a system, community or society exposed to hazards to resist, absorb, accommodate, adapt to, transform and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions through risk management.

3. *Mitigation (acc. to Sendai Framework of UNDRR)*

The lessening or minimizing of the adverse impacts of a hazardous event.

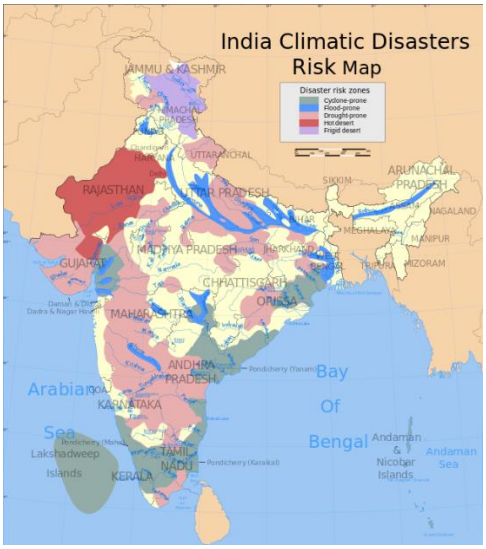

Figure 5 India climatic disasters

Figure 6 India Wind zone map

3. LITERATURE REVIEW

Research paper-based reviews:

Coastal cities globally exemplify multifaceted priorities across disaster preparedness, cultural heritage protection, environmental sustainability, and socio-economic security for tourism-dependent populations. Reviewing domain literature enables contextualization of the research by illuminating planning initiatives, persisting gaps, and interlinkages between key variables. This grounds the primary investigation within established theoretical discourse while identifying avenues for contributing original perspectives centered on cyclone risks facing Indian coastal cities.

Few of them are listed below:

1. *Barrios, A., Williams, D. S., Le Masson, V., & Norton, D. (2022). Managing climate extremes in faith-based tourism destinations: The case of Lourdes. Current Issues in Tourism, 1-19*

Lourdes in France is a major Catholic pilgrimage destination near the Pyrenees mountains. Barrios et al. (2022) examined the city's resilience planning for flash floods, landslides and other mountain hazards exacerbated by climate change. Key initiatives include early warning systems, emergency management strengthening, infrastructure adaptations, ecosystem-based approaches and tourism enterprise preparedness.

2. *Tantiwiramanond, K., & Pandey, R. (2021). Progress and challenges of building urban climate change resilience: A case study of Pattaya City, Thailand. Climate Risk Management, 33, 100305.*

Pattaya in Thailand attracts beach tourism but faces tropical cyclone and coastal erosion risks. Tantiwiramanond and Pandey (2021) reviewed resilience initiatives like coastal replenishment, mangrove restoration, disaster risk reduction planning and community capacity building.

3. *Sadeh, E., Paz, S., & Zolotov, Y. (2022). Urban resilience vs sacred space: The case of tourism resilience in the city of Tiberias. Tourism Geographies, 1-23*

Tiberias in Israel, an important spiritual destination, grapples with seismic risks and water scarcity challenges. Sadeh et al. (2022) reviewed resilience initiatives like earthquake-resistant construction, desalination facilities, public preparedness programs and tourism sector readiness. Holistic planning integrating physical and social dimensions with community participation was highlighted

4. *Samikannu, R. J. (2020). Disaster preparedness and coastal tourism–A study about Velankanni, a coastal pilgrimage town. International Journal of Religious Tourism and Pilgrimage, 8(vii), 47-56.*

Velankanni in Tamil Nadu is an important Christian pilgrimage site along India's cyclone-prone southeastern coast. Samikannu, R. J. (2020) listed key measures including early warning systems, emergency shelters near the Basilica, evacuation planning, cyclone-proofing of infrastructure, and mangrove restoration. The study noted continued risks to marginalized fishing communities' resilience and advocated their inclusion in planning.

5. *Ramachandran, A. (2018). Rameswaram–Building a resilient city to overcome coastal vulnerabilities. Urban resilience to climate change-related disasters, International seminar report, 40-49*

Rameshwaram, attracting Hindu pilgrims, grapples with cyclones, storm surge and erosion threats. Ramachandran, A. (2018) said resilience initiatives include shoreline protection walls, mangrove restoration, disaster management planning and community capacity building. Gaps exist in early warning access, infrastructure upgrades and socio-economic vulnerabilities.

6. *Jigyasu, R., & Upadhyay, R. (2021). Covid-19: Integrating top down and bottom up strategy for building urban disaster resilience in India. Disaster*

Prevention and Management, 30(4/5), 588-602.

Jigyasu and Upadhyay (2021) examined urban disaster resilience planning in India and proposed a model integrating top-down and bottom-up strategies focused on vulnerable communities. They conclude that effective resilience building requires integration across urban planning domains alongside strengthening community capacities.

7. *Jain, S., Jain, P. K., & Jain, C. (2016). An assessment framework for urban sustainability in Indian cities. International Journal of Sustainable Built Environment, 5(2), 472-491.*

Jain et al. (2016) developed a sustainability assessment framework for urban development projects in India consisting of environmental, economic and social parameters. Applying this to planned smart city proposals revealed moderate sustainability scores, indicating scope for improvement. The study emphasized that urban planning in India needs to move beyond growth-centric models and integrate sustainability principles for liveable and inclusive cities.

8. *Perera, N., & Weerakoon, D. (2021). Building resilience cities to climate change: lesson learned from Galle, Sri Lanka. Proceedings of the International Forestry and Environment Symposium, 26*

The coastal heritage city of Galle in Sri Lanka with its fort attracts significant tourism but faces climate risks like storms, flooding and erosion. Perera and Weerakoon (2021) assessed Galle's resilience planning centered on early warnings, ecosystem restoration, community preparedness, livelihood continuity and cultural heritage protection.

9. *Sharma, A., Srivastava, S., Bhasin, S., Khare, D., & Gill, S. S. (2022). Scorecarding City Disaster Resilience: Learnings from Asian Cities. International Journal of Disaster Risk Science, 1-17.*

Sharma et al. (2022) reviewed disaster resilience approaches in 6 Asian cities using a disaster resilience scorecard tool. The findings showed a lack of integrative planning for enhancing physical, social, economic and institutional resilience. The study advocated for resilience frameworks tailored to local contexts over one-size-fits all models.

10. *Comerio, M. C. (2014). Disaster recovery and community renewal: Housing approaches. Cityscape, 51-68*

Tacloban was devastated in 2013 by Typhoon Haiyan which killed over 6,000 residents. Previously allowed residential construction within 40 meters of coast left communities extremely exposed (Comerio, 2014). Post disaster, Tacloban revised its Comprehensive Land Use Plan 2015-2025. It imposed a no-build zone 100 meters inland from shore, elevated base flood levels by 2 feet based on storm surge data and designated specific sites for relocated housing of survivors away from storm surge hotspots.

Inferences

1. Various religious tourism destinations combat climate challenges through diverse strategies, including early warnings, infrastructure adaptations, and community capacity building, such as earthquake-resistant construction and mangrove restoration.
2. Successful resilience involves integrated planning, considering both physical and social dimensions. Strategies merging community participation, early warnings, and infrastructure upgrades prove vital, addressing a spectrum of risks.
3. Resilience planning must be inclusive, incorporating marginalized communities like fishing communities. Recognizing their vulnerabilities ensures comprehensive and fair disaster preparedness.
4. Despite efforts, resilience planning faces challenges like limited early warnings and socio-economic vulnerabilities. Addressing gaps, including infrastructure upgrades, is crucial for effective disaster management.
5. Tailoring resilience frameworks to local contexts is crucial. One-size-fits-all models prove inadequate, emphasizing the need for context-specific approaches, especially in diverse Asian cities.

Case study-based reviews:

Velankanni, Tamil Nadu

Velankanni in Tamil Nadu is an important Christian pilgrimage center and coastal tourism destination along the Bay of Bengal facing cyclone and flood risks. The Basilica of Our Lady of Good Health attracts millions of devotees annually.

Recognizing vulnerability of tourism-dependent communities, Velankanni has invested building. As examined by Asha et al. (2020), key initiatives include:

- Early warning communication systems along the coast
- Cyclone shelters constructed near the Basilica
- Coastal afforestation using casuarina trees for bioshielding
- Evacuation planning with routes and procedures
- Training programs for local community members and tourism operators
- Upgrades to storm water drainage infrastructure

Rameshwaram, Tamil Nadu

Rameshwaram in Tamil Nadu is an important Hindu pilgrimage center located on Pamban island and faces risks from cyclones, storm surges and coastal erosion. The Ramanathaswamy temple attracts devotees throughout the year being part of the Char Dham pilgrimage.

Rameshwaram has invested in resilience building though gaps persist. As per Nallathiga (2019), initiatives include:

- Seawalls along vulnerable beach stretches for coastal protection
- Mangrove planting to restore degraded mangroves

- Cyclone preparation plan and disaster management authority
- Community awareness programs on preparedness

Puri, Odisha

Puri in Odisha, India attracts over 5 million Hindu pilgrims annually to the revered Jagannath Temple located on the cyclone prone Bay of Bengal coast. The temple and city have faced repeated cyclones, storm surges and floods, disrupting religious tourism and linked livelihoods.

After the devastating 1999 Odisha cyclone, Mohapatra (2021) discussed that Puri has invested in resilience building for the temple area and city through measures like shelters, evacuation planning, mangrove restoration and community preparedness.

Vishakapatnam, Andhra Pradesh

Visakhapatnam in Andhra Pradesh, located on the Bay of Bengal coast, faces risks from frequent cyclones, storms and floods. It is also an important port city and industrial hub. Past disasters have caused loss of lives, property damage and economic disruptions.

Visakhapatnam has invested in resilience building. As per Krishna (2021), major resilience initiatives are implemented through early warnings, evacuation planning, shelter construction and seawalls along vulnerable beach stretches. Mangrove restoration has also been undertaken.

Gaps and Challenges:

Velankanni

- Participation of marginalized fishing communities and affordable housing residents in planning and accessing resilience measures remains limited.
- Land use regulation and disaster-resilient infrastructure upgrades are less

Rameshwaram

- Gaps in cyclone shelter infrastructure and capacity to accommodate large numbers of pilgrims and residents during cyclones.
- Lack of disaster-resilient infrastructure and amenities at the temple and tourism sites to ensure continuity of religious tourism.
- Absence of customized resilience building programs and resources for tourism enterprises and small businesses.
- Limited regulation on new construction in high-risk coastal zones, increasing vulnerability.

Puri

- Gaps in evacuation infrastructure around temple area during peak tourist seasons.
- Constraints in harnessing private sector participation for ecosystem-centric initiatives like shelter infrastructure and mangrove restoration.
- Shortfalls in following disaster-resilient building codes for hotels, small businesses and public amenities around the temple area.
- Coordination gaps between disaster management agencies, temple administration and tourism promotion boards.
- Unregulated development in high-risk zones that exacerbate risk exposure.

Vishakapatnam

- Inadequate early warning coverage in marginalized fishing settlements lacking communication infrastructure.
- Limitations in structural protection measures like seawalls and protective coastal ecosystems like sand dunes and mangroves which require complementary natural buffers.
- Lack of climate-proofing and resilience standards for critical economic infrastructure in the port and industrial zones.
- Absence of customized business continuity, livelihood protection and recovery schemes tailored to the large informal sector.

4. RESILIENCE FOCUSED INTERVENTIONS AND THEIR IMPACTS

INTERVENTIONS	IMPLEMENTATION	IMPACT
Early Warning Systems (2000-2020)	Implemented extensively across Odisha, Andhra Pradesh and Tamil Nadu cyclone hotspots through grids of observation infrastructure, communication networks and community outreach.	Enhanced lead times for response, informed evacuation planning, and lowered mortality from severe cyclones.
Coastal Bioshields (2021)	Mangrove restoration and plantation initiatives along vulnerable shorelines like in Odisha and West Bengal.	Reduced inland surge penetration, minimized erosion and restricts damages of major storms. Must integrate livelihood security

		for effectiveness and sustainability.
Post-Disaster Cash Transfers (1999-2020)	Direct benefit cash transfers to affected households piloted post-disasters in Tamil Nadu, Puducherry and Andhra Pradesh.	Supported early relief and short-term recovery of vulnerable sections like fishers, farmers and informal workers. Administrative and data barriers must be addressed.
Resilient Housing Programs for Fisherfolk (2019)	Initiating programs to construct resilient housing for fishing communities along the coastline, integrating climate-resilient designs and materials in Chennai.	Enhanced housing stability for fisherfolk, reduced vulnerability to cyclones and storms, and ensured continuity in livelihoods even after severe weather events.
Integrated Coastal Zone Management (ICZM) (2016)	Implementing an ICZM plan tailored to Kochi's coastal region, involving stakeholders for sustainable coastal development, erosion control, and biodiversity conservation.	Improved coastal resilience through balanced development, reduced vulnerability to erosion, preservation of marine ecosystems, and sustainable use of coastal resources. This approach aims for long-term environmental and socio-economic benefits.

5. ANALYSIS

Study Of Livelihood Reliance On Tourism Activities From Case Studies

Velankanni

- Popular Catholic pilgrimage center receiving over 4 million religious tourists annually to the Basilica of Our Lady of Good Health (The Hindu, 2022).
- Estimated 35-40% residents directly engaged in tourism related jobs like lodging, restaurants, souvenir shops catering to tourists (Srinivasan, 2014)

Rameshwaram

- Major pilgrimage site for Hindus to the Ramanathaswamy Temple, also gateway for trips to nearby Pamban Island beach attracting over 4.5 million tourists yearly (Tourism.gov, 2020).
- Local fishermen double up as tour guides and taxi operators due to the boom in faith tourism supporting nearly 60% households (Shakeela & Becken, 2015).

Puri

- The city receives over 6 million pilgrimage tourists annually to Puri's Jagannath Temple and its beach attracts leisure visitors (Padhiary, 2010).
- Tourism employs over 35% of the workforce directly and indirectly - in hotels, transport and street vendors (Nayak, 2021).

Vishakapatnam

- Major tourist destination with 2.2 million visitors in 2018, renowned for beaches, Buddhist sites and wildlife tourism (India Tourism Statistics, 2020).
- Direct contribution of travel & tourism in city GDP was 13.1% in 2017 providing 11.3% of jobs (WTTC, 2019).

Identified vulnerable marginalized class in classified cities:

Directly Engaged With Tourism

VULNERABLE MARGINALIZED CLASS IN CLASSIFIED CITIES	MAJOR TRADE AND THEIR OCCUPATION TYPE	Impact Scale (H/M/L)
Tour Guides and Hospitality Workers	People from marginalized backgrounds often work as tour guides, drivers, or in the hospitality sector catering to tourists	M
Street Vendors and Small-Scale Traders	Individuals and communities run small shops or stalls selling religious offerings, souvenirs, food items, and other goods to pilgrims and tourists visiting temples.	M
Performers and Musicians	They entertain pilgrims and tourists by showcasing their traditional dances, music, or street performances near religious sites.	H
Temple priests and associated workers	Ancestral Communities involved in temple activities on daily basis and religious tourism does supplement to highest extent.	L

Indirectly Engaged With Tourism

VULNERABLE MARGINALIZED CLASS IN CLASSIFIED CITIES	MAJOR TRADE AND THEIR OCCUPATION TYPE	Impact Scale (H/M/L)
Local Artisans and Handicraft Workers	Communities engaged in pottery, sculpture, weaving, painting, and other crafts often sell their products to tourists visiting religious sites.	M
Service Providers and Labourers	Daily wage laborers, rickshaw pullers, and individuals offering services like flower garland making, religious rituals, or cleaning services at these sites	H

Other Existing Vulnerable Occupations

VULNERABLE MARGINALIZED CLASS IN CLASSIFIED CITIES	MAJOR TRADE AND THEIR OCCUPATION TYPE	Impact Scale (H/M/L)
Fisherman community	Fishermen are individuals engaged in the capture of fish and other marine resources for sustenance or commercial purposes	H
Aquaculture Farmers	Aquaculture farmers engage in the cultivation of aquatic organisms, such as fish, prawns, or mollusks, in controlled environments like ponds or enclosures.	M
Agricultural Labourers	Agricultural labourers in coastal areas are individuals involved in farming activities, including cultivation and harvesting of crops in proximity to the coastline.	M
Coastal Transport	Cyclones can disrupt coastal transportation, damage vessels,	H

	and impact the livelihoods of those dependent on coastal transport	
Boat builders and repairers	Individuals involved in the construction and repair of boats, which are crucial for the fishing industry.	M
Salt pan workers	Salt pan workers are involved in the extraction of salt from saline water in coastal areas	H

6. Identified components in socio-economic vulnerabilities

Physical Interventions <-> Possible Social Implications

Physical Interventions	Possible Social Implications
Construction of cyclone shelter	• Acquisition of small amount of private lands • Use of public lands • Impacts to non title holders on public lands • Damages to standing crops and plantations • Loss of livelihoods
Construction of link roads/bridges and culverts	• Resettlement of families • Loss of existing structures and community property • Loss of livelihoods
Construction of saline embankments	• Temporary influx of labour • Loss of mangrove ecosystem/community forest on which nearby residents/local population are dependent for fuel wood/grazing etc • Private Land acquisiton
Regeneration of mangroves & Shelterbelt plantations	• Loss of livelihood • Small amount of land requirement for plantations
Towers for communication	• Acquisition of land • Loss of livelihoods

Physical Interventions <-> Possible Entitlement Implications

Private Property:

- Loss of Property: Individuals may experience the loss of personal or residential property due to cyclone-resilient construction activities in coastal areas.
- Compensation at Market Value: As per the Land Acquisition, Rehabilitation, and Resettlement Act (LARR), 2013, affected property owners are entitled to compensation at the prevailing market value.

Agricultural Property:

- Agricultural Land and Standing Crops/Trees: Cyclone resilience measures may impact agricultural lands and standing crops, necessitating compensation for losses incurred.
- Compensation at Replacement Cost or Actual Market Value: Compensation is provided based on the "replacement cost" or the actual market value of the affected agricultural property.

Livelihood:

- Wage Earning (Occupation): Individuals reliant on specific occupations may face disruptions to their livelihoods due to cyclone-resilient constructions.
- Income Restoration: Compensation and support mechanisms are implemented to restore lost income and ensure financial stability for those whose livelihoods are affected.
- Financial Assistance: Direct financial assistance may be provided to individuals to mitigate the economic impact on their livelihoods.

Non-Title Holders:

- Encroachers (Squatters): Individuals residing in areas without legal title may be considered as encroachers or squatters.
- Assistance/Rehabilitation: Cyclone-resilient constructions may involve assistance and rehabilitation programs for non-title holders to address housing and settlement issues.

Special Category:

- SC/ST/Tribal Communities: Special provisions are made for Scheduled Castes (SC), Scheduled Tribes (ST), and tribal communities.
- Assistance: These communities may receive specific assistance tailored to their unique needs to ensure

equitable access to benefits and opportunities arising from cyclone-resilient measures.

Inferences

The identified socio-economic vulnerabilities linked to cyclone resilience interventions underscore the intricate balance needed between developmental efforts and their potential adverse impacts. Land acquisition, a common thread across projects, has far-reaching consequences on livelihoods and ecosystems. Resettlement efforts, though essential, may disrupt existing community structures. The nuanced interplay of physical interventions and social implications highlights the need for meticulous planning, community engagement, and sustainable strategies to mitigate the unintended consequences of cyclone resilience projects.

7. Laws, Rules, Regulations and policies review

POLICIES AND PLANS

National Cyclone Risk Mitigation Project (NCRMP):
Year: Started in 2011

Regulatory Body: Ministry of Home Affairs

Funding Body: World Bank and Government of India

Managing Body: National Disaster Management Authority

Objective: Focuses on enhancing preparedness, early warning systems, infrastructure improvement, and capacity building for cyclone-prone areas.

National Disaster Management Plan (NDMP):
Year: Introduced in 2016

Regulatory Body: Ministry of Home Affairs Funding Body: Government of India

Managing Body: National Disaster Management Authority (NDMA)

Objective: Provides a framework for disaster management, including cyclones, with a focus on preparedness, response, recovery, and mitigation measures.

Cyclone Warning Dissemination System (CWDS):
Year: Ongoing

Regulatory Body: India Meteorological Department

Funding Body: Ministry of Earth Sciences

Managing Body: India Meteorological Department

Objective: Aims to disseminate timely and accurate cyclone warnings to vulnerable communities through various communication channels.

National Cyclone Risk Mitigation Project-II (NCRMP-II):
Year: Commenced in 2015

Regulatory Body: Ministry of Home Affairs

Funding Body: World Bank and Government of India

Managing Body: National Disaster Management Authority

Objective: Focuses on enhancing cyclone risk mitigation infrastructure, capacity building, and strengthening early warning systems in high-risk areas.

Integrated Coastal Zone Management (ICZM) Programme:
Year: Launched in 1997 (later revised in 2015)

Regulatory Body: MoEFCC

Funding Body: Government of India and World Bank (in some phases)

Managing Body: MoEFCC, SCZMAs

Objective: Aims to manage coastal zones sustainably, considering various aspects including cyclone vulnerability, habitat conservation, and livelihood improvement.

The array of policies and plans for cyclone mitigation in India reflects a comprehensive and collaborative approach involving various government bodies, international organizations, and meteorological departments. The presence of initiatives like the National Cyclone Risk Mitigation Project (NCRMP) and the Cyclone Warning Dissemination System (CWDS) emphasizes the priority placed on preparedness, infrastructure improvement, and timely warnings.

These efforts, collectively outlined in policies such as the National Disaster Management Plan (NDMP) and Integrated Coastal Zone Management (ICZM) Programme, underscore the nation's commitment to a holistic and multi-dimensional strategy for cyclone resilience.

Laws, rules, regulations and policies:

National-level policies with only physical interventions

NOTIFICA-TIONS	ABOUT	REGUL-ATIONS	PHYSICAL IMPLICATIONS
Environment (Protection) Act, 1986 & EIA Notification	Introduced as an umbrella legislation that provides a holistic	Category 'A' projects are those having potential impacts	Cyclone shelters being proposed under the project are less than 20,000 sqm in size Saline

	framework for the protection and improvement to the environment	on human health, and natural and manmade resources. Those projects require clearance from MoEF. Category 'B' projects require prior environmental clearance SEIAA	embankments - the area (base x width) is ≥20,000 sq. m in size requires. Road/Culverts/Bridges, Plantation Shelter, Mangroves, Coastal Canal and Transmission Tower: Not applicable
Coastal Regulation Zone Notification (CRZ), 1986	Restrictions have been imposed on industries, operations and processes within the CRZ	Based on: For regulating development activities, the coastal stretches within 500 metres of HTL on the landward side are classified into four categories (CRZ 1-4)	CRZ Norms --- State/Union Territory level --- CRZ regulation and in the state / UT coastal zone management plan
Forest (Conservation) Act, 1980	Cases of diversion of forest area and felling of roadside plantation	Depending on the size of the tract to be cleared, clearances are applied for at the following levels of governme	>20 Ha (or, 10 Ha in hilly area) – Central Govt | 5 to 20 Ha – CCF Regional Office | < 5 HA – State Govt | Area has forest density of more than 40%, permission to undertake any work

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Water and Air (Prevention & Control of Pollution) Acts	CPCB and SPCB : Responsibilities include managing , standardizing , monitoring, licensing.	Managing water quality and effluent standards , as well as monitoring water quality, prosecuting offenders and issuing licenses for construction and operation of certain facilities.	All construction contractors need to obtain the consent-to-establish and consent-to-operate for the various plants - concrete batching, stone crushing and other plants that they may erect for the purpose of construction from SPCB.
Ancient Monuments and Archaeological Sites and Remains Rule 1959	Regulation and Controlling for protection of monuments and archealogical sites in India.	No development activity is permitted in the "protected area"(100 m) and development activities likely to damage the protected property are not permitted in the "controlled area"(300 m) without prior permission of the Archaeological Survey of	If activities are to be done in the controlled area of protected properties, then the respective line department should take the necessary permissions from the ASI.

		India (ASI)	

National level policies with both physical interventions and social interventions

NOTIFICATIONS	ABOUT	REGULATIONS	PHYSICAL IMPLICATIONS	SOCIAL IMPLICATIONS
National Rehabilitation and Resettlement Policy, 2007	Policy strikes a balance between the need for land for developmental activities & protecting the interests of land owners and others	Rehabilitation and Settlement Policies	All PAPs for the sub-projects should be compensated accordingly. State specific Rehabilitation & Resettlement Policies also apply based on the Entitlement Matrix adopted for the project	The benefits under the new policy are available to all Project Affected Persons (PAP) & families whose land, property or livelihood is adversely affected by land acquisition, involuntary displacement due to natural calamities, etc.
The Ramsar Convention, 1971	International treaty for the conservation and sustainable utilization of wetlands	Stem the progressive encroachment on and loss of wetlands	According to the Ramsar list, there are 9 designated coastal wetlands in the country which are required to be protected.	Recognizing the fundamental ecological functions of wetlands and their economic, cultural, scientific, and recreational value
2. WORLD BANK POLICIES (Bank lending operations)				
Environmental Assessment (OP 4.01)	Prevent and mitigate undue harm to people and their environment in the development process. These policies provide guidelines for bank and borrower staffs in the identification,	Identify, avoid, and mitigate the potential negative environmental impact.	Operational Policy (OP)/Bank Procedure (BP) 4.01: Environmental Assessment	Improve decision making, to ensure that project options under consideration are sound and sustainable and that potentially affected people have been properly consulted
Involuntary Resettlement (OP 4.12)		Avoid involuntary resettlement to the extent feasible / minimize and mitigate adverse social and economic impacts	• Participation of displaced people in resettlement planning and implementation • Assist displaced persons in their efforts to improve or at least restore their incomes and standards of living after displacement • Compensation and other resettlement measures to achieve its objectives	

Indigenous Peoples (OP 4.10)	on, preparation, and implementation of programs and projects	To identify indigenous peoples, consult with them, and ensure that they participate in, and benefit from Bank-funded operations in a culturally appropriate way

Discussion on the existing policies

The array of national policies and plans underscores India's strategic focus on enhancing cyclone preparedness and response capacities. Initiatives like the National Cyclone Risk Mitigation Project, early warning dissemination mechanisms, and coastal zone management programs reflect policy priorities around risk-informed infrastructure upgrades, timely forecasting, and community-centric capacity building. These efforts align with global frameworks like Sendai and integrate learnings from past disasters to systematically bolster resilience. However, policy gaps exist regarding implementation, especially in catalyzing action across scales through coherent governance and inclusive community participation.

Similarly, while environmental and social safeguard regulations mandate robust impact assessments, their fragmented governance hinders streamlined enforcement, necessitating coordination under holistic frameworks like the National Disaster Management Plan.

However, resilience policies exhibit limited integration with key issues like sustainability, climate adaptation or addressing socio-economic disparities exacerbating cyclone vulnerability. Laws and standards around resilient land use, housing and infrastructure also require further strengthening to effectively disaster-proof exposed urban coastal settlements through regulation in addition to commendable risk mitigation investments underway.

8. Recommendations

1) Mainstream resilience across urban coastal planning through coordinated efforts between city agencies, communities and the private sector around risk-informed land use, housing policies and infrastructure upgrades.
2) Implement differential land use zoning defining no development zones or density restrictions for high risk areas based on surge models, mangrove buffers and affordable housing sites.
3) Expand funding and technical support for resilient affordable housing schemes, integrating disaster-resilient materials, customized designs and relocation stipends through housing agencies and private developers.
4) Develop localized resilience indexes tracking socio-economic vulnerabilities through granular analytics on housing quality, healthcare access, secure jobs and enterprise stability to enable targeted planning.
5) India's coastal cities must transition towards resilience planning frameworks that align cyclone preparedness with sustainability and social inclusion to secure equitable outcomes. Mainstreaming resilience requires coordinated efforts between urban planning agencies, infrastructure bodies, communities and private sector around risk-informed development.
6) Cities can implement differential land use policies defining no development zones in high risk areas near shorelines based on storm surge models, while imposing density limits aligned with protective ecosystems like mangroves. Expanding resilient affordable housing schemes through public-private partnerships is vital, integrating disaster-resilient building materials, customized community-centric design, relocation stipends and land titling support. Granular vulnerability analytics assessing housing quality, health access, secure jobs and small business stability can inform localized planning.
7) The National Cyclone Risk Mitigation Project, National Disaster Management Plan and State Coastal Zone Management Plans provide entry points for operationalizing these recommendations through existing programs for early warning systems, capacity building, and infrastructure development. Climate-centric funding mechanisms also offer scope for investments in resilience, sustainability and inclusion.
8) By coupling risk mitigation programs with policies tackling inequality, cities can address exposure, socio-economic risks and sectoral dependencies holistically, enhancing capacities of vulnerable communities to prepare, adapt and transform in the face of climate threats.

9. Conclusion

Coastal cities in India, especially along the Bay of Bengal, face amplified threats from intensifying cyclones and storm surges. This necessitates urgent enhancements in resilience planning to secure the safety and wellbeing of millions of residents dependent on religious tourism economies.

Early warning systems, emergency shelters, evacuation protocols have expanded over past decades, enhancing preparedness. However, significant gaps persist regarding implementation of resilience standards for infrastructure, housing, customized enterprise support tools catering to marginalized groups. Coastal resilience planning must shift from isolated efforts to integrated frameworks recognizing the interactions between physical climate risks, socio-economic disparities and sectoral dependencies like tourism. Outcomes should balance hazard mitigation alongside sustainability imperatives and social inclusion.

The path forward demands a paradigm shift to participatory, bottom-up planning processes that engage vulnerable fishing settlements, religious tourism workers and urban poor

alongside top-down resilience policies and investments. India's coastal cities must implement resilience benchmarks for construction, land use regulations and public infrastructure, hand in hand with social protection schemes like resilient affordable housing, secure jobs and enterprise continuity tools.

By coupling hard resilience measures like early warnings and shelters with soft resilience mechanisms designed through participation of marginalized communities, coastal cities can enhance capacities to absorb climate shocks. They can also enable inclusive rebuilding of inequitable tourism-based economies, addressing exposure, socio-economic risks and sectoral dependencies in a holistic manner.

The key would be to adopt integrated frameworks recognizing the need to balance resilience for lives and livelihoods in the face of cyclones alongside imperatives of sustainability and social equity. Coastal cities must also leverage emerging innovations around nature-based resilience, risk transfer tools like insurance, Climate-Smart technologies and shared accountability across city agencies, private sector and communities themselves.Only through multi-dimensional perspectives bridging top-down and bottom-up action across scales, can India’s coastal cities secure inclusive outcomes, enhancing capacities of vulnerable communities to prepare, adapt and transform in the face of climate risks.

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BIOGRAPHIES

Pravash Ranjan Rout is an architect and pursuing urban planning with a Bachelor's in Architecture from VSSUT and currently pursuing Master's in Urban and Regional Planning from AKTU. He has professional experience working on government infrastructure projects, master planning, and architectural design. Rout is a member of the Council of Architecture, Government of India and has expertise in geospatial technologies, climate resilience planning and urban policy formulation.

Ar. Mahima Thussu is currently working as an Assistant professor in Faculty of Architecture and Planning, Dr. APJ Abdul Kalam Technical University, UP. Worked under variety of projects from research on housing sector to preparation of area development plan, master plan and development control regulations revisions, policy making as well as assessment in rural and urban context.