COMMUNITY-DRIVEN SALTY URBANISM: COMBATING COASTAL EROSION

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Abstract. Coastal erosion is a growing problem worldwide and seriously threatens coastal infrastructure ecosystems and communities, particularly in areas where urban development has encroached on natural shorelines. Salty urbanism, an approach to urban design that incorporates natural features and works in harmony with coastal environments, offers a promising solution to this problem. This review explores strategies for coastal erosion reduction, particularly emphasizing community participation within the context of salty urbanism. By investigating the advantages of incorporating salty urbanism and community engagement in coastal management through a literature study, this paper explores a case study-Paradeep, a coastal city in India. The aim is to comprehend how salty urbanism principles have been assimilated into coastal erosion initiatives in Paradeep and to identify potential opportunities for further integration to maximize benefits. The results emphasize the importance of integrating salty urbanism and community participation into coastal erosion management strategies, especially in coastal areas where these principles are either lacking or only minimally incorporated, often without a clear recognition of the term "salty urbanism" itself. Utilizing a mixed-methods research approach, the study integrates primary data from case studies and interviews, along with inferences from literature studies to gain valuable insights from coastal community residents and stakeholders. The findings will provide a significant contribution to advancing strategies and initiatives that advocate for sustainable coastal development and management by suggesting ways to incorporate a community participation-based salty urbanism approach in similar contexts.

Key words: coastal protection, community empowerment, adaptation strategies

1. Introduction

Coastal erosion is a major challenge facing urban areas around the world. It is a significant environmental issue that affects many communities around the world, particularly those in urban areas. Coastal erosion is the gradual or sudden removal of sediment or rock from the shore or cliff face. Coastal erosion arises from a combination of natural phenomena, including storms, tides, sea-level rise, sand mining, changes in sediment supply, and pollution alongside human activities such as coastal development. Coastal erosion can result in the loss of property, infrastructure, and habitats, and it also increases the risk of flooding and storm damage. The threat to

the world's ecosystems and coastal communities due to coastal erosion has been documented by many studies. Studies predict that by the conclusion of the century, approximately 67% of the Earth's sandy beaches may face the risk of disappearing due to sea level rise and coastal erosion (Matin and Hasan, 2021). Others point out that 85% of European coasts so far have been affected by erosion, with an estimated annual economic cost of 1 billion euros (Pranzini, 2015). Studies on India state that over 7500 kilometers of India's coastline is experiencing an average rate of erosion of 3.3 millimeters per year due to a combination of natural processes, geology, climatic conditions, and human activities such as construction and sand mining (Kunte *et al.*, 2001; Nair *et al.*, 2018).

The economic cost of coastal erosion is significant, with estimates ranging from billions to trillions of dollars per year globally. This encompasses both immediate expenses, such as infrastructure and property damage, and indirect expenses, such as the decline in tourism revenue and ecosystem services. (Gopalakrishnan *et al.*, 2018). To tackle this issue, the Indian government has implemented several initiatives, including the National Coastal Zone Management Programme. This program aims to facilitate sustainable development and conservation of the coastal zone (Gopalakrishnan *et al.*, 2018). Coastal regions confront a diverse array of environmental hazards that encompass both spatial and temporal dimensions. Addressing these threats requires collaboration among many relevant disciplines like architecture, engineering, urban planning, climate studies, etc. for deriving holistic solutions. Nevertheless, the intricacy of environmental challenges and the multitude of disciplines and methodologies involved create significant obstacles in establishing shared understanding and integrated solutions. These barriers could potentially be overcome through a collaborative and comprehensive framework.
The objective salty urbanism approach is to foster sustainable coastal development by comprehending the interplay between human activities, coastal erosion, and the associated dynamics. Unlike traditional approaches that have often focused on hard infrastructure solutions, such as seawalls and jetties, implementing such measures can be costly and may result in adverse environmental consequences. Salty urbanism offers a more sustainable and ecologically friendly approach to addressing coastal erosion and bases its actions on community participation and interdisciplinary inputs (Beatley, 1999; Martynoga, 2015).

1.1. Aim of the research

The goal of this paper is to promote the appropriateness and importance of salty urbanism as an effective strategy for addressing coastal erosion hazards, with a specific focus on examining community participation as an integral component of its suitability.

1.2. Significance of the research

This paper holds significance in offering valuable insights into the effective utilization of salty urbanism to tackle coastal erosion hazards. By emphasizing the crucial role of community participation within this approach, the paper addresses the need for a more comprehensive understanding and practical application of salty urbanism in coastal regions. Through its exploration of community involvement, the paper aims to contribute to the development of sustainable strategies for coastal protection and resilience.

1.3. Scope and limitations

The scope of the research paper is related to a literature study on different aspects of coastal erosion and how they can be mitigated through the salty urbanism approach. Though salty urbanism encompasses a universe of materials and strategies, this paper only focuses on the role of community participation to establish its relevance in the coastal erosion protection domain. A limitation arises due to the scarcity of data specifically related to the case study; Paradeep. Despite a wealth of available data on coastal erosion in the broader state of Orissa, the restricted information about the Paradeep coast poses an additional constraint in conducting a comprehensive analysis. Another limitation of the paper is that only 3 types of interview respondents are considered based on ease of data collection, though other types of stakeholders' views have a significant bearing on the topic being investigated.

2. Literature study

The literature study is categorized into six different sections; the first five investigate different aspects of coastal erosion including the erosion protection measures positioning it in the context of climate change and sustainability, adaptation theory, and community participation dynamics. In the last section, various aspects of the salty urbanism approach are explored to establish its relevance as a strategy to combat coastal erosion.

By delving into the existing body of knowledge, this study seeks to provide a foundation for addressing coastal erosion through the adaptation of a salty urbanism framework.

2.1. Coastal erosion: different aspects

Coastal erosion is a complex and urgent issue with widespread implications for both the environment and human communities. It is a multifaceted phenomenon influenced by various natural and anthropogenic factors (Chowdhury, 2023). The causes of coastal erosion are diverse, including storm surges, sea level rise, sediment dynamics, and human activities. Elevated sea levels result in waves reaching farther inland, increasing the frequency and severity of storm surges. This, in turn, raises groundwater tables, contributing to erosion through soil saturation (Wolff, 2020). Human activities, such as land use changes and construction, worsen coastal erosion by disrupting natural sediment flow and destabilizing coastlines (Prasad and Kumar, 2014).

The geological and geographical features of a coastline, including coastal topography, geology, and sediment composition, also significantly determine its susceptibility to erosion (Anfuso *et al.*, 2021). Climate change, particularly rising sea levels and shifts in weather patterns, intensifies coastal erosion, necessitating adaptive measures to inform long-term resilience strategies. Coastal erosion not only threatens human infrastructure but also critical habitats and biodiversity. Ecological consequences encompass habitat loss, shifts in species distribution, and disruptions to ecosystems. Additionally, vulnerable communities in these areas face challenges to their living conditions and livelihoods (Senevirathna *et al.*, 2018).

2.1.1. Coastal erosion in the context of climate change and sustainability

Several perspectives have emerged from the literature, shedding light on the impact of climate change on coastal erosion and the quest for sustainable mitigation strategies:

(i) Societal risk: Climate change accelerates shoreline erosion, posing a

threat to coastal communities. This risk stems from society's dependence on fossil fuels and unsustainable practices, necessitating the promotion of alternative, sustainable approaches (Rangel-Buitrago *et al.*, 2020).

(ii) Resilience building: Addressing the challenge of coastal erosion in the context of climate change requires building resilience in coastal communities. This involves implementing sustainable strategies to enhance adaptability and recovery from environmental challenges (Townend *et al.*, 2021).

(iii) Strategies for adaptation: Coastal communities can adapt to the growing threat of erosion through proactive measures like infrastructure relocation, changes in land use practices, and adopting enablers such as diversity and flexibility to enhance their adaptive capacity (Whitney and Bennett, 2007; Lebbe and Bongarts, 2021). Promoting strategies that facilitate adaptation to environmental pressure, such as coastal erosion, is crucial for the sustainable growth of communities (Amos and Akib, 2023).

(iv) Ensuring environmental justice: Vulnerable communities are disproportionately exposed to threats arising from climate change and coastal erosion. This underscores the need for sustainable mitigation strategies that consider social equity and justice (Gotham, 2016).

(v) Holistic interpretation: Coastal erosion patterns are influenced by various ecological systems, encompassing both built and unbuilt components. This necessitates a holistic framework and multidisciplinary knowledge for a comprehensive understanding (Graci *et al.*, 2018).

2.1.2. Coastal erosion protection measures

Coastal erosion protection encompasses a spectrum of strategies, with engineering structures and nature-based solutions emerging as prominent approaches.

Engineering structures, comprising seawalls, groins, and breakwaters, have stood as traditional guardians against coastal erosion (Schoonees *et al.*, 2019). Extensive literature explores these structures, emphasizing their effectiveness in immediate coastal protection. Seawalls, designed to absorb wave energy, have proven efficient, yet concerns arise over 'coastal squeeze' impacting adjacent areas (Rashidi *et al.*, 2021). Groins, perpendicular to the shoreline, reveal mixed effectiveness, offering beach accretion updrift but potential erosion downdrift. Breakwaters, offshore energy dissipators, effectively reduce wave impact but may alter coastal currents, influencing sediment distribution (Rubinato *et al.*, 2020). However, the notable limitations of engineering structures cannot be overlooked. High construction and maintenance costs present financial challenges, shoreline hardening may accelerate erosion in adjacent regions, and the structures' rigidity limits adaptability to changing conditions. Ecologically, alterations in natural sediment transport and habitat degradation are identified as consequential impacts. Striking a balance between the immediate efficacy of engineering structures and the need for sustainable, nature-based alternatives becomes pivotal, prompting a more nuanced exploration in subsequent sections (Saengsupavanich *et al.*, 2023).

Nature-based solutions, encompassing strategies like beach nourishment, dune restoration, and the establishment of living shorelines, represent a transformative approach to coastal protection (Slinger *et al.*, 2021). Beach nourishment, involving the supplementation of eroded beaches with sediment, emerges as ecologically advantageous by enhancing habitat diversity and supporting biodiversity (Chen *et al.*, 2022). Sustainability considerations favor beach nourishment, especially when utilizing locally sourced sediment, aligning with natural coastal dynamics, and exhibiting adaptability to changing conditions but necessitates careful planning and consideration of environmental impacts (Staudt *et al.*, 2021). Dune restoration, focusing on the re-establishment of natural dune systems, not only provides crucial erosion buffers but also promotes ecological benefits such as the restoration of native plant species and the stabilization of coastal sediments. Sustainability is underscored through the method's alignment with natural processes and its contribution to ecosystem stability (Sigren *et al.*, 2014). Living shorelines, integrating natural elements like vegetation, oyster reefs, and marshes, demonstrate ecological advantages, including habitat creation, improved water quality, and enhanced shoreline stabilization. Sustainability considerations highlight the method's adaptability to changing environmental conditions and its role in promoting overall coastal ecosystem health (Polk and Eulie, 2018). Coastal ecosystems like salt marshes, mangroves, seagrass meadows, beaches, dunes, coral, and shellfish or oyster reefs bear the potential to bridge the gap between coastal engineering and nature conservation, since they provide benefits and support beneficial processes for water, nature, and people alike (Jordan and Frohle, 2022). As a whole, nature-based solutions emerge from the literature as ecologically sound and sustainable alternatives, fostering a holistic approach that effectively controls erosion while preserving and enhancing coastal ecosystems. The overriding premise when working with coastal ecosystems as Nature-based Solutions is, of course, to work within the given, natural boundary conditions and not to create artificial landscapes as foreign bodies in the coastal environment. Furthermore, possible differences between naturally developed coastal ecosystems and those, whose development is triggered or facilitated by human intervention and actions, need to be considered and examined further (Abelson *et al.*, 2020).

2.1.3. Coastal adaptation theory: futureproofing the coast

Coastal defence strategies, though have been used for centuries as tools to prevent coastal erosion have certain limitations due to the expense associated and their temporary nature. In the face of climate change and other uncertainties, the adaptability of these strategies often becomes a determining factor behind their success or failure. (Tobey *et al.*, 2003). The complex and dynamic nature of coastal environments necessitates smart, innovative, and robust coastal erosion management plans that consider socioeconomic, environmental, and climate-related factors (Rangel-Buitrago *et al.*, 2018; Coelho *et al.,* 2023). The adaptation pathways approach aids in studying the extension of feasible options over time, and how current response portfolios can be diversified through adaptation measures (Tompkins *et al.*, 2008; Henstra, 2016; Rangel-Buitrago *et al.*, 2018).

Coastal management strategies are classified into retreat, accommodation,

and protection, emphasizing the need for a nuanced and context-specific approach (Coelho *et al.*, 2023). Despite variations in terminology, the underlying vision of these strategies aligns with the common goal of addressing sea-level rise, erosion, and coastal flooding challenges in densely populated coastal areas (Lebbe and Bongarts, 2021).

Beach nourishment which emerged as a pioneering alternative in the 1970s remains a preferred method in many countries to control shoreline degradation (Pranzini *et al.*, 2015). However, in the wake of demands for more sustainable ways of managing the coasts' managed retreats are gaining popularity (Haasnoot *et al.*, 2021). Managed retreat or realignment, represents a coastal management approach enabling the shoreline to naturally move inland, as opposed to relying on structural engineering to maintain the existing line. Simultaneously, this strategy enhances natural coastal habitats seaward of a newly established defence line (Setter *et al.*, 2023). However, planned / managed retreat / relocation, despite being recognized as effective, faces complexities in implementation, both politically and et al., socially (Barnett and O'Neill, 2012; Haasnoot *et al.*, 2013).

Coastal accommodation strategies encompass various methods aimed at addressing coastal erosion by modifying and reordering human activities within the coastal zone. In the recent past, ecosystem-based accommodation approaches have gained traction, demonstrating how ecosystems can mitigate wave power, reduce erosion, and enhance overall coastal protection (Lebbe and Bongarts, 2021).

The global scenario of coastal erosion management practices exhibits mixed success in terms of adaptation capability (Pranzini *et al.*, 2015). Different national approaches to coastal protection in Europe highlight the need for socio-economic planning and practical alternatives for making coastal management adaptive to modern-day disruptions (Nicholls *et al.*, 2013). Specific programs in the United States of America(USA), such as the National Flood Insurance Program and Coastal Area Management Act, have faced adaptability challenges due to legal flaws and inadequate projections of sea-level rise and erosion (Rangel-Buitrago *et al.*, 2018). The coastal defence strategy in Buenos Aires is reported to be deficient in terms of adaptability whereas combining hard and soft solutions has improved adaptability and positive impacts on coastal management projects along the Colombian Caribbean coast. Erosion strategies in Africa, are often individual and uncoordinated exacerbating coastal erosion (Coelho *et al.*, 2023). In India, the coastal environments and resources are reported to be undergoing rapid degradation and erosion, and current approaches to the management of coastal resources are found to be incapable of adaptive development despite a multitude of measures and policies being in force (Mohanty *et al.*, 2023).

2.1.4. Community participation to address coastal erosion

Recognizing that over 40% of the world's population resides in coastal areas (Tobey *et al.*, 2010; Nash *et al.*, 2022), facing anthropogenic pressures and climate change effects (Santos *et al.*, 2013), there is an urgent need for effective adaptation measures public participation is a major principle of Integrated Coastal Zone Management, enhancing the success of adaptation measures. While coastal management discussions traditionally

positioned citizens and anthropogenic activities as central drivers of negative impacts, there is a growing acknowledgment of individuals and communities as part of the solution to strengthen coastal resilience (Sutton-Grier *et al.,* 2015; Uddin *et al.*, 2020). Despite the benefits of public participation, sustained involvement in coastal zone management remains challenging worldwide (Ballinger *et al.*, 2010; McKinley *et al.*, 2021).

Community participation in coastal hazard mitigation depends significantly on community perceptions of how these hazards can disrupt life and living (Areia *et al.*, 2023). In the past decades' studies exploring coastal hazard mitigation strategies have been predominantly found to be focused on physical processes, planning, and engineering solutions and seemed to have neglected the social factors, such as public attitudes and perceptions associated with such hazards (Tran *et al.*, 2021). But in present times, advocacy for sustainable coastal communities has gained momentum, emphasizing a shift from a top-down to a bottom-up approach in coastal planning. Coastal experts argue that empowering coastal communities which include diverse stakeholders like coastal residents, absentee coastal property owners, beach users, and visitors to collaboratively devise locally appropriate, people-friendly, and ecologically sustainable solutions is crucial for resilience. (Butler *et al.*, 2014; Gaymer *et al.*, 2014).

Also, public and technical assessments of risk often differ considerably. Laypeople's conceptualization of risk may reflect legitimate concerns that are typically omitted from expert risk assessments. Therefore, involving the community in discussions about coastal erosion, natural hazards, and coastal management options is essential (Storch *et al.*, 2015; Sandifer and Scott, 2021). A study on coastal management and community management in Malaysia, Vietnam, Cambodia, and Thailand, carried out by Nopparat Nasuchon under the United Nations-Nippon Foundation Fellowship program in 2008- 2009 interlinked the success of projects aimed at sustainable conservation of coastal resources with their diverse approaches and engagement involving community members (Song *et al.*, 2020). After studying a wide range of coastal management scenarios in the above-mentioned countries, the study reported, that Thailand facing challenges related to fiscal decentralized responsibility, Malaysia lacking community-based management practices, and Vietnam exhibiting a growing trend toward community-based management for fisheries. These findings were then analyzed and it was found that the overall success rate of the projects was closely interlinked with the level and extent of community participation they garnered in various stages of the project (Schofield, 2007).

In the context of Bangladesh, to address the shortcomings of government strategies, which often mimic mainland conservation policies and inadequately consider coastal conditions, there's been a radical shift towards community participation in Bangladesh (Shampa *et al.*, 2023). This transformative approach involves a seven-step plan encompassing project site selection, community integration, issue prioritization, cultivation of local leadership, formation of core groups, education and mobilization, and the establishment of community organizations. The primary

goal is to propose sustainable livelihood alternatives and effectively tackle long-term challenges (Ahmad, 2019). Despite the acknowledged necessity for a bottom-up approach, Bangladesh's centralized bureaucratic system impedes the efficient implementation of community-driven solutions. Advocates emphasize the imperative to empower marginalized coastal communities both educationally and economically, recognizing their "double vulnerability" as both uneducated and economically disadvantaged (Barua and Rahman, 2018).

Indonesia, with the world's largest sea biodiversity, has adopted Integrated Coastal Zone Management (ICZM) to address intersectoral policy impacts. However, challenges arise from a top-down approach, similar to issues faced by Bangladesh. The exclusion of local communities from decision-making impedes timely feedback, hindering citizens' ability to contribute constructively to policies. A notable concern involves the merging of sustainable goals with economic welfare, leading to unintended consequences for fishing-dependent communities (Nandi, 2014; Dewi and Bijker, 2020).

In the European context, one noteworthy project that has ensured public participation in the coastal management process is the SCORE project. It introduces Coastal City Living Labs (CCLL) as a novel concept to address climate change impacts on coastal cities. The incorporation of local expertise from city partners in the CCLLs provides context-specific knowledge, acknowledging potential biases in perceptions and scientific findings. (Laino and Iglesius, 2023). In India, The concept of "integrated coastal management" is central to the management of coastal zones and ocean areas (Telave and Chandankar, 2021).

2.2. Salty urbanism: a strategy for coastal management

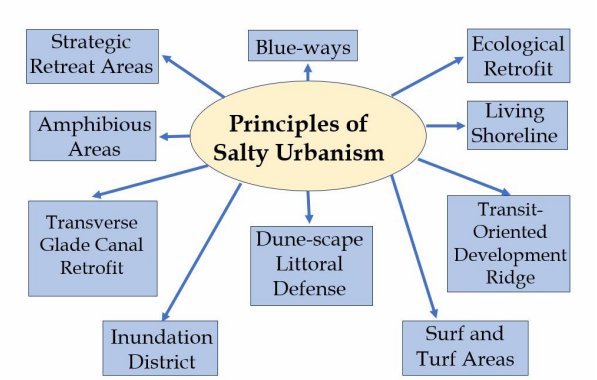

Fig. 1. Salty urbanism: urban adaptation strategies adopted in South Florida, U.S.A. suggested by Dr. Tim Beatley (Source: Author).

The term "salty urbanism" is relatively new and its origin is not attributed to any one specific person or organization. It is an emerging concept that has gained popularity in recent years owing to its rootedness in the principles of 'working with nature' (Fig. 1). It describes how natural and artificial coastal features can reduce the unintended consequences of coastal erosion, sea level rise, and flooding and is aimed at enhancing the resilience of coastal communities and ecosystems. The term was first introduced in the academic literature in 1999 by Dr. Tim Beatley, a faculty member specializing in sustainable communities at the University of Virginia, in his book "Blue Urbanism: Exploring Connections Between Cities and Oceans," Beatley explored the relationship between urban areas and the oceans, and how coastal cities can be designed and managed to promote sustainability and resilience (Beatley, 2014).

The term salty urbanism started to be a mainstream strategy for coastal area

development in the year 2018 when the urban design firm FL BROOKS + SCARPA located in Los Angeles, United States of America won the American Institute of Architects (AIA) Award for their proposal under the same title in collaboration with Florida Atlantic University, University of Southern California, and the University of Kansas. The study focused on the North Beach Village neighborhood in Fort Lauderdale, Florida, renowned as the 'Venice of America' for its extensive 300-mile coastline (Ariza *et al.*, 2014). This neighborhood served as a case study for the project. Along the coast of this city, a large number of industries depended on seawater for their operation. Working under the larger threat of 490 communities in major American cities getting chronically flooded due to the impact of climate change by the year 2100, the salty urbanism project introduced a novel framework for urban design, presenting innovative approaches and concepts that incorporated ecosystem services with structural measures. It provided several toolboxes for addressing various coastal threats in vulnerable South Florida and to reap the potential of waterfront-cityscape interaction, the plan proposed development aligned to the specificities of biodiversity networks (Sklar *et al.*, 2021). As commended by the jury of the AIA Award committee: " *The success of these frameworks lies in its nuanced, organic approach which engages the community and universality making them implementable in almost any community grappling with the challenge of rising sea levels. In addition, to focus on green, and streetscape improvements in the immediate future, the adoption of a "green jacket" composed of living shoreline, the proposals incorporated guidelines to integrate building typologies to a salt-tolerant landscape through radical zoning shifts and promoting amphibious building. The proposal initiated and successfully provided momentum to the deliberations on modes and mechanisms that can enable residents of Fort Lauderdale to coexist with, reside on and utilize water resources effectively through ecologically-based infrastructure that promotes functionality and facilitates future growth. and suggested strategies aimed at reconciling ecological demands with the economic aspirations of coastal communities."* Salty urbanism offers essential resilience strategies for a future that is inevitably characterized by ongoing climate change and the rise of sea levels.

It is important to note that while the term "salty urbanism" may be relatively new, the concepts and practices that it represents have been developed and implemented by coastal communities for decades. For example, many coastal communities have long-standing traditions of sustainable fishing practices, resource management, and community-based decision-making that align with the principles of salty urbanism (Beatley, 2014; Huber *et al.*, 2017).

2.2.1. Characteristics and principles of salty urbanism

The principles of salty urbanism include a focus on ecosystem services, community engagement, and adaptive management (Beatley, 2014). Some of the key characteristics and principles of salty urbanism include:

(i) Salty urbanism encompasses a comprehensive approach to coastal hazards, advocating for mitigation strategies rooted in a holistic understanding of the hazard paradigm. This involves considering contextual causes and multifaceted implications. With coastal areas facing increasing threats, a nuanced comprehension of these diverse aspects becomes crucial to

fostering resilience and sustainable coastal development (Graells *et al.*, 2021).

(ii) Implementing sustainable strategies for resilience against coastal erosion and climate change aligns with the principles of salty urbanism. This approach emphasizes environmental justice considerations and integrates ecological and societal factors into coastal management (Dhar and Khirfan, 2023).

(iii) Salty urbanism employs an integrative approach with natural processes and ecosystem-based strategies to address coastal erosion. This design strategy revolves around the utilization of features such as wetlands, dunes, mangroves, and coral reefs to enhance ecological resilience and reduce erosion. It combines both natural elements and artificial structures like breakwaters, seawalls, and engineered reefs to effectively mitigate coastal hazards and stabilize coastlines. These artificial features, constructed from materials like concrete or rocks, are often designed to mimic or amplify natural coastal processes. Additionally, beach nourishment schemes may involve adding sand to widen beaches, serving as a physical barrier between the shore and the ocean, ultimately lessening the impact of waves (Jordan and Frohle, 2022).

(iv) Monitoring and adaptability are crucial characteristics of salty urbanism projects. The projects adopting salty urbanism principles are designed to be adaptable over time, as sea levels and erosion patterns change, to ensure long-term resilience. Regular monitoring and adapting strategies as necessary through continued data collection and analysis are important for the success of projects (Dovie and Pabi, 2023; Pasquali and Marucci, 2021).
(v) The multidisciplinary and holistic approach is a fundamental principle of salty urbanism, emphasizing a comprehensive strategy to address coastal challenges. This approach involves integrating diverse fields of study and considering various factors, such as ecological, societal, and environmental aspects, in coastal management. By combining natural features like wetlands and artificial structures such as breakwaters, salty urbanism seeks to mimic or enhance natural coastal processes. This holistic perspective ensures that coastal erosion and climate change are tackled from a well-rounded standpoint, incorporating scientific, social, and ecological considerations. The principle of a multidisciplinary, holistic approach underscores the need for an inclusive and thorough understanding of coastal dynamics to develop sustainable and resilient solutions(Huber *et al.*, 2017).

(vi) Community participation is an inherent aspect of salty urbanism emphasizes the need to include residents in the formulation of coastal development projects. The involvement of locals will ensure that the resulting coastal management strategies are more culturally and socially appropriate and have greater community support (Burak *et al.*, 2004).

2.2.2. Salty urbanism: advantages over other strategies in reducing coastal erosion

(i) Leveraging natural features like dunes, mangroves, or salt marshes is renowned for their effectiveness in erosion reduction and storm surge protection. Salty urbanism stands out as a coastal management strategy due to its unique advantage of seamlessly integrating these features into urban planning and design schemes, maximizing their benefits significantly (Islam and Ryan, 2016; Palinkas *et al.*, 2022).

(ii) Salty urbanism projects also provide ecological benefits for coastal ecosystems. For example, the restoration of wetlands or mangroves can improve water quality, enhance biodiversity, and support fisheries (Huber *et al.*, 2017).

(iii) Cost-effectiveness and sustainability of salty urbanism projects: Salty urbanism projects are often seen as a cost-effective and sustainable alternative to traditional hard engineering solutions, such as seawalls or revetments. By using natural or nature-based features, salty urbanism projects can reduce the need for expensive maintenance and repair, and provide multiple benefits beyond coastal protection (Turner *et al.*, 1998).

2.2.3. Impact of salty urbanism projects on coastal ecosystems

Principles of Salty urbanism have been applied in various contexts around the world, with varying degrees of success. Table 1 lists some examples of salty urbanism projects and their impact on coastal ecosystems.

These case studies demonstrate the potential for salty urbanism to be effective in diverse contexts. The principal factors that contributed to the success of these projects are effective community engagement, collaboration among stakeholders, and innovative design solutions. In the "Living Breakwaters" project, for example, community members were involved in the design and implementation of the project, which helped build trust and ensure that local values were reflected in the final product. Collaboration among various stakeholders, including government agencies, NGOs, and academic institutions, was also a key factor in the project's success. Finally, the use of innovative design solutions, such as oyster reefs and breakwaters, helped reduce erosion and enhance coastal habitats. Overall, salty urbanism offers a promising approach to reducing the impacts of sea level rise and coastal erosion, while also promoting ecological health and cultural values. However, the success of salty urbanism projects depends on effective community engagement, collaboration among stakeholders, and the use of appropriate design interventions that can prove useful to the local communities. The impact of the above projects which incorporated various principles of salty urbanism on coastal ecosystems has been largely positive, with benefits such as reduced erosion, improved water quality, and increased habitat for marine species. These projects also often provide social and economic benefits, such as recreational opportunities and support for local fisheries. However, care should be taken to avoid any unintended negative consequences on the surrounding ecosystems because of them.

2.2.4. Salty urbanism and community participation

Community participation is critical in the successful implementation of salty urbanism projects as it enables the participation of local communities and their knowledge, skills, and resources in developing and implementing effective solutions. Table 2 lists the various theoretical frameworks under which salty urbanism projects can formulate community involvement strategies.

2.2.5. Community participation: challenges and opportunities

Community participation is very important and successful coastal management.

Table 1. Salty urbanism projects and their impact on the coastal ecosystem (Source: Author).

S. No.	Salty urbanism project	Description	Impact on coastal ecosystems
1	Living Breakwaters (Marrone *et al.*, 2019; Martin, 2021)	Construction of offshore breakwaters using concrete and natural materials to create habitats for marine life	Reduces coastal erosion, mitigates storm surge impacts, and provides recreational opportunities for the local community
2	Oyster-texture (Michaelis *et al.*, 2020)	Utilizes oyster reefs to reduce erosion, enhance marine habitat, and improve water quality	Enhances habitat for other marine species, acts as a natural water filter, improves water quality and clarity
3	The Sand Engine (Luijendijk *et al.*, 2017; Briere *et al.*, 2018)	Large-scale placement of sand to build up natural dunes and beach systems, reducing erosion and increasing habitat	Reduces erosion, increases habitat for beach-dwelling species, popular recreational area for locals and tourists
4	Mangrove Plantation (Naohiro *et al.*, 2012)	Restoration and protection of mangrove forests	Acts as a natural barrier against damages brought by erosion and also provides habitats to many species supporting local fisheries
5	The Coastal Greenbelt (Han *et al.*, 2007)	Creation of a greenbelt along the coastline with native vegetation and dune systems for erosion control and habitat	Protects the land from erosion and storm surges, provides habitat for wildlife, offers recreational opportunities for locals
6	Living Shorelines Project (Palinkas *et al.*, 2023)	Restoration of 3 miles of shoreline using natural techniques in the Chesapeake Bay, USA	Restores shoreline using sustainable methods, enhances ecosystem health and biodiversity
7	The Green Coast Project (Cahyo and Sualia, 2008)	Restoration of over 100 km of coastline in Brazil using a combination of natural and engineered solutions	Restores coastal areas using a sustainable approach, preserves natural resources and biodiversity
8	Mangrove Cover in India (Mugade and Sapkale, 2014)	About 40% of the world's mangrove is found in South East Asia. India has about 3% of the share of the total Mangrove cover that is found in South Asia. Mangrove Cells have been established and numerous projects have been undertaken in these states to protect and restore mangrove natural barriers against ecosystems, which act as a coastal erosion protector	Mangroves protect and restore coastal ecosystems, support biodiversity and fisheries
9	Green-Gray Infrastructure (Wescoat and Rawoot, 2020)	Combines traditional gray infrastructure (seawalls, levees) with natural green infrastructure (wetlands, dunes) in Boston	Enhances coastal resilience, balances infrastructure needs with ecological benefits, protects against erosion and storm surges
10	Sargaalaya (Patel and Ganeshgudi, 2020)	The cultural and tourism center in Kerala, India, was built using natural materials to withstand sea level rise and erosion	Promotes local cultural and ecological values, resilient to sea level rise and coastal erosion, supports sustainable tourism
11	Kudapaduwa Project (Kodikara *et al.*, 2017)	Community-led restoration of mangrove forests and improvement of fisheries in Kudapaduwa, Sri Lanka	Restores mangrove ecosystems, and improves fisheries through sustainable aquaculture practices

Table 2. Salty urbanism projects and their impact on the coastal ecosystem (Source: Author).

S. No.	Theory	Definition	Application
1	Social-ecological systems theory (Refulio-Coronado *et al.*, 2021)	Social-ecological systems theory recognizes the interconnectedness and interdependence between social and ecological systems. It examines how these systems interact and influence each other, particularly in the context of coastal management	Understanding the interactions between social and ecological systems in coastal management, identifying drivers of change and feedback loops, informing management strategies considering social and ecological factors
2	Community-based participatory research (Hegarty, 1997)	Community-based participatory research (CBPR) is an approach that involves collaboration between researchers and community members. It recognizes the valuable knowledge and expertise that communities possess and involves them in the research process	Collaboration between researchers and community members in salty urbanism projects, incorporating community knowledge and priorities in project design and implementation
3	Critical urban theory (Wongbusarakum *et al.*, 2019)	Critical urban theory examines the power dynamics and inequalities that shape urban development and governance. In coastal management, it is applied to identify and address power imbalances among different stakeholders	Challenging power dynamics in coastal management, identifying and addressing power imbalances between stakeholders, and amplifying the voices of marginalized communities in decision-making processes

Local communities' involvement in coastal projects can ensure that local demands are taken into account which in turn makes it easier to win trust, increase awareness and build support (Mathbor, 1997; Butt *et al.*, 2018). However, community participation in salty urbanism projects can also present challenges, such as limited resources, conflicting interests, or lack of expertise. It is important to address these challenges to enhance community involvement and make salty urbanism projects more effective, sustainable, and equitable. One of the main challenges associated with community participation in salty urbanism projects is the lack of resources. Coastal management requires significant financial and technical resources, which may be difficult for communities to access which may lead to unequal participation. In addition, competing interests among stakeholder groups can also present challenges to community participation. For example, conflicts may arise between environmental conservation goals and economic development objectives. Another challenge is the complexity of coastal management and the need for interdisciplinary collaboration. Salty urbanism projects require collaboration between various stakeholders, such as government agencies, scientists, engineers, and local communities. This can be a daunting task, and it may be difficult for communities to fully engage in the process. Moreover, communities may lack the expertise needed to fully understand the technical aspects of coastal management (Edwards *et al.*, 1997).

2.2.6. Strategies for effective community engagement

Effective community engagement requires the use of various strategies, including building trust and partnerships, providing education and outreach, and involving diverse stakeholders. Trust can be built through transparent communication, shared decision-making, and responsiveness to community needs and concerns. Partnerships can also be formed

with local NGOs, businesses, and other organizations to increase community involvement in management initiatives. Education and outreach can help increase community awareness and understanding of coastal management issues, and can also build support for management initiatives. Finally, involving diverse stakeholders can ensure that in decision-making processes, a broad spectrum of perspectives is considered. Despite these challenges, there are opportunities for enhancing community participation in salty urbanism projects. One opportunity is the use of participatory approaches, such as co-design or co-management. Engaging with diverse stakeholder groups is another opportunity for enhancing community participation in salty urbanism projects. For example, indigenous communities may have unique knowledge about the local impacts of coastal erosion. Youth organizations can also play a role in coastal management, as they can bring new ideas and perspectives to the table. Finally, enhancing capacity-building and knowledge-sharing can help empower communities to effectively engage in coastal management processes. This can include providing training on coastal management, creating educational materials, and promoting community-based monitoring and data collection. Overall, the challenges and opportunities associated with community participation in salty urbanism projects are complex and varied. By addressing these challenges and leveraging the opportunities, stakeholders can create more effective and equitable solutions for coastal management (Osore *et al.*, 2022).

2.2.7. Community participation in salty urbanism projects: examples

Table 3 lists a few examples of salty urbanism projects worldwide where significant community participation can be noticed. These projects range from identifying vulnerable areas and developing adaptation strategies to planning and implementing green infrastructure projects (Wu and Barrett, 2022).

3. Methodology

This section of the paper describes the research methodology undertaken for this research.

3.1. Research design and approach

This paper adopts an exploratory research methodology. A literature study is undertaken to augment the existing knowledge repository on coastal erosion and to establish the salty urbanism approach as an effective one in mitigating risks associated with it. Then, the various aspects of community participation within the larger framework of salty urbanism are investigated. Various literature case studies are used to understand the positive impacts of salty urbanism strategies on coastal ecosystems.

A primary case study of Paradeep, a coastal town in the state of Orissa, India is undertaken to understand different aspects of coastal erosion including the role of community participation and other engineering measures employed there in mitigating the risk of coastal erosion.

Interviews were undertaken to grasp the community's perception of salty urbanism concerning coastal development and management. The focus was on identifying the factors that coastal and non-coastal communities perceive as obstacles to community participation in the context of coastal development and management.

Table 3. Community participation in salty urbanism projects (Source: Author).

	Projects	Project Objectives	Remarks
1	Integrated Coastal Zone Management (ICZM), India	ICZM Project in India, launched by the Ministry of Environment and Forests in 2010, aims to reduce erosion along coasts and support the cause of sustainable development. The project incorporates stakeholder engagement, capacity building, mangrove restoration, and beach nourishment techniques to mitigate erosion and protect against storm surges.	The ICZM Project showcases a holistic approach to coastal zone management, integrating community participation in a range of strategies and techniques to achieve sustainable development and ensure coastal protection.
2	Tamil Nadu Coastal Zone Management Authority (TNCZMA), India	The TNCZMA was established in 2011 to manage the highly vulnerable coastal zone of Tamil Nadu, India. It employs an interdisciplinary approach, involving experts from engineering, geology, and ecology, to develop comprehensive strategies, and promote stakeholder engagement, awareness campaigns, and community-based conservation programs.	The TNCZMA establishes the importance of interdisciplinary collaboration and stakeholder involvement in coastal management. Through its initiatives, the authority aims to safeguard the coastal zone and enhance community resilience.
3	Sustainable Coastal and Marine Fisheries Management (SCMFM) Project, India	The SCMFM project, initiated by the Ministry of Agriculture and Farmers' Welfare in 2019, focuses on the sustainable management of coastal and marine fisheries in India. It incorporates stakeholder engagement, capacity building, innovative management techniques, sustainable fishing practices, and sustainable fisheries management.	The SCMFM project plays a crucial role in promoting sustainable practices in coastal and marine fisheries, emphasizing the importance of stakeholder engagement and education to achieve long-term conservation and livelihood benefits.
4	Mumbai Waterfronts Centre, India	The Mumbai Waterfronts Centre is a research and advocacy organization dedicated to sustainable development along the Mumbai waterfront. It employs an interdisciplinary approach, and promotes stakeholder engagement, through awareness campaigns, and community-based conservation programs.	The project showcases the significance of interdisciplinary collaboration and stakeholder engagement for preserving marine biodiversity and promoting environmentally conscious practices.
5	Community-Based Coastal Resource Management Program, Philippines	Community-Based Coastal Resource Management program in the Philippines protects coral reefs and benefits local communities	Community-based approaches empower local communities and foster their active participation in coastal management, resulting in sustainable solutions that address environmental and social challenges effectively. These initiatives recognize the value of local knowledge and collaboration
6	Fostering Adaptation to Coastal Threats program in Ghana	Engages communities in climate change adaptation strategies.	
7	Development post-Hurricane Sandy, New York, USA	Local communities participated in developing adaptation strategies. The project included the implementation of green strategies like planting trees and designing rain gardens to minimize the runoff of stormwater and control floods.	

	Projects	Project Objectives	Remarks
8	Project to address rising sea level, a partnership between Cochin municipal corporation and Indian Institue of Technology, Chennai, India	Local communities participated in identifying vulnerable areas and developing adaptation strategies. The community members contributed their knowledge of local water bodies and developed an effective mapping system to identify the areas that were most at risk.	
9	Flood mitigation in partnership with World Bank, Jakarta, Indonesia	Local communities are involved in developing flood risk maps, early warning systems, and evacuation plans.	
10	Partnership with local universities and community groups for stormwater management, Semarang, Indonesia	Local communities involved in planning and implementing green infrastructure projects	
11	Green infrastructure, Rotterdam, Netherland	Collaboration with local communities in planning and implementing projects, such as the floating community garden	

A sample size of 50 respondents from three categories (Respondents belonging to three categories were interviewed; R1(respondents presently living in the case study area), R2 (Respondents who are not living presently in the case study area but lived in the past 10 years for a minimum period of 3 years) and R3 (Respondents who never lived in case study area or any other coastal area coastal areas) are selected through random probability sampling. 40% of respondents belonged to the R1 category, 40% of respondents belonged to the R2 category, and the rest to the R3 category. Both structured and unstructured questionnaires were used to generate the responses. Face-to-face interviews, telephonic interviews, and electronic surveys through google forms were conducted.

3.2. Case study -port town, Paradeep, Orissa, India

Paradeep, situated at the junction of the Mahanadi River and the Bay of Bengal, is a significant seaport city and municipality in the state of Odisha, India (Fig. 2). It has been a major center of maritime trade for a long time. The town of Paradeep is home to Paradeep Port, a deep-water port that was established in 1966. It was constituted as a Notified Area Council in 1979 and converted into a municipality in 2002. Initially, the municipality consisted of five revenue villages, which later expanded to include 15 villages owing to the increasing population and industrialization. The town is at present an industrial hub supported by Paradeep Port (Nanda, 2011). Some of the major industries utilizing the bulk cargo handling facilities of Paradeep Port are Paradeep Phosphates Limited, Cargill, the Indian Oil Corporation, Bharat Petroleum, Hindustan Petroleum, Indian Farmers Fertiliser Cooperative, and Goa Carbon Limited (Behera *et al.*, 2023).

Pardeep Coast is part of an 80-kilometer-long Paradeep- Dharma coastal stretch, which was adopted by the state of Orissa

in 2010 as a stretch under the ICZMP Project (Mohanty *et al.*, 2008).

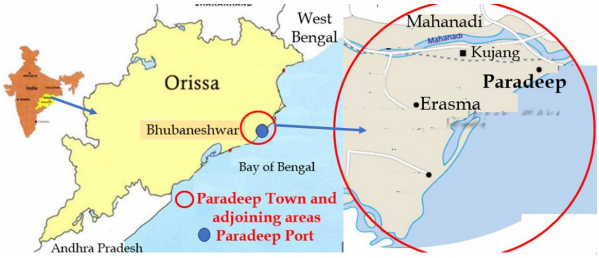

Fig. 2. Location of Paradeep coast (Source: Author).

The concept of Integrated Coastal Zone Management (ICZM), born in 1992 during the Earth Summit in Rio de Janeiro, seeks to balance environmental, economic, social, cultural, and recreational objectives over the long term, all within the limits set by natural dynamics. ICZM is a comprehensive process for managing the coast and emphasizes the integration of all relevant policy areas, sectors, and levels of administration transcending geographical and political boundaries, with the overarching goal of achieving sustainability. It entails the integration of both terrestrial and marine components of the target territory, considering both time and space (Ramesh *et al.*, 2012).

Covering 2448 square kilometers on the landward side, the Paradeep-Dharma coastal stretch includes 1302 villages and 3 urban areas with a population of approximately 12.5 lakh. This coastal section is intricately woven with meandering estuaries from 3 major river systems namely Mahanadi, Brahmani, and Hansua, forming low-lying wetlands, mangrove habitats, and deltaic formations (Mohantya *et al.*, 2015). Many ecologically sensitive areas like Bhitarkanika Sanctuary (home to estuarine crocodiles) and Gahirmatha Marine Sanctuary (hosting olive ridley turtles) define this stretch. Paradeep port, vital for overseas trade, further contributes to the region's significance (Barman *et al.*, 2015).

3.2.1. Coastal erosion: a threat to the town and the port

Coastal erosion in the state of Odisha, in which Paradeep is located has emerged as a critical environmental challenge, impacting local communities and biodiversity. The state's extensive coastline faces severe erosion and has witnessed a significant rise in sea levels, increasing by 9.5 centimeters from 1966 to 2015. Rising sea levels, accelerated cyclones, and a delayed Integrated Coastal Zone Management Plan (ICZM) prepared by the Union Environment Ministry in 2010 have exacerbated the crisis, prompting the need for effective mitigation strategies.

Paradeep has been severely threatened by rapid coastal erosion taking place on the Mahanadi River mouth for the last few years. Traditionally, a fisherman's town was dependent on an agricultural economy to some extent; the town started to transform with the establishment of a port. Nehru Bungalow (primarily a guesthouse for visiting port officials and guests) near the Mohna (The point where the Mahanadi River meets the Bay of Bengal) was the first multistorey building that came up in the town. Near Nehru Bungalow locality, the first port township, Jawahar Guest House, The View Tower (Fig. 3), and a Manmade Park were constructed in due course of time to augment amenities for tourists and create better infrastructures for the residents. At present, all the buildings on the shoreline and the park are facing severe threats of inundation due to the rise in water level and coastal erosion. The land on which the port's foundation

stone was laid in the 1960s has vanished, courtesy of the aggressive sea waves.

Fig. 3. View Tower, Nehru Park: Paradeep, Orissa, India (Source: Author).

The area extending from Mahanadi's stone embankment to the fishing jetty is experiencing continuous erosion, resulting in the loss of over 100 acres of land in the past year. More than 100 trees have also been uprooted and washed away due to erosion, which has only accelerated the process. Cyclonic storms and floods further exacerbate the erosion of the river bank. There are concerns that the View Tower may collapse soon due to erosion, as a significant part of the tower and its restroom area has been swept away by the sea. Also, formerly, the manmade park had a beautiful and vibrant garden with tourist amenities, an open-air gymnasium, and areas for walking, jogging, picnicking, and parking vehicles. Regrettably, due to erosion, the sea has engulfed all of these zones (Gopikrishna and Deo, 2018).

Scholars from the Indian Institute of Technology, Mumbai, India have used climate modeling experiments, for a study to simulate the state of Paradeep. The study predicts an increase in the following parameters; wind speed, sand deposition, wave height, etc. as impacts of climate change which may lead to stronger erosion of the town's shoreline. The altered wind and wave conditions will result in the increased suspension of sediment, leading to significant alterations in shoreline configurations and changes in erosion and accretion patterns along this specific coastline (Mahalik *et al.*, 1983).

3.2.2. Actions for reducing erosion

Despite numerous government initiatives since 2012 aimed at stabilizing the coastline, coastal communities, including Paradeep in Odisha, remain significantly exposed to the threats of rising sea levels and coastal erosion to date. The following describes these measures in the context of the principles of salty urbanism.

(i) Orissa has largely adopted engineering structures to combat the threat of coastal erosion. Deployment of geosynthetics, tube, and sea walls, and break walls are some of the steps taken by the government to mitigate the threats of rising sea levels, storm surges, and erosion. Between 2012 and 2015, Odisha implemented its initial geo-synthetic tube deployment in response to a devastating supercyclone. However, the flawed execution further triggered erosion along the coast and led to the submergence of an active nesting site for Olive Ridley sea turtles.

Seawalls, despite being discouraged by the National Green Tribunal, have been constructed in different places on the Orissan coast including Paradeep. Paradeep attempted to reduce erosion by building a stone embankment in 1982, but it proved ineffective. As a result, the port authorities have experimented with breakwaters and seawalls. Breakwaters are walls constructed at an angle to the shore, creating an artificial harbor that protects an area from wave action and provides safe berthing for vessels Paradeep currently has two breakwaters, one to the north and the other to the south, and is constructed an offshore

breakwater to counter the current erosion. Paradeep has two breakwaters: one to the north, approximately 500 meters in length, and another to the south, approximately 1200 meters long. To counter current erosion, the port authorities are constructing an offshore breakwater that will be 1600 meters long.

The construction of two breakwaters at the Paradeep port has led to coastal erosion due to obstruction to the littoral drift. While the southern side has experienced accretion, the northern side has faced erosion. To counter the erosion, a sand pump was installed on a trestle constructed south of the south breakwater. The purpose was to pump material accumulating on the southern side to the eroding northern beach. However, the trestle was damaged during a cyclone in 1972, leading to a short supply of sand to the northern beach and further erosion (Kumar *et al.,* 2006).

The seawall of about 5 kilometres in length constructed from the root of the northern breakwater along the coast has been successful to a certain extent in preventing the sea from encroaching on the land, but the reflection of waves has caused scouring at the toe of the seawall. The seawall has also proved maintenance-intensive, as erosion continues to occur at a rapid rate. The effect of erosion can be seen in the deepening/scouring of the coast which has resulted in shoreward shifting of the -3 meters and -5 meters depth contours. The sea wall is currently proving to be maintenance-intensive. In 2013, the 180-meter berth inside the Paradeep fishing jetty was washed away due to erosion. To prevent further erosion, the Fisheries Department has undertaken stone packing of the area, and the port authorities are seeking technical assistance to restore the area. Although the construction of these protection structures has increased the economic viability of port operations, it has also changed the sediment movement and accretion-erosion patterns accelerating the latter (Murali *et al.*, 2009; Roy *et al.*, 2018).

A notable example of nature-based intervention to control erosion is the massive mangrove plantation carried near Arakhakuda village in Orissa from 1994-1999. While mangrove restoration and regeneration are globally recognized as effective ecosystem-based solutions, the trial-and-error method used in this plantation, covering an unsuitable area, resulted in immature plants unable to withstand the impact of supercyclone Fani, which devastated the region in the same year. The indiscriminate plantation of mangroves without a scientific assessment of suitability proved ineffective in erosion control and led to the waste of public money.

3.2.3. Community participation in coastal management

The Orissa State Pollution Control Board (OSPCB), established in accordance with the Water (Prevention and Control of Pollution) (Amendment) Act, 1974 by the Government of India, initiated its capacity-building journey among coastal communities in 2010. However, its approach has been more reactive than proactive, focusing on surveillance rather than preventive measures in coastal environments. The board's activities, aimed at coastal pollution control, emphasized the development of surveillance machinery, stricter environmental standards, and compliance monitoring. At the beginning of the ICZM initiative, OSCPB presented

the draft ICZM policy to stakeholders for a discussion in a meeting of the Paradeep Environmental and Social Association, this was one of its one-of-a-kind efforts(Palai and Mandhaniya, 2020).

However, the lack of any future effort in this direction has raised questions about the legitimacy of OSPCB's claim of public participation. Also, the dissemination of information and inclusion of the knowledge of local stakeholders in coastal management policies proved to be inadequate over the years, limiting the effectiveness of public participation (Behera *et al.*, 2023).

OSPCB has also constructed a green facility; the center for Management of Coastal Ecosystem (CMCE) at Paradeep, under the Integrated Coastal Zone Management Project (ICZMP) to raise awareness about sustainable coastal practices. A coastal environmental laboratory at Bhubaneshwar was also set up by OSCPB for the analysis of coastal samples and providing time series data to aid in understanding coastal pollution dynamics.

In Paradeep, involvement in the maintenance of Paradeep ports' properties provides livelihood opportunities to a few local inhabitants e.g. a woman self-help group called 'Swarnamayee' maintains the view tower in Nehru Park, Paradeep, and associated tourist facilities, providing necessary services to tourists.

Though ICZMP since its inception has been involved in improving the livelihood of coastal communities through self-help groups, facilitating alternative livelihoods through integrated pisciculture, dairying, and coir-making activities, direct involvement of the community in decision-making aspects of coastal management including addressing coastal erosion is significantly absent (Palai and Mandhaniya, 2020).

Also, a lack of resources and coordination between different departments such as Paradeep Municipality, Fisheries, and Water Resources departments, Marine Fisheries department, technical review teams, etc. act as a major hindrance at present for framing coastal erosion reduction and arrest policies and their implementation (Mukhopadhyay *et al.*, 2018).

4. Results

This section of the research paper discusses the findings from the literature review and interviews.

4.1. Lessons learned from the literature review

The study on different aspects of coastal erosion suggests that coastal erosion presents various facets, encompassing root causes, mitigation strategies, and social implications. As coastal areas confront escalating threats, a nuanced understanding of these diverse aspects is essential for promoting resilience and sustainable coastal development (refer to section 2.1).

The literature on coastal erosion in the context of climate change and sustainability stresses the importance of adopting sustainable strategies for resilience against coastal erosion and climate change. It calls for a shift from unsustainable practices to eco-friendly alternatives and emphasizes proactive adaptation measures for community viability. Environmental justice considerations are crucial, ensuring equitable protection for vulnerable communities. A holistic,

multidisciplinary approach is advocated for a comprehensive understanding of coastal erosion, incorporating ecological and societal factors. The inference underscores the necessity of sustainable mitigation strategies for both community protection and environmental and social equity (refer to section 2.1.1).

Literature on Coastal erosion protection measures reiterates that alongside the effective and satisfactory coastal protection structures currently in place, safeguarding people, assets, and shorelines from flooding and associated risks, the integration of coastal ecosystems as nature-based solutions is a promising, sustainable, and multifaceted component of coastal protection strategies. This integrated approach is imperative to harmonize the strengths of both engineered structures and natural ecosystems, ensuring comprehensive protection that considers ecological and societal needs(refer to section 2.1.2).

The study also calls for adaptive approaches and tools in coastal erosion management capable of handling the uncertainties that may arise in the realm of coastal environments in the future (refer to section 2.1.3).

Literature on community participation in the domain of coastal erosion suggests that the participation of the public and coastal communities in coastal management is significantly advantageous, legitimizing social and cultural values, enhancing public understanding of coastal dynamics, risks, and management processes, facilitating knowledge exchange and co-learning processes, establishing community trust, avoiding tension and conflict, and enhancing public support for coastal hazard adaptation strategies and related policies (refer to section 2.1.4).

The findings of the literature study outlined above and the principles of salty urbanism listed in section 2.2 harmoniously align with each other, affirming the adequacy and appropriateness of the salty urbanism approach in combatting coastal erosion. Table 4 presented below elaborates on this corroboration:

Table 4. Literature study inferences and principles of salty urbanism: corroboration (Source: Author).

S. No.	Inferences from the literature study	Corroboration with salty urbanism principles
1	A holistic understanding of diverse aspects related to coastal erosion is essential for addressing it	Salty urbanism encompasses a holistic understanding of the hazard paradigm rooted in contextual realities.
2	Eco-friendly erosion protection and proactive adaptation measures along with consideration of environmental justice are required for sustainable and climate-sensitive coastal erosion management	The salty urbanism approach integrates ecological and societal factors and ideals of environmental justice into coastal management.
3	Integration of engineering structures and nature-based solutions based on need assessment is crucial for framing effective erosion prevention strategies	Salty urbanism integrates engineering structure natural processes and ecosystem-based strategies for addressing coastal erosion
4	Adaptive approaches and tools capable of handling the uncertainties that may arise in the future are important for coastal erosion management	Monitoring and adaptability are inherent in salty urbanism projects. The multidisciplinary and holistic approach facilitates adaptation
5	Participation of the public and coastal communities in coastal management enhances public understanding and public support for coastal hazard adaptation strategies	Community participation is an inherent aspect of salty urbanism

4.2. Lessons learned from the interview

Table 5 lists the findings of interviews conducted with the respondents.

The majority of respondents believe that organizing regular community meetings and workshops and establishing a collaborative decision-making process are the most effective ways of engaging and involving local communities in coastal management initiatives (Fig. 8). The most significant barriers to effective engagement of communities in coastal development and management projects were identified as limited resources or capacity, lack of trust in authorities, lack of awareness, sense of responsibility, and interest of community members, coupled with the absence of a well-defined framework for community participation (Fig. 8). A large number of respondents voted for meaningful community involvement in decision-making as the most significant factor, followed by effective communication and outreach and innovative design solutions.

Table 5. Community participation in salty urbanism projects (Source: Author).

S.No.	Survey Item	Response	Discussion
	Perception of salty urbanism about coastal development and management		
1	Awareness of coastal development and management (Fig. 4 and Fig. 5)	86% of the respondents were aware of the term coastal development and management. This indicates a relatively high level of understanding and recognition of the concept among the interview participants.	There is a relatively high level of understanding and recognition of the concept among the interview participants. This suggests that coastal development and management are familiar concepts to a majority of the respondents. While the awareness of salty urbanism is not as high as that of coastal development and management, it still represents a significant portion (34%) of the participants who have some level of knowledge about the concept. This indicates a potential opportunity for education and outreach to enhance awareness and understanding of salty urbanism among the surveyed group.
2	Familiarity with the term salty urbanism (Fig. 6)	66% of the respondents were not familiar with the term salty urbanism. Portion of the participants who have some level of knowledge about the concept.	
	Challenges to coastal communities		
3	Climate change and sea-level rise	45% of respondents identified climate change and sea-level rise as the primary challenges facing coastal communities.	This highlights the recognition of the significant impact of these factors on coastal erosion and other coastal management issues.
4	Limited public awareness and engagement	25% of respondents mentioned limited public awareness and engagement as a challenge.	This suggests that there is a need for increased efforts to raise awareness among the public and encourage their active participation in coastal management initiatives.
	View on community participation		
5	Barriers / Challenges negatively affecting community engagement (Fig. 6)	44% of respondents cited limited capacity or resource crunch as a major barrier to community participation.	Resource mobilization must be treated as an important aspect of community-centric coastal management plans.
6	Importance of community participation (Fig. 7)	81% of respondents believed that community participation is extremely important for the success of Coastal Development and Management projects.	This establishes the importance of encouraging community participation and engagement strategies for addressing erosion and other coastal management issues. The salty urbanism approach becomes highly appropriate for addressing coastal erosion as community participation is one of its basic tenets.

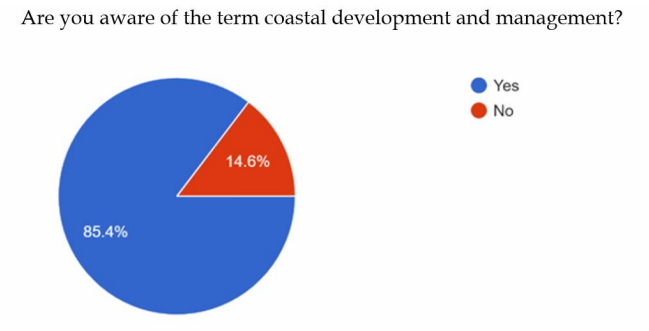

Fig. 4. Interview Response (Source: Author).

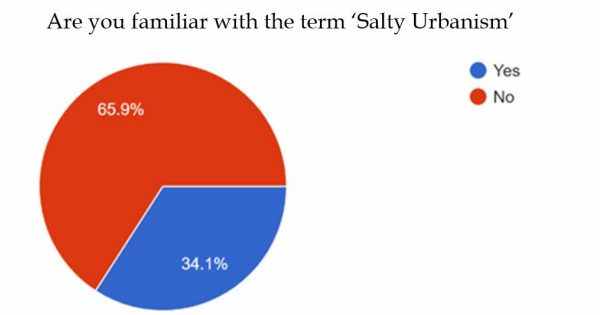

Fig. 5. Interview Response (Source: Author).

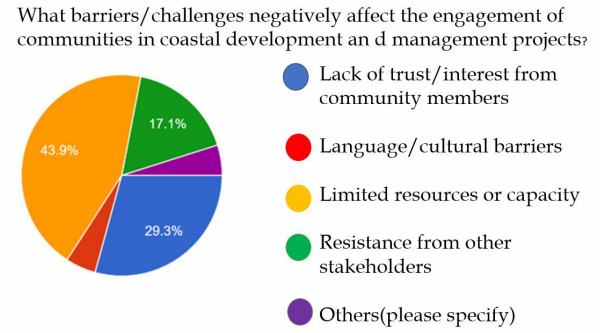

Fig. 6. Interview Response (Source: Author).

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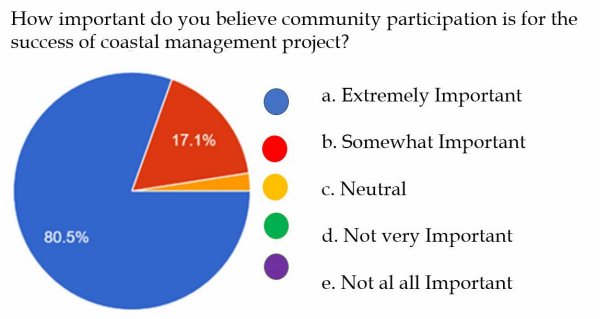

Fig. 7. Interview Response (Source: Author).

Potential risks and drawbacks associated with community participation processes were identified by the respondents. These include politically demotivated and bribed community members may create hindrances in the overall development of the community, local resistance, community disputes, problems due to a lack of knowledge, and misunderstandings. Many times the local community people are rigid with their thought processes or their local beliefs which makes it very difficult to change and work on the project further.

Fig. 8. Interview Response (Source: Author).

Monetization and commercialization of such projects may lead to a competitive environment, which could cause this field to become politicized or become a tool to gain power. This will take away from social betterment and may cause environmental degradation and increase the class divide. Salty urbanism adopts an interdisciplinary approach with not only resource-intensive engineering solutions but also advocates nature-based solutions, which are more forthcoming from the community. This makes it an appropriate approach to coastal development and management where community participation is expected to play a significant role in success.

Several responses were gathered regarding what sustainable coastal development and management projects should focus on. A few are highlighted below:

"It should minimize damage to the environment but must also ensure opportunities and benefits for local communities.

Understanding the context with respect to not just the environmental issues but also community dynamics and its effects on the feasibility of the developmental processes is important."
"Better infrastructure and safety "
"The first and foremost focus should be to protect the environment and to deal with the rising sea levels by minimizing erosion. Coastal development and management projects should keep in mind marine ecosystems as well as the importance of the ocean for the coastal people. Spreading awareness should be a major part of such projects."
"Socio-economic growth of local communities (through capacity building and conscious and voluntary participation), awareness and engagement of local communities for environment conservation must be focused on."
"Educating tourists and others who visit the coast in other capacities is also important for sustainable coastal development."
"Beach tourism "
"Economic growth, social inclusion, Innovative designs to mitigate disaster, and arrangements for alternative livelihood are very important for the Conservation of the coastal ecosystem and the promotion of the sustainable utilization of marine resources."

These responses highlight the importance of minimizing environmental damage while also ensuring opportunities and benefits for local communities. It is crucial to understand the context not only regarding environmental issues but also community dynamics and their effects on the feasibility of developmental processes. Other important aspects include better infrastructure and safety, protecting the environment and dealing with rising sea levels, spreading awareness, socio-economic growth of local communities through capacity building and voluntary participation, and educating tourists and others who visit the coast.

These responses emphasize the significance of promoting community involvement in the sustainable development of coastal areas. Additionally, the other principal characteristics of salty urbanism presented in this paper, such as integration with natural processes, ecosystem-based approaches, community participation, monitoring and adaptability, use of innovative design, emphasis on sustainability, and a multidisciplinary approach, are cited as important determinants sustainable coastal urbanism must focus on (Fig. 8).

5. Discussion

The coastal erosion control efforts by the Orissa government demonstrate a lack of contextual application of measures. In the case of Paradeep, though data related to coasted erosion is available at the state and district level; a comprehensive study listing site-specific causes of erosion, specific data about the local coast, and an understanding of local challenges and opportunities, is notably absent.

The theoretical framework of ICZM implementation plans and Enhancing Climate Resilience of India's Coastal Communities (ECRICC) initiative undertaken by the state of Orissa are commendable for their commitment to environmental justice considerations and the integration of ecological and societal factors into the coastal management framework for resilience against coastal erosion. However, the challenge lies in the piecemeal implementation and top-down procedural approach, which does not offer adequate attention to vulnerable communities. For example, in some coastal areas of Orissa, the combined impacts of dynamic sea currents, intensified by extreme sea level events and cyclones, have changed the salinity gradient of local lakes. These lakes, which traditionally served as

rich reserves of biodiversity, experienced a reduction in fish catch, resulting in the loss of livelihoods for local communities. Unfortunately, the coastal management strategies implemented by the state government seldom addressed such localized issues, rendering the ideals of environmental justice ineffective in practice.

Paradeep has so far erected many engineering structures to control coastal erosion with limited success but has yet to implement nature-based strategies on a large scale and in an integrated manner. Pardeep has also experimented with small-scale mangrove plantations and bringing in agricultural reforms to aid salinity amelioration to reign in coastal erosion, but their effectiveness has been far from making any noticeable impact in reducing erosion risk.

Paradeep has constructed numerous sea walls and breakwaters to control erosion. However, these engineering structures are rigid and lack adaptability. Furthermore, erosion measures lose their adaptability due to the incremental or need-based strategy, which is not favored by the current bureaucratic system that sanctions such measures. Monitoring is piecemeal, and this approach does not support the adaptability of the engineering measures adopted.

Studies on coastal erosion in Paradeep primarily focus on climate data, hazard data, engineering knowledge for erosion mitigation, agricultural policies for salt amelioration, hazard forecasting, early warning systems, and the disruption caused to the livelihoods of local communities affected by hazards. However, the influence of social and cultural peculiarities, urban planning aspects, the potential of community knowledge and participatory realms, and the integration of sustainability aspects in coastal erosion-related risk and hazard documentation and mitigation is largely absent from scholarly works and policy documents. This suggests a gap in multidisciplinary collaboration regarding the comprehensive understanding and management of coastal erosion issues.

The level of community participation in addressing coastal challenges including coastal erosion is very minimal in Paradeep. Although the CMCE building achieved a platinum LEED (Leadership in Energy and Environmental Design) rating and the coastal environmental laboratory at Bhubaneshwar has produced several valuable research publications, they did not aid the advancement of knowledge related to sustainable coastal management practices among community members due to limited accessibility and lack of integration in the knowledge dissemination network.

6. Conclusion

In light of the aim to promote the appropriateness and importance of salty urbanism as a strategic response to coastal erosion hazards, the findings from the literature review align significantly with the objectives of this paper. The comprehensive exploration of various aspects of coastal erosion underscores the complex nature of this challenge, emphasizing the need for integrated and sustainable solutions.

The findings affirm that salty urbanism is not only an appropriate but also an essential strategy for addressing coastal erosion hazards. Its alignment with sustainable practices, integration of nature-based solutions, adaptability, and emphasis on community participation position salty urbanism as a

comprehensive and effective approach. In the context of Paradeep, where the study is focused, the literature on community participation gains significance. Recognizing the community's role becomes imperative for the successful implementation of salty urbanism, ensuring that strategies are tailored to local conditions and garnering community support for resilient coastal development. The advantages of involving the public and coastal communities in coastal management, such as legitimizing cultural values and enhancing public understanding, resonate with the local context. Considering the paucity of data specific to the Paradeep coast, as mentioned earlier, community participation becomes paramount in filling information gaps and tailoring solutions to the unique needs of the local community.

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