



COMMUNITY-ORIENTED RIVERFRONT DESIGN FOR FLOOD RESILIENCE: A CASE STUDY OF THE PUZHAKKAL RIVER, THRISSUR

¹Lakshmi P S, ²Hudha Abdul Salam

¹15th Year B. Arch Student, ²Assistant Professor

^{1,2}Department of Architecture and Planning,

^{1,2}TKM College of Engineering, Kollam, Kerala, India.

Abstract : Urban riverfronts are significant ecological and social assets, yet a vast majority of them in India faces degradation due to unplanned development, encroachment, and inadequate flood management. This study addresses the gap between flood management practices and inclusive public space design along urban riverfronts by focusing on community-oriented design strategies. The main goal is to identify design frameworks that enhances flood resilience and quality of life of the urban population, using the Puzhakkal River in Thrissur as a reference case. The methodology involves a comprehensive secondary study of existing riverfront development case studies of similar contexts, such as the Sabarmati Riverfront in Ahmedabad and the Yangpu Riverfront Greenway in Shanghai. A site study of the Puzhakkal Riverfront was conducted, including interviews to gather public experiences and concerns about floods and community engagement. The site study confirms that the riverfront is a critical zone where unregulated urban sprawl from Ayyanthole directly compromises the flood-mitigation capacity of the Puzhakkal Padam (Kole Wetland), leading to ecological degradation and an unaddressed community demand for safe, resilient, and multi-functional public recreational space. The findings of the study are a set of design recommendations that can transform urban riverfronts into active public spaces that are not only flood-resistant but also socially vibrant. The framework includes concepts such as GBI integrated promenade system, bioswale integrated filtration system, adaptable public spaces, and landscapes designed to manage floods, and promote community engagement. By utilizing these concepts, similar cities and riverfronts can revitalize neglected riverfronts and create accessible spaces that bring people together while protecting against floods. Further research could focus on more detailed engineering studies to refine these concepts.

Index Terms - Riverfront development, Flood resilience, Community-oriented design, Puzhakkal river, Urban riverfront

I. INTRODUCTION

In early days riverfronts used to be a place where settlements were based on, where human activities and community interactions were centered. As some of the most significant natural entities, rivers have played a crucial role in human civilization, particularly in India, where cities like Benares, Patna, Ahmedabad, and Delhi have emerged along their banks. (*Urban Kaleidoscope: Riverfront Development: Implication, Challenges and Way Ahead, Fourth Edition - People's Resource Centre, n.d.*) Historically, these urban centers were developed in harmony with their rivers, fostering communities that relied immensely and contributed to the health and quality of these waterways. However, with urbanization rivers have been progressively channelized and degraded, leading to poor water quality, loss of biodiversity, and increased flood risks — a condition known as the *urban stream syndrome*. (Guimarães et al., 2021) In response to which there emerges a substantial requirement for the development of these riverfronts to maintain their quality and usability. Riverfront Development refers to the strategic planning, design, and utilization of land along riverbanks, aiming to enhance urban landscapes, promote economic growth, and improve public access to waterfront areas. (*Riverfront Development, n.d.*) It includes a wide range of activities like the construction of public parks, commercial and residential buildings, cultural institutions, and recreational facilities, to make use of the aesthetic and economic potential of riverfronts while often also addressing environmental and flood concerns. The rapid urbanization in India has introduced significant challenges in managing and sustaining urban environment with over 70,000 urban waterbodies and multiple rivers traversing the urban landscape, the initiative for waterfront development in the cities is critical for harnessing the potential and reviving the lost connections between the water resources and people (Prasad et al., n.d.)

A high-quality waterfront not only boosts urban water tourism but also has a positive impact on mental well-being. (Hin & Wuijts, 2021). Therefore, there is a necessity to enhance the standard of urban rivers and the adjacent environment. (Wang et al., 2020). To promote urban water tourism, it is essential that the riverfront is aesthetically pleasing (Simons et al., 2023). Rivers are naturally dedicated to providing ecological, recreational, and aesthetic benefits but urban rivers often lose these qualities due

to various interventions. In response, there exist a major change in stormwater management, from purely functional solutions to ecological approaches focused on restoring natural condition of the river.(Guimarães et al., 2021) Global examples, such as the Quaggy river and Wandle park projects in London, and the Matanza-riachuelo River project in Argentina, shows various riverfront restoration approaches. Despite their limitations, these efforts demonstrate that even partial restoration/efforts can improve water quality, reduce flood risk, and enhance urban life.

The Puzhakkal river in Thrissur, originating from the Peechi reservoir, is a prime example of an urban riverfront that is being neglected and facing decline despite its immense potential. The river, situated in the rapidly urbanizing area of Thrissur city is facing several issues like seasonal flooding, poor waste management, and inadequate drainage infrastructure. This has limited its role as a community asset. However, its proximity to several major locations like Shobha city mall, Thrissur collectorate etc and the natural peaceful setting offers opportunities for a better, accessible riverfront that contributes to everyday community interaction and wellbeing. The growing tourism initiatives like the Puzhakkal river tourism Village, offers a timely opportunity to reimagine the river as a vibrant civic space that also functions adaptively during floods (*Puzhakkal River Tourism Project to Be Ready before Onam*, n.d.) This study focuses on conducting studies on the urban riverfronts and identifying frameworks that can transform them into vibrant spaces with inclusive, multifunctional public spaces, using the Puzhakkal riverfront as a case example.

II. METHODOLOGY

The research follows mixed approaches, integrating literature review, case study analysis, and site study to develop strategies for successful riverfront design. The initial phase involved a Literature Review of academic papers, and books to form a surface level understanding of the challenges of flooding, trends in waterfront development, and the importance of community engagement. This was followed by a case study analysis on the Sabarmati riverfront in Ahmedabad and the Yangpu waterfront greenway in Shanghai looking at what problems they faced, what strategies worked, and how local communities were affected. The last phase is focused on a site investigation of the Puzhakkal riverfront, which integrated secondary data collection (flood history, mapping of flood-prone areas, and currently existing strategies) with primary research using local data and informal interviews with residents to gain first-hand insights. These interviews were essential in analyzing public experience, residents' concerns, and making certain that the final design suggestions are grounded and responsive to local needs.

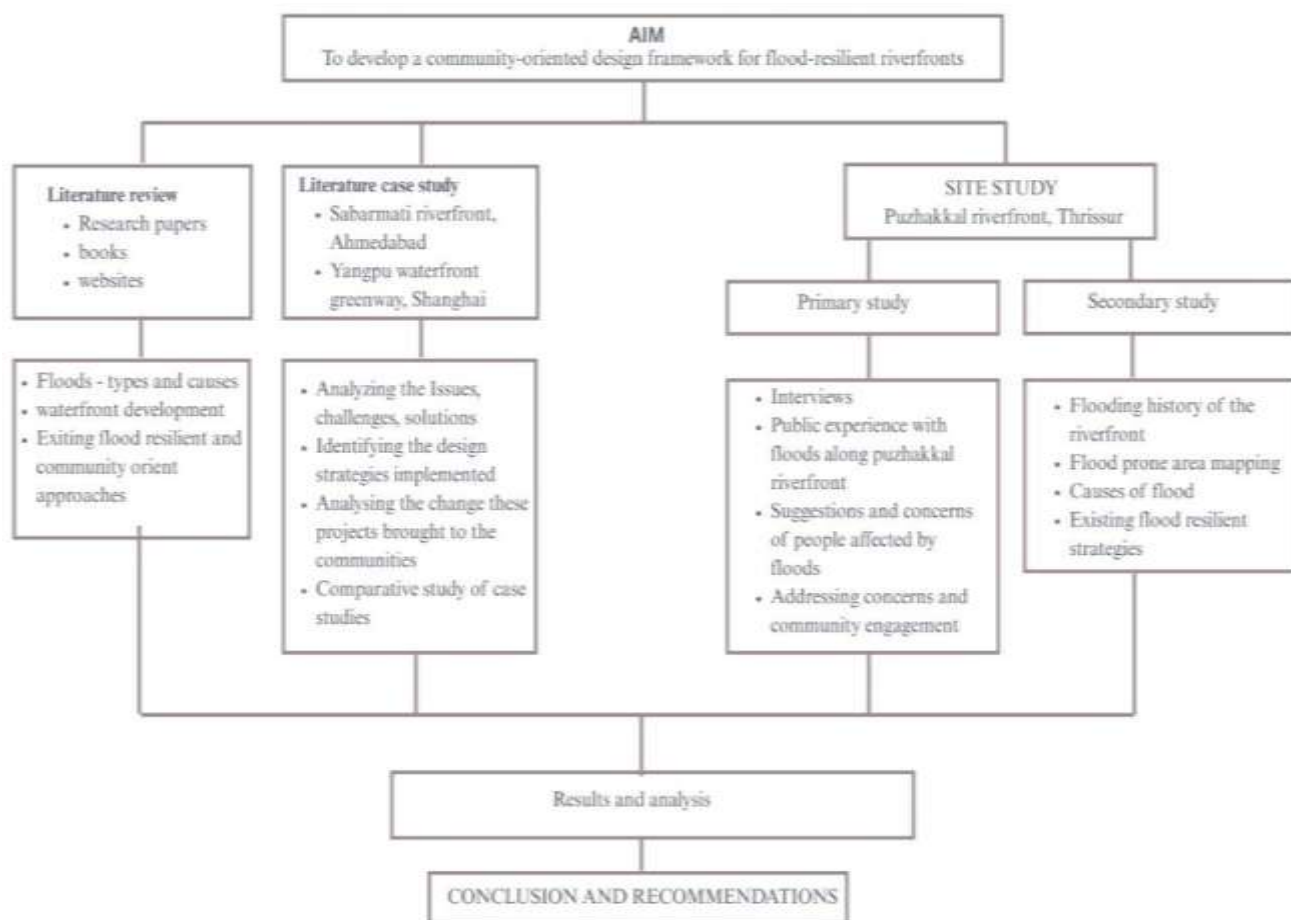


Figure 1 Detailed Methodology showing the steps involved in the study.

III. LITERATURE REVIEW

The successful redevelopment of urban riverfronts is more about prioritizing social life of the community and ecological health above functional or monumental engineering. This review synthesizes key concepts across urban design and flood management, establishing the theoretical foundation for a community-oriented, flood-resilient approach.

3.1 Human Scale in Urban Waterfronts

The human-scale is a concept which is key in design and execution of urban public space. (Gehl & Jan 2010) Give emphasis on the human-scale approach, where spaces are designed to treat the human dimensions gracefully. Gehl argues that

waterfronts must give priority to everyday social life, accessibility, and community engagement over monumental form-making. The book pinpoints how the success of urban public spaces depends on their ability to encourage everyday social interaction and accessibility. A case study example illustrating this concept is the reopening of the Arhus River in Denmark in 1998. Since its transformation from a covered thoroughfare to a pedestrian friendly recreational area, the river has become the most popular spot in the city. This shift has had a positive impact on real estate prices alongside its banks, spiking them up to their highest levels. This demonstrates a direct correlation between human-centric design, public desirability, and economic value. Supporting this concept, (Sivapalan et al., 2012) argue that managing floods is not merely engineering, but it is also learning about how the river is being utilized, altered, and reacted to by the community. These studies highlight why there is a place for community-led design interventions in the context of urban riverfront.

3.2 Integrating Flood Resilience through Ecological and Adaptive Frameworks

Flood control measures are increasingly influenced by modern concepts and techniques that offer better flood resilience. And the traditional control measures are being replaced by these emerging new techniques and theories. Several contemporary theories and concepts highlight this shift:

- Natural systems such as wetlands, vegetation buffers, and restored floodplains are being used for their potential to reduce floods while enhancing public spaces. (Cohen-Shacham et al., 2016)
- Ecological strategies like riparian buffers, floodable parks, and wetland restoration offers both flood protection and public amenity. (Perini & Sabbion, 2017)
- The ‘Sponge City’ initiative of China, illustrates the capacity of vegetated systems, infiltration zones, and distributed water storage to enhance urban flood resilience. (Hamidi et al., 2021)
- Concepts like Bioswales and rain gardens
- Floodable parks and stepped embankments have been successfully used in projects like Rotterdam’s benthemplein water square (*Watersquare Benthemplein, Rotterdam — DE URBANISTEN*, n.d.) and New York’s Big U (*PROJECT PAGES: THE BIG U - Rebuild by Design*, n.d.) which help reduce flooding in urban rivers.

Together, these frameworks establish that riverfront development should consider flood resilience as a primary interest in redevelopment projects.

3.3 Literature case studies

In order to translate theoretical concepts into practical design, two case studies with similar context, the Sabarmati riverfront in Ahmedabad and the Yangpu waterfront greenway in Shanghai—were compared based on their different approaches to development and resilience.

Selection criteria

The selection of case studies was based on a set of parameters to ensure a level of relatability with the selected site. They include contextual similarity, flood resilience, ecological restoration and creation of engaging public spaces.

The two selected case studies were chosen based on the following criteria:

- Geographical and climatic similarity
- Urban context
- Approach to flood resilience: Emphasis was placed on cases that demonstrate innovative strategies for flood mitigation (e.g., hard vs. soft infrastructure) while integrating ecological restoration and public amenities.
- Community and social relevance: Cases involving community engagement, accessibility, and multifunctional public spaces
- Data availability: Projects with documented outcomes

Sabarmati riverfront development, Ahmedabad

The Sabarmati River is a monsoon fed river that has been an integral aspect of Ahmedabad city and flows through the city dividing it into eastern and western halves. It has throughout the years been a major source of water at the same time a hub to cultural and recreational activities. The area along the Sabarmati River used to suffer from regular flooding, posing a significant risk to the city and its residence. During monsoon seasons, uncontrolled water surges would often cause widespread inundation, leading to property damage, infrastructure-disruptions, and disturbances in daily routines (SRFDCL, 2020). Through the SRFD project, the situation has seen a remarkable improvement. The project has implemented effective flood protection measures that have significantly reduced the risk of flooding.

Yangpu riverfront greenway, Shanghai

The Huangpu Riverfront Development Project in Shanghai represents one of the most ambitious urban regeneration initiatives in China, transforming a historically industrial waterfront into a vibrant, accessible, and ecologically resilient public realm. Initiated as a part of the city’s broader strategy to reconnect its citizens with the river, the project consists of five parts, with a total length of approximately 46.5 km. This study will focus on the Yangpu riverfront greenway which is situated at the eastern bank of the Huangpu River covering a stretch of 1.2 km shoreline.

Comparison

Table 1 The detailed comparison of flood parameters on the selected case studies.

Design strategies	Sabarmati riverfront	Yangpu waterfront greenway
Flood walls	Concrete embankments and retaining walls (specifically, RCC retaining walls and anchored diaphragm walls) have been constructed along both banks of the river for an extended length to protect from rising water levels	Instead of creating a single huge flood wall, it is split into 2 floodwalls to create a dual-level system.
Rain garden	–	Rain gardens are used as part of its green infrastructure strategy to absorb storm water runoff improving water quality and reducing flood risk
Flood resistant vegetation	Incorporated in the green parks and open spaces zoned in the riverfront. Use of native vegetation has prevented soil erosion.	An array of diverse herbaceous plants, including reeds and water -resistant shrubs, mirror the local ecosystem. These withstand floods while improving water quality
Terracing	Applied mainly for two reasons- to improve accessibility and for flood protection.	In order to create a better visual corridor, two levels are created in vertical direction. This in turn reduces the steepness, hence slows down the flowing of water during floods and reduce erosion
Floodplain restoration	Lowering of floodplain is done in order to facilitate space for the river to spillout during the floods	–
Waterfront parks	The riverfront park provided a source of identity to the entire city. Use of native plants, proper zoning of activities and critical infrastructure, incorporation of green spaces are the major features of the riverfront	3-way planning which include rest, replenishment, and basic medical assistance. Walkways, jogging, cycling paths creating a green esplanade alongside the river and prioritizing historical building preservation.

The Sabarmati Riverfront utilized mostly a "hard infrastructure" strategy, featuring the building of wide concrete embankment and retaining wall flood protection, along with the use of terracing mostly for accessibility and flood protection. The Yangpu Waterfront Greenway, however, utilized a "soft infrastructure" and "resilient design" strategy, ingeniously dealing with flood risk by substituting the monolithic floodwall with an innovative two-level system that blended with the landscape to maintain river views. The strategy is further illuminated with the employment of rain gardens and flood-resistant plants to handle stormwater and increase water quality, and the use of strategic terracing to minimize the angle and regulate water flow and erosion.

IV. SITE STUDY

The **Puzhakkal River** is a small significant west-flowing river in Thrissur district, Kerala, originating from the Peechi-Vazhani region and joining the Kole wetlands before draining into the Arabian Sea. It plays an important role in supporting local agriculture, particularly paddy cultivation in the Thrissur Kole fields, and serves as a natural drainage channel for the surrounding urban and rural areas. A stretch of the Puzhakkal River adjacent to the Ayyanthole area and the Puzhakkal Padam—is strategically selected for the study due to specific reasons.

- The core city population is declining (-0.61% growth rate), while the periphery growing and commercializing. The selected riverfront area a prime example of the urban fringe experiencing rapid, often unorganized, development and encroachment. (Devika et al., 2016)
- The adjacent Puzhakkal Padam (paddy fields) are not merely agricultural land, they are classified as functional, man-managed artificial wetlands that serve as the natural drainage system and flood reservoir for a large portion of the city. (Bhavan, 2014)
- The site represents a sensitive area where the pressure of unplanned urban sprawl (from Ayyanthole) meets a critical, low-lying flood-control ecosystem (the Puzhakkal Padam). Which offers a wide range of possibilities for riverfront revitalization.

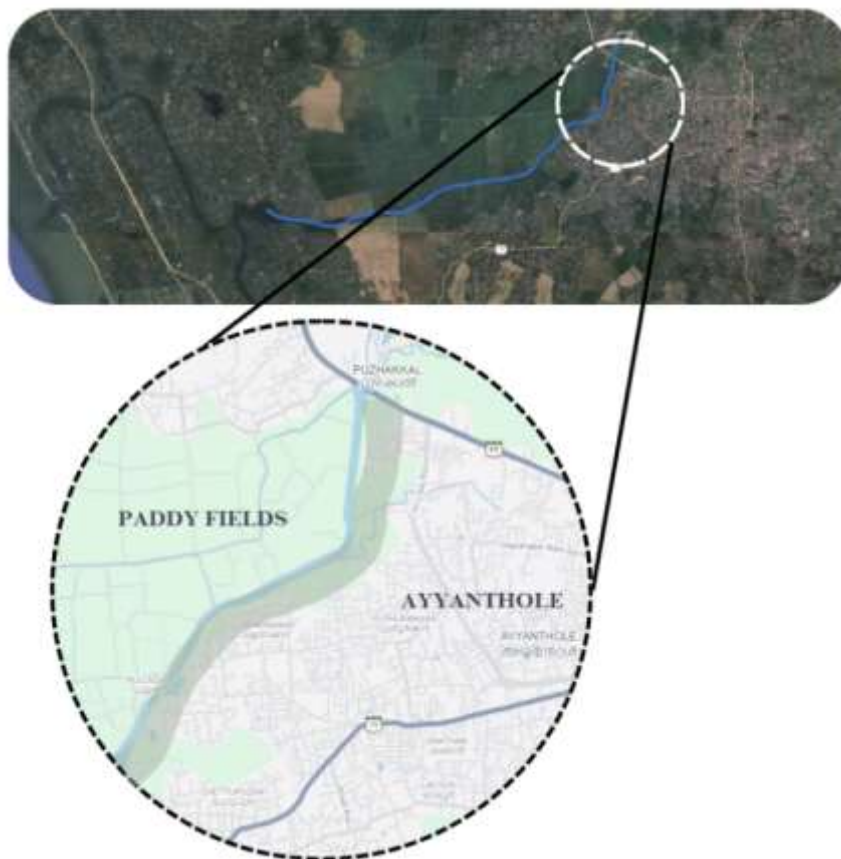


Figure 2 Location of the study area

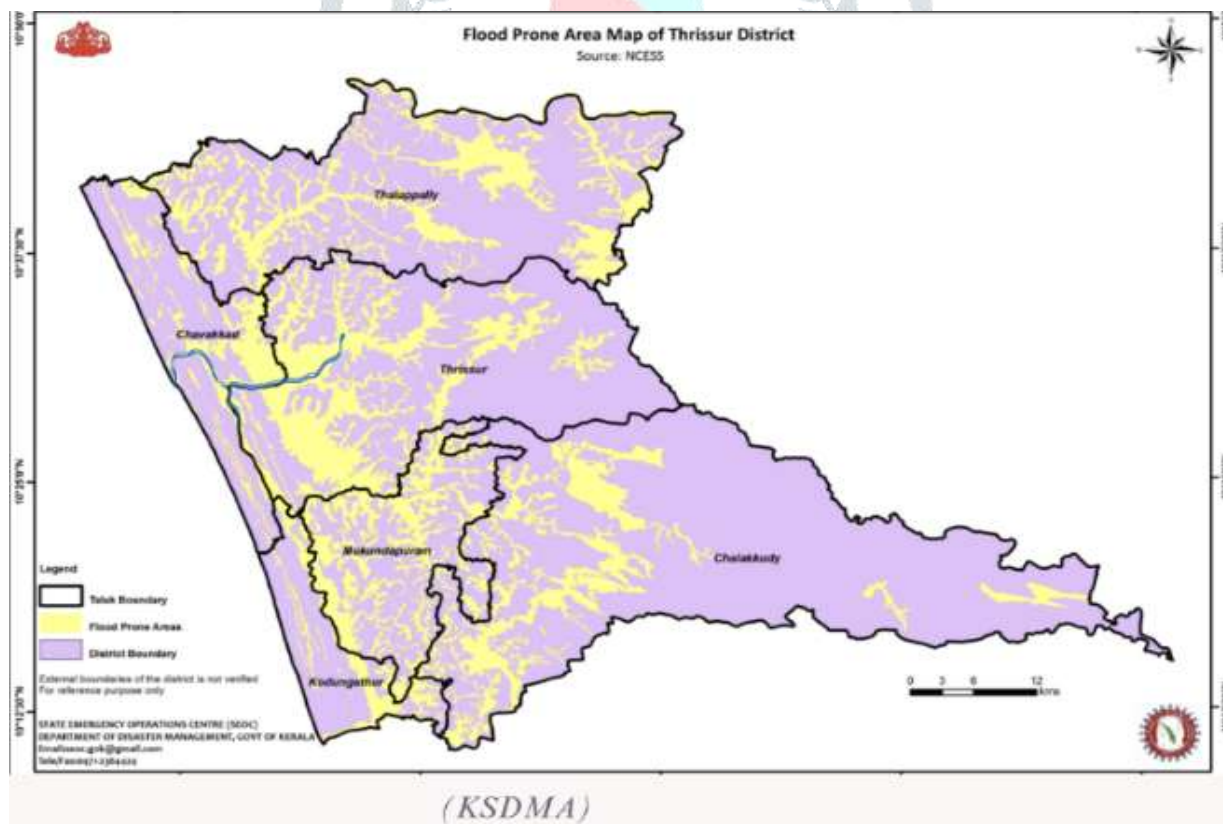


Figure 3 The Flood Prone Map of Thrissur District (prepared by Kerala State Disaster Management Authority (KSDMA))

4.1 Interviews

The local community was interviewed through open-ended questions to gain first hand insights about the existing conditions of the riverfront.

Questionnaire:

- How often do you visit the riverfront area?

- In your opinion, what are the biggest problems or challenges currently facing the riverfront area?
- How have you and your community been affected by flooding from the Puzhakkal River in recent years?
- Do you feel that the current state of the riverfront area satisfies the needs of the community?
- Do you suggest any kind of activities or facilities that you wish to add to the riverfront?
- How would you describe the quality of the water and surrounding natural environment?
- Do you feel safe around the riverfront area, especially during different times of the day or year?
- How would you describe the current accessibility of the riverfront area for multiple users of the community?
- Have you noticed any significant changes to the riverfront area over the years?
- If you could imagine an ideal future for the Puzhakkal riverfront, what would it look like and how would it benefit the community?

V. RESULTS AND ANALYSIS

The site visit revealed the riverfront's critical environment and the challenges it faces. The terrain gently slopes from Ayyanthole region (23-25m MSL) to the low-lying paddy fields (14-16m MSL) forming a natural drainage path. Various observations showed increased discharge of untreated sewage and storm water into the river which has reduced the water quality and biodiversity tremendously. The field observations confirmed that the adjacent puzhakkal padam functions as a wetland and natural flood reservoir for the city during rains.

Interviews with local residents and vendors along the periphery of the river mixed perceptions and experiences about the riverfront condition. Most respondents expressed concern about water contamination and poor maintenance of existing public amenities. Flooding during monsoons was identified as a recurring problem disrupting daily life and damaging property. While people seemed to appreciate the natural setting of the riverfront many highlighted the unsafe and deteriorating edges that restrict recreational use. The community also noted the lack of basic amenities like seating, lighting, dust bins, safe pathways etc. Promised tourism initiatives like houseboat services were never implemented. Accessibility for children, elderly and differently abled people remain limited. Overall, the interviews show a strong community desire for the development of the riverfront area that integrates safety, flood resilience, accessibility and community engagement.



Figure 4 Site Pictures - Highlighting the Present condition of the site and its neighboring areas.

VI. CONCLUSION

The revitalization of urban riverfronts is key in creating flood resistant, socially vibrant communities along the riverfront. Case studies conducted on redevelopment projects around the world showcases the need and impacts of urban riverfront developments. The study shows that the success of urban riverfronts hinges on their ability to create vibrant public spaces that integrate flood resilient principles. Drawing from Jan Gehl's principle "If nothing happens, then nothing happens, then nothing happens", the engagement a public space draws upon itself is directly proportional to the activities they provide. A single activity can spark a chain reaction of engagement which can transform neglected riverfronts into active, inclusive community spaces where people are encouraged to walk, stop, and interact. Site study analysis on the Puzhakkal riverfront revealed that urban sprawl from Ayyanthole and inadequate flood management have degraded the ecological health, reduced accessibility and limited its recreational potential. The findings highlight opportunities like providing a GBI integrated promenade system, bioswales and raingardens integrated filtration system, and activities that encourage year-round engagement of the riverfront. Promoting youth-oriented activities like jogging, cycling and sports not only attract younger demographics but also stimulate economic activity in the peripheral shops creating a chain reaction of community engagement. Furthermore, the study identifies a need for revenue-generating systems that can ensure the maintenance of the riverfront periodically. The research establishes that urban riverfronts can evolve from flood-prone liabilities to active public spaces that enhance the quality of life, boosts tourism and ultimately bridge the gap between flood management and inclusive urban development.

VII. RECOMMENDATIONS

The study recommends a set of concepts for urban riverfronts like Puzhakkal for transforming the riverfront to active community spaces. This may include:

- A GBI-integrated two level promenade system that uses terraced bio retention steps and permeable surfaces instead of concrete floodwalls. Creates a floodable lower promenade area and a flood tolerant upper promenade which can be utilized for various activities

- For riverfronts with a proximity to wetlands (like Puzhakkal river) a series of systems including bioswales and rain gardens can direct and filters stormwater runoff from the city to the wetland borders ensuring that only clean water is discharged into the sensitive wetlands.
 - Integration of diverse activities to maintain community engagement across different seasons. (e.g., Water lily viewing- June to September, paddy cultivation and related activities- December to May)
 - Design of adaptable spaces that can be repurposed during different seasons. (e.g., Water plays zones in monsoons and drr-land sports in summer)
 - Promoting youth- oriented activities like jogging, cycling and sports in-turn stimulate economic activity in the peripheral shops creating a chain reaction of community engagement.
 - Incorporate revenue generating elements like cafes, equipment rental kiosks, pay parking or event spaces for generating funds for maintenance of public infrastructure.
 - Flexible design strategies like flood resistant vegetation, and terraced landscapes
- Further engineering studies need to refine these concepts, creating models that not only mitigate floods but also revitalize riverfronts as socially vibrant, ecologically healthy hubs for urban life.

VIII. REFERENCES

- [1] Bhavan, V. (2014). *Commissioner Kerala State Land Use Board KERALA STATE LAND USE BOARD*.
- [2] Cohen-Shacham, E., Janzen, C., Maginnis, S., & Walters, G. (2016). Nature-based solutions to address global societal challenges. In *Nature-based solutions to address global societal challenges*. IUCN International Union for Conservation of Nature. <https://doi.org/10.2305/iucn.ch.2016.13.en>
- [3] Devika, K. C., Ranjini Bhattathiripad, T., & Kothari, B. S. (2016). Emerging Paradigms for Development Planning: A Case of Thrissur, the Cultural Capital of Kerala. *Procedia Technology*, 24, 1681–1690. <https://doi.org/10.1016/j.protcy.2016.05.190>
- [4] Gehl, & Jan. (2010). *Cities for people I*.
- [5] Guimarães, L. F., Teixeira, F. C., Pereira, J. N., Becker, B. R., Oliveira, A. K. B., Lima, A. F., Veról, A. P., & Miguez, M. G. (2021). The challenges of urban river restoration and the proposition of a framework towards river restoration goals. *Journal of Cleaner Production*, 316, 128330. <https://doi.org/10.1016/J.JCLEPRO.2021.128330>
- [6] Hamidi, A., Ramavandi, B., & Sorial, G. A. (2021). Sponge City — An emerging concept in sustainable water resource management: A scientometric analysis. *Resources, Environment and Sustainability*, 5, 100028. <https://doi.org/10.1016/J.RESENV.2021.100028>
- [7] Hin, J., & Wuijts, S. (2021). Future outlook studies: The use of scenarios to create healthy blue cities. *Urban Blue Spaces: Planning and Design for Water, Health and Well-Being*, 431–450. <https://doi.org/10.4324/9780429056161-20/FUTURE-OUTLOOK-STUDIES-JUDITH-HIN-SUSANNE-WUIJTS>
- [8] Perini, Katia., & Sabbion, Paola. (2017). *Urban sustainability and river restoration: green and blue infrastructure*. John Wiley & Sons.
- [9] Prasad, S. L., Verma, P., Kumar, Y., Chandra, V., Harode, D., Chopra, R., Pandey, V., Singh, C., Barpanda, S., Sharma, A., Sinha, D., Mathur, R., Saravagi, M., Singh, I., & Daksh, J. (n.d.). *Smart Cities Mission Management Unit (SCMMU)*.
- [10] *PROJECT PAGES: THE BIG U - Rebuild by Design*. (n.d.). Retrieved August 12, 2025, from <https://rebuildbydesign.org/work/funded-projects/the-big-u/>
- [11] *Puzhakkal River Tourism project to be ready before Onam*. (n.d.). Retrieved August 12, 2025, from <https://www.onmanorama.com/travel/travel-news/2017/08/25/puzhakkal-river-tourism-project-onam.html>
- [12] *Riverfront Development*. (n.d.). Retrieved October 30, 2025, from <https://design-encyclopedia.com/?T=Riverfront%20Development>
- [13] Simons, S., Kinjawadekar, A., & Kinjawadekar, T. A. (2023). Assessing the impacts of ecological framework of Indian riverfront revitalization projects. *Environment, Development and Sustainability* 2023 26:11, 26(11), 27553–27583. <https://doi.org/10.1007/S10668-023-03771-3>
- [14] Sivapalan, M., Savenije, H. H. G., & Blöschl, G. (2012). Socio-hydrology: A new science of people and water. In *Hydrological Processes* (Vol. 26, Issue 8, pp. 1270–1276). <https://doi.org/10.1002/hyp.8426>
- [15] *Urban Kaleidoscope: Riverfront Development: Implication, Challenges and Way Ahead, Fourth Edition - People's Resource Centre*. (n.d.). Retrieved October 30, 2025, from <https://prcindia.in/publications/urban-kaleidoscope-riverfront-development-implication-challenges-and-way-ahead-volume-4/>
- [16] Wang, C., Xing, R., Sun, M., Ling, W., Shi, W., Cui, S., & An, L. (2020). Microplastics profile in a typical urban river in Beijing. *Science of The Total Environment*, 743, 140708. <https://doi.org/10.1016/J.SCITOTENV.2020.140708>
- [17] *Watersquare Benthemplein, Rotterdam — DE URBANISTEN*. (n.d.). Retrieved August 12, 2025, from <https://www.urbanisten.nl/work/benthemplein>