

## A SUSTAINABLE APPROACH TOWARDS URBAN RIVERFRONT DEVELOPMENT : A CASE STUDY OF MULA-MUTHA RIVER, PUNE, MAHARASHTRA

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### ABSTRACT

Rivers play a vital role in enhancing the identity of any city. Similarly, Mula, Mutha, and Mula-Mutha rivers are the identity of Pune city. When we look at the rivers of Pune closely, we will find the horrendous scenario. The major issues with the rivers of Pune are river flooding, river pollution, partial dry riverbeds, underutilized riverbanks, slum encroachment, and inaccessibility. These rivers are in a vulnerable state due to rapid urban growth. The unplanned growth of Pune city has degraded the quality of its river. The overall perspective towards the river has changed and the city is showing its back to its rivers. These kinds of scenarios have raised challenges for Pune city which is affecting the lives of its citizens. Therefore, we should investigate these issues closely and come up with the best possible compatible solutions for retaining the identity of the city and enhancing the quality of life. The riverfront development along these rivers can overcome these issues and integrates socio-cultural, economic, and environmental activities which are existing along the rivers of Pune.

*Keyword* : Sustainable; Development; Urban Riverfront

### 1. INTRODUCTION

The urban riverfront consists of a natural-artificial blend of landscapes and represents culture (Zhang L Q *et al*, 2019). The characteristics of the riverfront vary along its river stretch (Hofmann M *et al*, 2012). Pune city is blessed with three rivers i.e., Mula river, Mutha river, and the Mula-Mutha river and currently, these rivers are neglected in their existing state and causing an unpleasant environment for the city. The rivers are degraded over the period due to urbanization (Barve and Sen, 2011). Citizens and rivers are disconnected due to several problems such as river pollution (Che Y *et al*, 2012). The Mula-Mutha river is a confluence of the Mula river and Mutha river. The study area is located on the Mula-Mutha combined river stretch in the eastern part of Pune city. The area of the study area is 7.123 km<sup>2</sup> and the length of the Mula-Mutha river stretch within the study area is 5.5 km. The maximum and minimum widths of the Mula-Mutha river within the study area are 248 m and 143 m respectively. The study area has a direct impact

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on the Mula-Mutha river and roads running along the periphery of the study area are acting as an edge for the other side of development (figure 1). The geographical setting of the river is a key factor in the relationship between river and city (Vian F D *et al*, 2021). The natural characteristics of the river are important to understand and how it has been altered by its morphology (Redzuan and Latip, 2016). This research work aims to rejuvenate the Mula-Mutha combined river stretch of Pune city and integrate its adjacent socio-cultural, economic, and environmental activities through appropriate planning strategies for sustainable riverfront development.

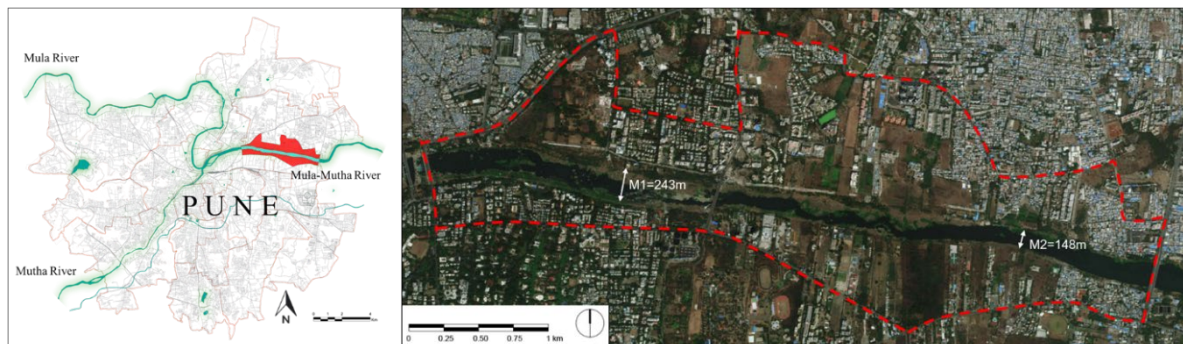


Figure 1. Location and delineation of the study area in Pune city.

### 1.1. Major Issues of Mula-Mutha

In the last three years, river flooding has become a critical problem and a hindrance for Pune's citizens. The second issue is river pollution. Although there are STPs along the river, there are few outlets of nallahs (Grey water channels) that are directly discarded into the river. The third issue is partial dry riverbeds, which cause biodiversity problems, leading to local ecological imbalance. The fourth issue is underutilized riverbanks. However, the potential of these riverbanks is not exploited to date. The fifth issue is slum encroachment. From a visual perspective, such encroachments along the river seem unpleasant. Finally, the sixth issue is inaccessibility, a lack of appropriate access to the rivers.

### 1.2. Need for a Sustainable Approach to Mula-Mutha

Currently, the recreational area of Pune is 20.4 km<sup>2</sup>. As per the census of India 2011, the total population of Pune is 31,24,458. The area of the Mula-Mutha combined river stretch is 1.11 km<sup>2</sup>. According to URDPFI, a 10-12 m<sup>2</sup>/person recreational area is desirable. In the current scenario, the recreational area of Pune is 6.52 m<sup>2</sup>/person. If the Mula-Mutha combined river stretch of the study area is included as a recreational space, then the recreational area of Pune will be 6.88 m<sup>2</sup>/person. In the 2031 scenario, the projected population of Pune is 42,83,714. If the river stretch of the study area is not included, then the recreational area of Pune will be 4.76 m<sup>2</sup>/person. However, if the study area's river stretch is included, Pune's recreational area will be 5.02 m<sup>2</sup>/person. In both scenarios, the Mula-Mutha combined river stretch is enhancing the share of the recreational area at the city level.

## 2. DATA COLLECTION AND MAJOR INFERENCES

### 2.1. Data Collection



The primary data is collected through a tourist survey, household survey, commercial survey, visual survey, and expert opinion survey. In contrast, secondary data is collected through government agencies, private agencies, and educational institutes.

**2.2. Primary Data Inferences**

The household survey found that most people are satisfied with their current residential location, irrespective of the current river scenario. In the commercial survey, it is found that the majority of shops are running just because it is their family business. Very few shopkeepers are satisfied with the current location scenario but are still not ready to relocate for several reasons. Many shopkeepers expect from the authorities that safety and security should be the most critical concern. The tourist survey found that most tourists prefer to visit the riverfront once a week for shopping purposes and usually spend their leisure time in and around the riverfront for less than half an hour. In the expert opinion survey, it is found that the majority of experts think that the environmental feature and the identity of the Mula-Mutha river are significant in the context of Pune. In river restoration, the people's role has varied perspectives fundamentally (Petss J, 2006).

**2.3. Secondary Data Inferences**

**2.3.1. Existing Land Use and Land Ownership.**

The majority of land use in the study area is covered by residential land use followed by transportation and recreation. From an economic perspective, commercial land use seems less than other land use (figure 2(a)). The majority of the land is private land which is a positive sign from an economic perspective (figure 2(b)).

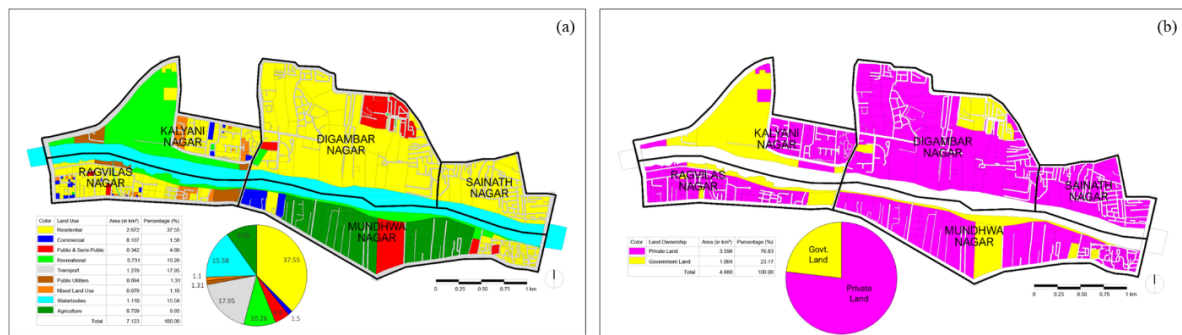


Figure 2. (a) existing land use map and (b) land ownership map (source: PMC).

**2.3.2. Figure-Ground and Socio-Cultural Activities.**

The eastern part of the study area has a densely built area whereas the remaining study area has a sparsely built area. The built-unbuilt ratio of the entire study area is 0.087 (figure 3(a)). Four such activities in the study area enhance the socio-cultural aspects like eateries, religious, crematoriums, and Ganesh visarjan (figure 3(b)).



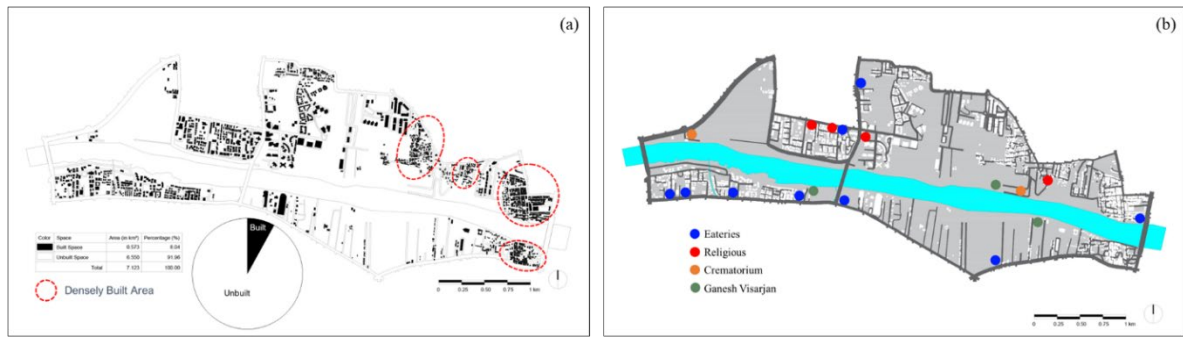


Figure 3. (a) figure-ground map and (b) socio-cultural activities map.

**2.3.3. Urban Design Elements and Road Hierarchy.**

The study area has four districts, i.e., underutilized land, vegetated area, densely built area, and sparsely built area. It has five landmarks, one node, and one edge (figure 4(a)). It also has four ROWs, i.e., 7.5m, 12m, 18m, and 24m (figure 4(b)).

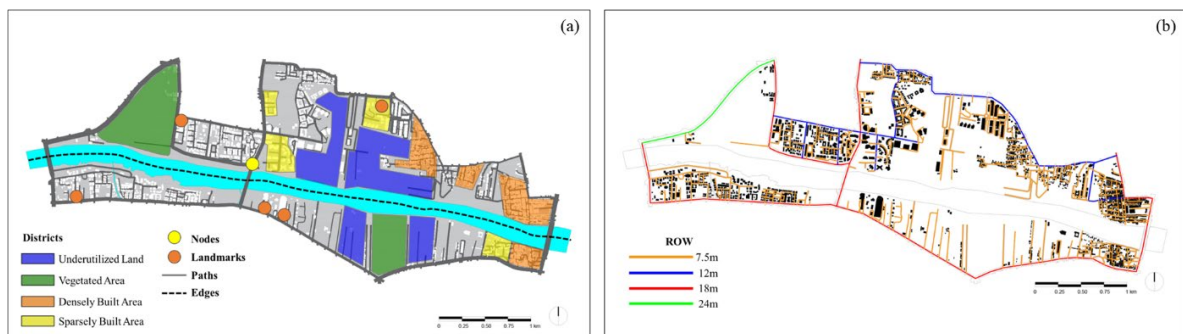


Figure 4. (a) urban design elements map and (b) road hierarchy map.

**2.3.4. Circulation Pattern and Public Transport Connectivity.**

The study area has good road connectivity for vehicular movements and few accessibility points for pedestrians to go closer to the river. There are few on-street parking spots and dead ends on roads (figure 5(a)). Also, it is well connected by public transport, i.e., corridor-1 of BRTS and corridor-2 of MRTS. The BRTS and MRTS routes of Pune run along the north-western side of the study area, whereas the route of the city bus runs along the southern side of the study area (figure 5(b)).

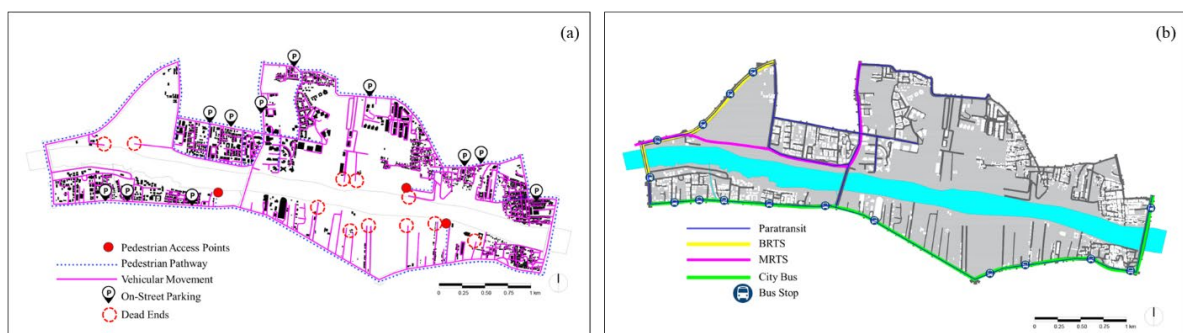


Figure 5. (a) circulation pattern map, and (b) public transport connectivity map.



**2.3.5. Topography and Slope.**

The lowest level of the study area is 456 m, whereas the highest level is 490 m. Few areas are affected by waterlogging during the rainy season (figure 6(a)). Most of the study area lies between 0 to 5% slope, and the areas affected by waterlogging during the rainy season have a slope of 5 to 10%. The maximum slope percentage is observed in the river region, i.e., 10-15% slope or more than that (figure 6(b)).

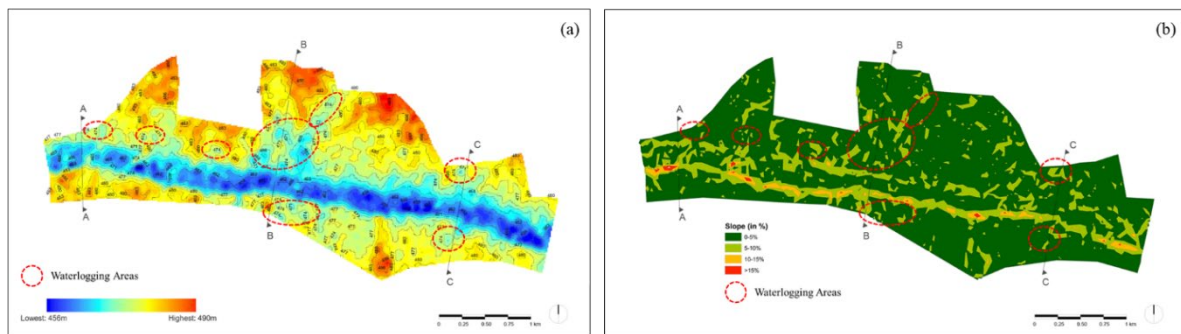


Figure 6. (a) topography map and (b) slope map.

**2.3.6. Highest Flood Level (HFL), River Pollution, STP, and Slum.**

The PMC has defined two lines, i.e., the blue line and the red line. The blue line indicates the 25 years highest flood level, whereas the red line indicates the 100 years highest flood level. The area in the eastern and western part of the study area was affected by river flooding in the past (figure 7(a)). The vulnerability of river flooding is generally quantified based on the enhancement in peak flows and occurrences (Ghosh and Dutta, 2012). The major sources of river pollution in the study area are effluent outfalls, and currently, there are three such outfalls in the intermediate region of the study area (figure 7(b)). Without treating the domestic sewages, they are directly discarded at various points of the river stretch (Suthar *et al*, 2009). In Pune, there are eleven existing STPs, of which only one STP is located near the study area called Bhairoba Sewage Treatment Plant and has a capacity of 130 MLD (figure 10(b)). Due to the inadequate capacity of STPs, the effluents are discharged directly into the river (Sekharan *et al*, 2022). So under the SMART (Sewerage Management Achieving River ecosystem Transformation) mission, the PMC will enhance its capacity by 70 MLD more. The existing slum area is located in Kalyani Nagar, i.e., in the western part of the study area (figure 7(b)). This slum consists of 63 households, and its area is 0.4 hectares. It is not assigned under the SRA (Slum Rehabilitation Authority) scheme, which seems to be a significant problem.

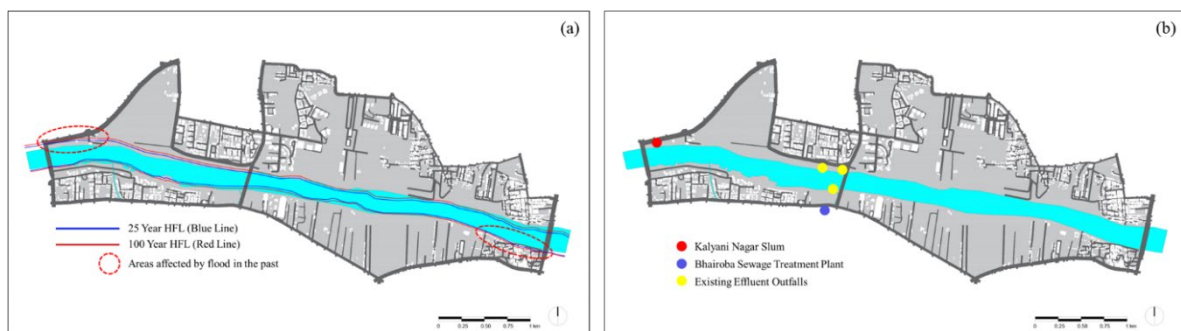


Figure 7. (a) highest flood level (source: PMC), (b) existing effluent outfalls, STP, and a slum.



**2.3.7. Natural Features and Heritage.**

The study area has tangible as well as intangible heritage. The tangible heritage is the Yerwada bridge, whereas the intangible heritage is the Ganesh visarjan spot. Two areas are densely vegetated (figure 8(a)).

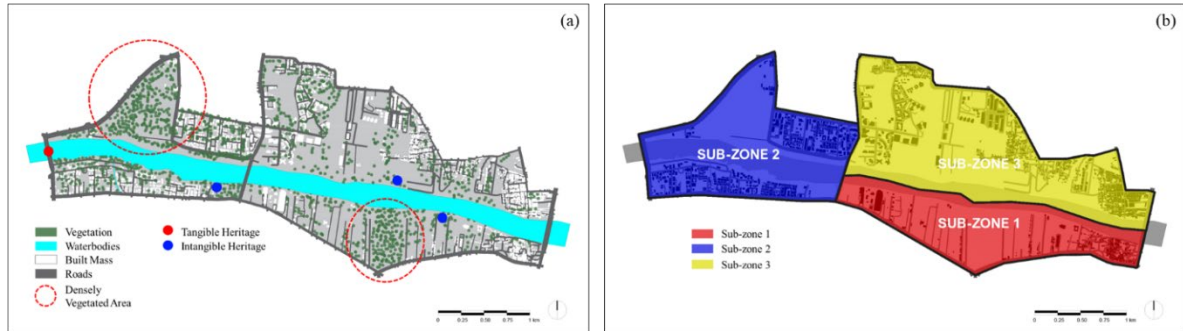


Figure 8. (a) natural features and heritage map, and (b) sub-zones of the study area.

**2.3.8. SWOT Analysis.**

Based on the ratios of the built-unbuilt characteristic, the subzones are delineated (figure 8(b)), and accordingly, the SWOT analysis is done (table 1). The built-unbuilt ratios of sub-zone 1, 2, and 3 are 0.046 (sparse), 0.079 (moderate), and 0.098 (dense) respectively.

Table 1. SWOT Analysis.

Sub-Zones	Sub-Zone 1	Sub-Zone 2	Sub-Zone 3
Strength	<ul style="list-style-type: none"> <li>●Connected with only City Bus.</li> <li>●Direct accessibility to the river.</li> <li>●Presence of socio-cultural activities.</li> </ul>	<ul style="list-style-type: none"> <li>●Connected with BRTS, MRTS, and City Bus.</li> <li>●Higher capacity roads with good ROW.</li> </ul>	<ul style="list-style-type: none"> <li>●Connected with MRTS and City Bus.</li> <li>●Presence of socio-cultural activities.</li> </ul>
Weakness	<ul style="list-style-type: none"> <li>●Less pedestrian friendly along with fast-moving traffic.</li> <li>●Less illumination.</li> <li>●Few areas are very congested.</li> </ul>	<ul style="list-style-type: none"> <li>●Dumping of waste.</li> <li>●Presence of slum.</li> <li>●Presence of effluent outfalls.</li> <li>●Presence of STP.</li> </ul>	<ul style="list-style-type: none"> <li>●Traffic Congestion.</li> <li>●No visual access.</li> <li>●No accessibility to the river.</li> <li>●Has congested areas.</li> </ul>
Opportunities	<ul style="list-style-type: none"> <li>●A good walkway can be developed.</li> <li>●Street furniture can be rebuilt.</li> <li>●A good public place can be developed.</li> </ul>	<ul style="list-style-type: none"> <li>●An opportunity for a heritage walk.</li> <li>●Existing Bird Sanctuary can enhance the environment.</li> </ul>	<ul style="list-style-type: none"> <li>●Can act as a gateway for a central park.</li> <li>●Abundant space for public place development.</li> </ul>



Threat	<ul style="list-style-type: none"> <li>● Affected by floods in the past.</li> <li>● Further development may affect the existing neighborhood.</li> </ul>	<ul style="list-style-type: none"> <li>● Unsafe for pedestrians in case of heritage walk being developed.</li> <li>● Affected by floods in the past.</li> </ul>	<ul style="list-style-type: none"> <li>● Further development might lead to congestion.</li> <li>● Water quality degradation due to STP.</li> </ul>
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**2.3.9. Priority for Development.**

Based on primary data, the development priority has been prepared for all three sub-zones by using the analytic hierarchy process. The analytic hierarchy process (AHP) is "a theory of measurement through pairwise comparisons and relies on the judgments of experts to derive priority scales" (Saaty, 2008). However, while using this method, one can experience interdependence problems between alternatives and criteria (Velasquez and Hester, 2013).

**3. FRAMEWORK AND PROPOSAL**

**3.1 Vision for Planning Strategies**

The vision for planning strategies is based on three aspects, i.e., socio-cultural, economic, and environmental. Based on these three aspects, three perspectives have been developed, i.e., river rejuvenation, city integration, and improved accessibility. These three perspectives have guided this research in formulating broad planning strategies.

**3.2 Broad Physical Planning Strategies Based on Survey Data Analyses**

The vision for broad physical planning is to address all the major issues of the study area such as reduction in risk of flooding, protection of bird sanctuary, slum upgradation, enhance heritage structure, divert effluent outfalls using interceptor lines, enhancing road connectivity, and allot spaces for proposed activities such as plazas, promenades, commercial kiosks, boating, botanical garden, etc (figure 9). These broad physical planning strategies mainly focus on improving visual and physical access to riverfront areas, promoting regional art and culture, providing alternatives to encroachments, creating public space along the bank, and creating an economically vibrant urban area by allowing informal activities. Therefore, comprehensive physical planning is based on socio-cultural, economic, and environmental aspects.



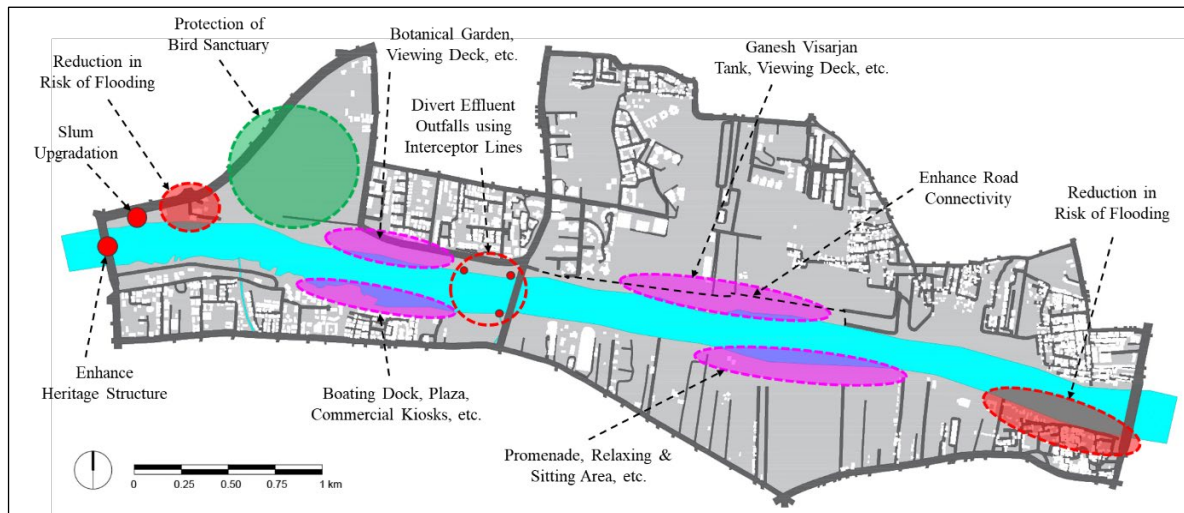


Figure 9. Broad physical planning.

### 3.3. Objectives for Proposal

The first objective is land use, assigning a compatible land use considering adjacent development and zonal characteristics, optimizing the potential of various sub-zones, and fulfilling the priorities derived from the survey analysis (primary and secondary data). The second objective is socio-cultural, creating opportunities for community involvement and bringing the people of Pune city back to the Mula-Mutha riverfront to enhance their identity through various cultural activities. The third objective is economical, augmenting employment opportunities while improving the vendors' current state and those performing traditional occupations along the banks throughout the year. The fourth objective is environmental, reducing the pollution of the river and adjoining areas to enhancing the existing ecosystem through proper waterfront planning strategies and interventions. Finally, the fifth objective is urban design, improving existing places and planning for new public places using urban design principles to create an identity and sense of place.

### 3.4. Proposed Land Use

The land use map is proposed based on future projections and data analysis. The commercial, recreational, and transport land uses have been enhanced, whereas residential, public utilities, mixed land use, and agricultural land uses have been reduced (figure 10). The enhanced land uses will provide opportunities to exploit the economic potential of the Mula-Mutha riverfront, which can be used as a financing instrument for maintaining and running the project's development. In addition, the proposed land use has not intervened in the existing bird sanctuary.





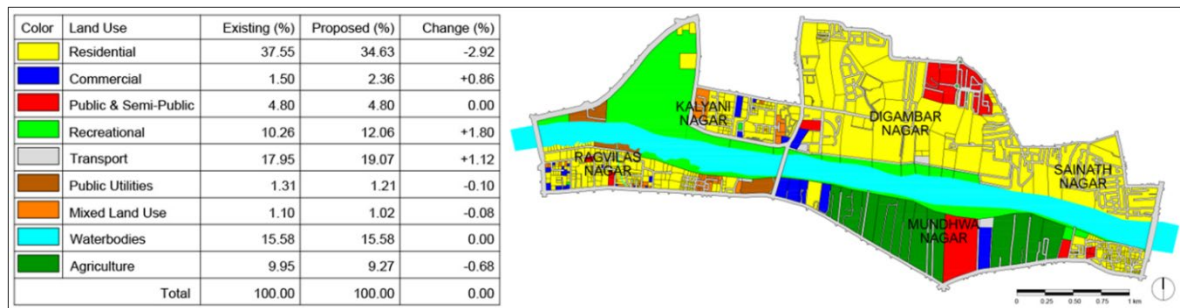


Figure 10. Proposed land use map.

### 3.5. Development Guidelines for the Entire Planning Area

Development and future proposals in the planning area will follow specific development guidelines that will consider aspects like natural features, landform and riverfront, built-up form, urban landscape and open space, transport and circulation. The natural features, landform and riverfront, will consist of river form, riverfront configuration, and significance of waterbody in land use planning. The built-up form will consist of regulations regarding land use, urban fabric, and architecture of the area. The urban landscape and open space will deal with dominant and auxiliary activities for visual appreciation, usage, activity and accessibility of open spaces. Finally, the transport and circulation will provide guidelines for network layout, circulation, parking facilities, and access to the riverfront.

### 3.6. Development Control Regulations

The development control regulations are based on collected primary and secondary data, focusing mainly on floor space index (FSI), ground coverage, permissible height, setbacks, activities, external facades, display structures, and illumination.

### 3.7. Fiscal and Development Management

The expenditure will be based on development, and operation & maintenance. The expenditure of development mainly consists of river restoration, infrastructure development, and proposed development of facilities. The revenue can be generated through leasing out spaces such as commercial shops, eateries & kiosks, exhibition spaces, event canopies, yoga clubs in parks, and other leisure activity spaces. The revenue can also be generated through infrastructure development such as parking fees, entry fees for exhibition space, event canopies, botanical gardens, boating, rowing, etc. The identified funding sources for the overall project are Pune Municipal Corporation (PMC), State Government Funds for Tourism Development, Smart City funds, PPP through BOT basis, and the BSUP scheme (figure 11). The river restoration will consist of cleaning the river, dredging the river, and water retention. The infrastructure development will include roads, pathways, green walkways, stormwater drains, event canopies, viewing decks, lighting, street furniture, and signage. The proposed development will include a pedestrian plaza, open gallery, commercial kiosks, a public park, slum upgradation, and a botanical garden. Mula-Mutha Riverfront Development Corporation Limited (MMRDCL) will be involved in the development works.



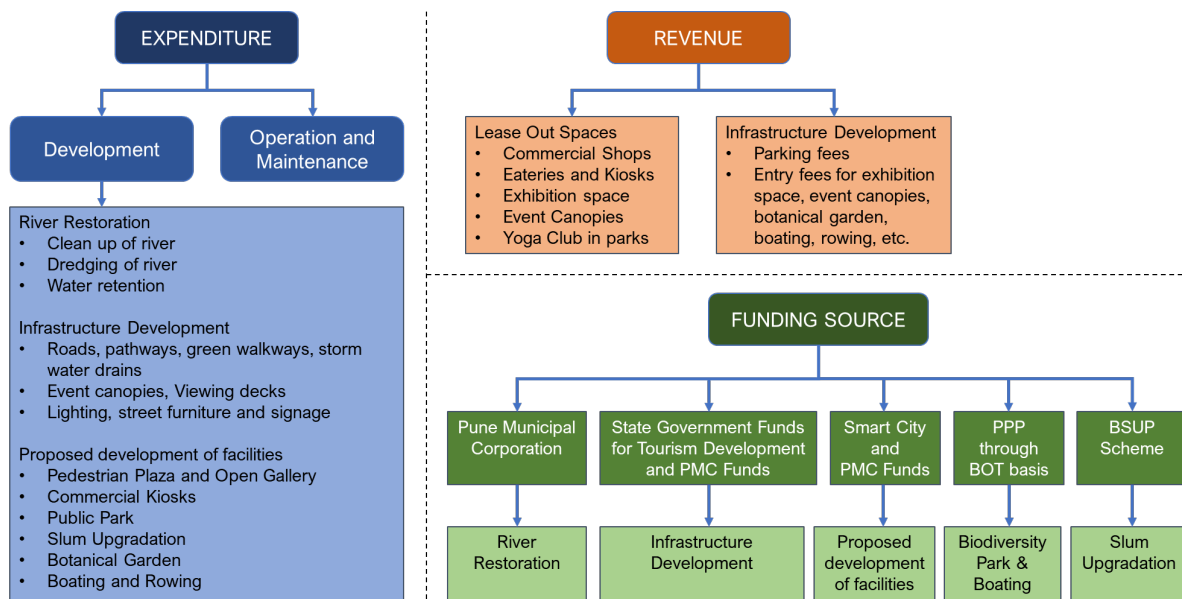


Figure 11. Fiscal management.

### 3.8. Actions towards Sustainable Approach for Mula-Mutha Riverfront

This research work attempts to enhance the socio-cultural, economic, and environmental aspects of the Mula-Mutha riverfront through a sustainable approach. For the socio-cultural aspect, open access is provided to a variety of spaces for social and cultural activities, and these spaces will serve as a unifying factor within the cultures of various communities. For the economic aspect, livelihood opportunities are created for the project-affected people. Finally, for the environmental aspect, significant issues like river flooding, pollution, and ecological imbalance are tackled through appropriate strategies.

#### 3.8.1. Socio-Cultural Aspect.

The accessibility and connectivity between people and the river are enhanced to bring people back and close to the river. Spaces like riverfront promenades, plazas, amphitheatre, botanical gardens, relaxing and sitting areas, visarjan tanks, boating dock, open-air theatre (OAT), viewing decks, and commercial kiosks are proposed for spending leisure time. Therefore, a mix of evergreen and dynamic blooming trees is selected for such spaces. The primary intention of such spaces is to integrate the riverfront with the traditional-cultural activities of Pune, like Shivaji jayanti, dhol pathak, Lavani dance, sangeet natak, Ganesh visarjan, and Malkhamb. So that people can stay connected with the Mula-Mutha river throughout the year. The ancillary spaces like parking and public toilets are also proposed for supporting the primary activities. The heritage structure, Yerwada bridge, is enhanced aesthetically with the help of illuminations for tourist attraction. For the well-being of the slum dwellers, the adjacent land of the existing slum area is proposed for slum redevelopment.

#### 3.8.2. Economic Aspect.

Job opportunities are created for the slum dwellers by involving them in the process of execution and running the project and in the commercial activities proposed on the riverfront. Commercial kiosks are proposed for the existing street vendors. Due to this riverfront development, the value of adjacent private buildings and lands will increase,



and therefore the local government can generate revenue through value-captured finance (VCF).

### 3.8.3. Environmental Aspect.

To reduce the risk of flooding, retaining walls are proposed along the river for the areas that were affected by the flood in the past. For the river pollution abatement, dredging of the river and the interceptor lines are proposed for diverting the effluent outfalls to the STPs. To resolve the ecological imbalance, the plantation of macrophytes and indigenous plants are proposed, and the vertical gardens on metro columns are proposed to blend the columns with the environment of the bird sanctuary. In addition, solar plant installation is proposed to generate energy for the entire planning area.

## 4. CONCLUSION

Since time immemorial, humanity and its cities have evolved around rivers and other water sources. Strengthening the Mula-Mutha riverfront is one of the last hopes for adding resources to Pune city. This resource must be used optimally to suit the city's needs and give back to the citizens the resources they long for. This research work attempts a holistic approach to the development of the riverfront, and it aspires to benefit all levels of society by optimally using land resources. However, due to time constraints, this research has certain limitations, a few of which indicate the way forward and future studies are required for the research. Public participation is attempted through limited surveys, which need to be expanded at each stage. It is essential to involve citizens in the organizational structure of the special planning authority so that proposals and recommendations can be ratified before implementation.

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