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WATERFRONT DEVELOPMENT FOR SUSTAINABLE URBAN PLANNING: A CASE STUDY ON BHAIRAB RIVER, KHULNA

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ABSTRACT

Urban waterfronts have inevitable linkage with sustainable urban living. To ensure sustainable urban development, waterfronts of the cities must be considered carefully while planning for an urban area. This study aimed at finding out the existing problems of waterfront areas of Bhairab River in Khulna City and thereby proposes some effective recommendations to improve the condition of the waterfront areas. Moreover, this study aimed at pointing out the importance of waterfronts and the ways they influence urban development from social, economic, environmental and aesthetic point of view. Performing questionnaire survey this study collected data on social, economic and environmental factors of influencing or representing the waterfront area (e.g. income, housing condition, education level, encroachment, waterlogging). Results of SWOT analysis showed the major strengths, weakness, opportunity and threats of the area. The major strength is the income generated from industries and the weakness is the excessive disposal of industrial wastes. The approved Detailed Area Development Plan (DAP) 2018 of Khulna Development Authority (KDA) has proposed a well decorated railway and tourist information center. Both quantitative and qualitative analyses were carried out to develop a conception about the study area and socio-economic condition of its people. The study found that waterfront areas in Khulna City face a number of problems (e.g. pollution, waterlogging, encroachment, inadequate recreational facilities). Considering existing condition this study provided some policy recommendations subdividing the study area into five zones to organize existing land use following proper planning standards. Consequently, waterfronts in Khulna City will be attractive places for people and that will contribute to the sustainable development of the city.

KEYWORDS: Waterfront development, Sustainable planning, Bhairab River, Khulna City, Khulna City Corporation (KCC), Khulna Development Authority (KDA)

1. INTRODUCTION

These days, creation and development of waterfront is one of the vital themes taken into consideration in metropolis or city design (Oh, Won, Kim, & Oh, 2015). Over the last some decades, rapid urbanization, intensive use of water resources, consumption patterns, life-style, and accelerated industrialization exacerbate the challenges of protecting the environment and addressing concerned problems - contamination, water scarcity, solid waste and biodiversity (UNDP, 2004). Waterfront development makes a cabalistic impression not only to physical residing environment but also to human emotional state (Oh, Won, Kim, & Oh, 2015). Water is a defining pressure that basically shapes the nature of each place it touches. It additionally shows

that waterfronts are unique locations where the land and water meet, in which finite resources embody the special history and character of each community. Urban waterfronts help the cities to be defined as vibrant and dynamic places (Mostafa, 2017). The developed waterfronts are highly visible urban spaces which often make a significant contribution to the character and expression of the entire city (Zukin, 2010; Marshall, 2001). Waterfront areas have enchanting influences over urban residents because of its aesthetic value, transportation facilities, recreation facilities, health issues and tourism attraction. A well planned and designed waterfront can attract potential investment (Davidson & Lees, 2005). The perception of social, economic and environmental benefits from waterfront areas emerged the necessity of redevelopment of the areas according to social needs (Cheung, 2015). "Sustainable urban waterfront development is an important factor in the process of urban transformation and renewal. Sustainability is crucial for cities in the 21st century, and sustainable cities can be distinguished by their strategies for sustainable waterfronts" (Shah, 2017). A positive contextual integration with water front will permit the general public to enjoy the existence of water body in their town (Latip, Shamsudin, & Liew, 2009).

If design solutions for an area can meet a higher standard, it can be beneficial for both existing and designed part of the area (Carmona, 2002). "The concept of sustainable development is an attempt to combine growing concerns about a range of environmental issues with socio-economic issues" (Hopwood, Mellor, & O'Brien, 2005). This concept grasps a major problem involving the extensive dissatisfaction with the sprawl of contemporary urban advancement (Berke, 2015). Some design solutions were given to ameliorate the social, economic, environmental dimension of the area.

A quantitative and qualitative study on Jeddah waterfront exerted some insights about the importance of waterfront development. The findings of the study established the fact that waterfront development influences the economy and environment. It enhances the cultural, social and historical values too (Mostafa, 2017).

Another study in Naples of Italy emerged the importance of landscape and soundscape of waterfront area to bring about changes in the existing scenario that requires improvement. According to this study, landscape and soundscape can make the waterfront area more attractive which will create more opportunities for the area (Romero, 2016).

Amsterdam in the Netherlands, Mediterranean cities of Naples, Venice and Marseille are the examples of successful trading cities that developed along with waterfront areas. Following these European imperial trading trends, many port cities like Mumbai in India, Cape Town in South Africa, Sydney in Australia, Boston in USA, London near River Thames were developed which are the examples of successful waterfront induced development (Davidson & Lees, 2005). Barry waterfront design and access declaration was prepared by Vale of Glamorgan council in 2009 with a purpose to determine the concepts of the improvement of waterfront and those standards are supposed to create a foundation for the waterfront master plan. For making planning technique; it was defined that combined land use, water use, progressive development, integration, experience of location, network, sustainability, design quality, movement and accessibility topics have crucial significance. After completing this plan it was considered as an

exceptional land mark, people came right here for refreshment and passing amusement time. Now a days, this place has been popular to the tourists (Yıldız, Şenlier, & Güzel, 2015).

The south Umpqua River is another example of successful waterfront investment. The metropolis's expectation for this mission was to provide a plan that reconnects the community to one of its greatest resources, the south Umpqua River. The dreams had been articulated by means of city personnel and the Citizen Advisory Committee (CAC) at the outset of the venture and feature shaped the improvement of the plan. It exerted one overarching goal which can guide the implementation of the plan that it must stimulate economic improvement and create jobs, create a memorable, top notch area, growth access to the river's aspect, beautify visibility of the waterfront, and broaden a plan with the collaboration of local landowners and stakeholders. After finishing this challenge the river side was taken into consideration as a mixed-use sector. Humans come here for passing their free time, fishing etc. There are many food courts and a cinema corridor. Many financial development approaches were executed and it solved the unemployment problem (Hansen, 2010).

Khulna is the third largest city of Bangladesh and Bhairab is a significant river of the city which influences the trade, economy and transport of the city to a great extent. A certain portion of Bhairab River was considered as study area and the condition of the waterfront area was assessed. Objective of the study was to investigate the existing condition (social, economic, environmental) of the waterfront area of Bhairab River and to recommend appropriate design solution for the development.

2. METHODOLOGY

To investigate the existing social, economic and environmental condition of the study area, at first relevant cases were reviewed to build concepts about waterfronts and their importance in urban planning perspectives. Bhairab River was considered as the study river and 500 meter area along with the river in both sides of the river was considered as the study waterfront area. Detail field observation was carried out to gather preliminary information of the area which contributed in analyzing the SWOT (Strength, Weakness, Opportunity, and Threat) of the area. Both field observation and Google Earth image helped a lot for making inventory of the site. The list of industries was found out by exploring Google Earth images. To gather knowledge about existing land use of the area, a land use map was prepared using ArcGIS 10.5. To present the land uses and their inter-linkage, cross sections of 500 meter lands accross the river both in eastern and western direction were drawn using Adobe Illustrator. Locational reticules of the cross sectional areas were also presented to make it easy to identify. The assessment of socio-cultural and socio-economic impacts of urban waterfronts was carried out to resemble the contribution and condition of waterfront in Khulna city. The socio-cultural value often reflects the social and political significance of extremely valued places in an urban area like waterfront (Davidson & Lees, 2005). To assess socio-cultural and socio-economic impacts, surveys, interviews, group discussions with local people can be helpful (Sairinen, 2005). Social dimension was identified and evaluated for the study area which included Resources and Identity (Nature, strength, weakness, opportunity, threat of the study location and standpoint of environmental, social-cultural and socio-economic values of local people), Social Status (socio-cultural or

socio-economic groups), Accessibility and Activities (Average distance of waterfront and available amenities from the local people and types of available water dependent amenities and entertainment facilities) and Waterfront Experience (Quality of water, condition of transport and other facilities, encroachment scenario etc. according to local people) (Sairinen, 2005). Questionnaire survey and interviews were conducted in order to collect information about the social dimension. A total of 300 households were surveyed through structured questionnaire in August, 2017. The questions investigated preliminary data such as income, educational status, housing condition, people's opinion in some factors regarding the area. For example, local people's opinion about reasons for water logging in the study area, responsible groups for encroachment in the riverfront area, preferred water vehicles for Bhairab waterfront development and for better water access in future, expected facilities for the waterfront area which will help to attract the people. Willingness of people's participation in development works were found out through the survey questions. Thus, the survey investigated the economic, social and environmental condition of the waterfront area and its people.

2.1. Formula for calculating a sample for proportions

"For populations that are large, Cochran (1963:75) developed the Equation 1 to yield a representative sample for proportions.

$$n_0 = \frac{Z^2 pq}{e^2} \quad \text{.....(1)}$$

Which is valid where n_0 is the sample size, Z^2 is the abscissa of the normal curve that cuts off an area α at the tails (1 –α equals the desired confidence level, e.g., 95%), e is the desired level of precision, p is the estimated proportion of an attribute that is present in the population, and q is 1-p. The value for Z is found in statistical tables which contains the area under the normal curve.

To illustrate, suppose we wish to evaluate a state-wide extension program in which peoples were encouraged to adopt a new practice. Assume there is a large population but that we do not know the variability in the proportion that will adopt the practice; therefore, assume p=.5 (maximum variability). Furthermore, suppose we desire a 95% confidence level and ±5% precision. The resulting sample size is demonstrated in Equation 2" (Israel & Glenn, 1992).

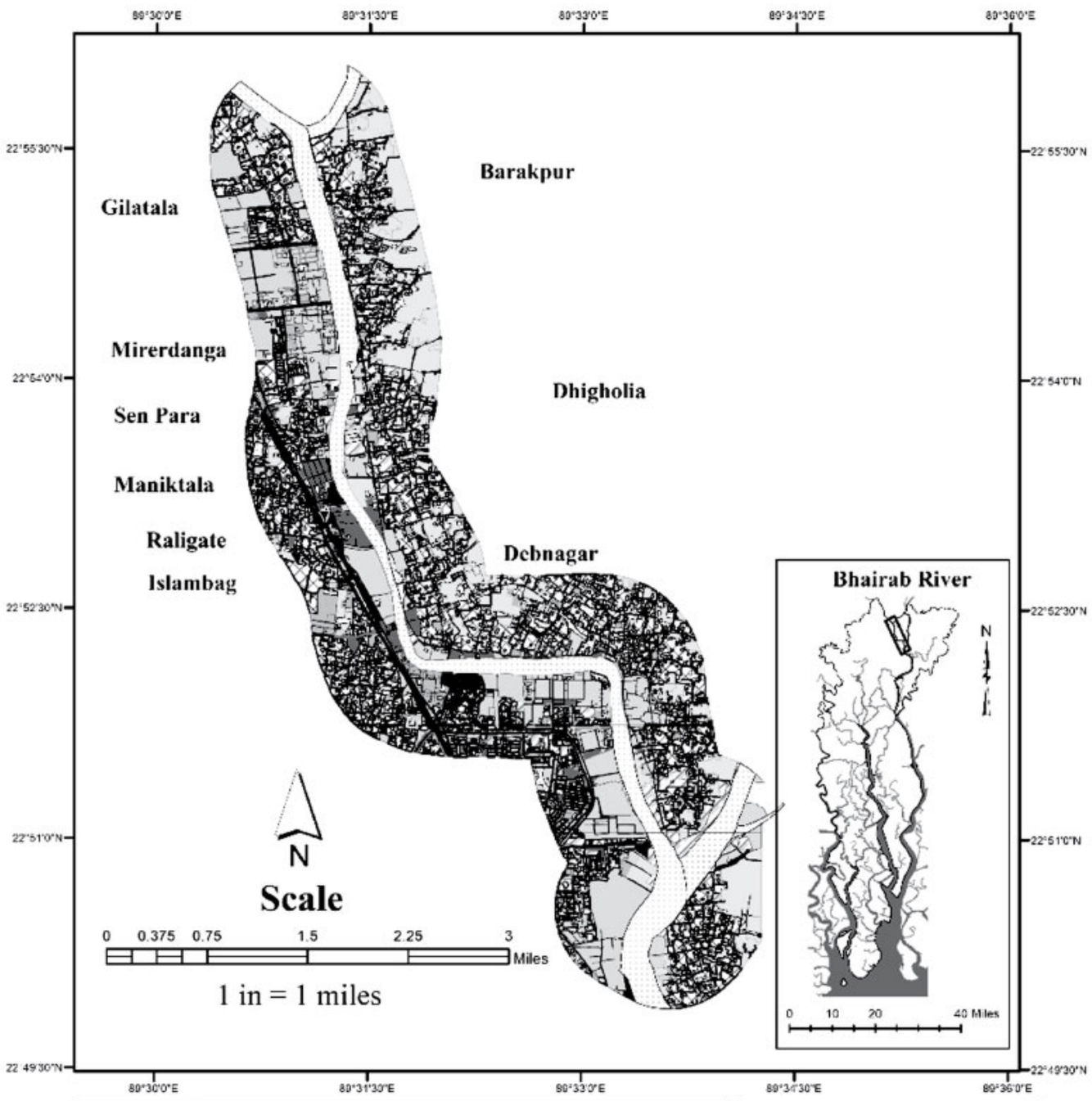
$$n_0 = \frac{Z^2 pq}{e^2} = \frac{(1.96)^2(.5)(.5)}{(.05)^2} \quad \text{.....(2)}$$

$$= 385 \text{ households.}$$

Due to lack of fund and shortage of manpower, 300 households instead of 385 were considered as survey samples. Statistical analysis and field observation yielded the result manifesting some problems of the waterfront area. The whole study area was divided into 5 zones and specific recommendations for each zone were made to ensure maximum utilization of existing land use and resources in order to attain sustainable development.

3. SITE INVENTORY OF THE STUDY AREA

The Bhairab River is situated in the southwestern part of Bangladesh and it is a distributary of Ganges. It passes through Khulna, dividing the city into two parts. After a certain distance the Bhairab River reassembled with the Rupsha River and flows in the name of Rupsha. Bhairab River has two main branches, the Khulna-Ichamati and the Kobadak. The Khulna-Iichamati forms a boundary between Bangladesh and India. The Khulna City and Jashore town are situated on the bank of the river. The development of their settlements and culture are influenced by the river. The waterfront area of this river contains a large number of important industries namely of jute, salt, fisheries and shipbuilding; and residential and commercial areas. An important bridge popularly named Rupsa Bridge (Khan Jahan Ali Bridge) on this river connects Mongla, the 2nd largest seaport of Bangladesh with the southwestern part of the country.





Legend

Agriculture	Industrial	Open Space
Circulation Network	Institutional	Residential
Commercial	Miscellaneous	Waterbody

Compiled from: KDA DAP report and shape file, 2018

Projection: Bangladesh Transverse Mercator (BTM)

Data source: KDA Detailed Area Plan, 2018

PREPARED BY: AUTHOR

Source : Prepared by Authors, 2018

Figure 1: Land use and location map of the study area

From the land use data, it was evident that most of the area was covered by circulation network. Circulation network includes different types of roads for transportation and communication. Residential area is also a prominent land use in the area. Agriculture is also an important land use for the area which includes land for cultivation of crops, homestead gardening, forestry and urban green etc.

Table 1: Land use type and their occupied portion

Land Use Type	Area (acre)	Percentage
Agriculture	1931.67	6.68
Circulation network	16895.47	58.44
Commercial	194.75	0.67
Industrial	955.34	3.30
Institutional	243.15	0.84
Miscellaneous	2267.99	7.84
Open space	156.81	0.54
Residential	4520.33	15.65
Water body	1745.69	6.04
Total	28911.2	100.00

Source: Khulna Development Authority, 2018

As a specific land use, commercial activity covers the least percentage of area. There is a little percentage of open space that includes recreational area and vacant lands. Institutional land use actually refers here educational institutions of the area. Commercial areas include shopping centers, small grocery shops, fruit market, fish markets etc. Industrial areas include manufacturing and service activity. The study area is a vibrant industrial and commercial zone which has attracted many investment and the reason behind this can be accessibility induced by river flow, well railway and road communication, easy access to Mongla port, cheap labor because of lack of alternative livelihood options and availability of raw materials (especially over production of jute and resources from the Sundarbans). Miscellaneous land use includes mixed use area, restricted area, service activity, government services, non-government services, community services etc.

There are different types of industries and important urban functions like food, jute, cement, oil, concrete, printing and packaging etc. in the study area. Important industries of the area are Goffer Food, Bangladesh Cable Shilpa Limited, Sonali Jute Mill, Ajax Jute Mill, Ansar Flour Mill, Maheshwarpasa CSD, Maniktala CSD, Dhaka Jute Mill, Jamuna Oil, Meghna Petroleum Limited, Padma Oil Co, Khulna Power Company Ltd, Khunla Power Station, Khulna 225MW Combined Cycle Power Plant, Peoples Jute Mills, Cresent Jute Mills, Platinum Jubille Jute Mill, Khulna Hard Board Mill, Khulna Newsprint Mill, Charerhat Natun Mach Company, Gercom Cement Factory, Poles and Concrete Factory Khulna, RFL Khulna Depot, Religate Mill, Khulna Industries Limited, Khulna Printing and Packaging Limited, Sagar Jute Spinning Mills Ltd., Daulatpur Jute Mill, Moshin Jute Mill, Jute Textile Mill Limited, Star Jute Mill, Surma Jute Press Ltd., Faridpur Jute Press Ltd etc. Main pollution sources of the area are mainly riverside

industries, water vehicles and sewage. A large number of cement, food processing, salt refinery industries and a large fish market near Rupsa Ferry Ghat contribute to the pollution of both river and waterfront area. The garbage and effluents of the industries and markets create unpleasant environment in some portion of the area. Drainage connections from different residential and commercial units are also found to dump sewage and other wastes in the river. Water vehicle is another source of pollution. Various types of water vehicles like motorboats, steamers, cargo ships etc. dump untreated oil, carbon, sulfur, nitrogen compounds etc. in the water.

3.1. SWOT analysis of the study area

Table 2: Strength and weakness of the study area

Strength	Weakness
Large number of industries being present in the area, a huge possibility of income generation and investment in waterfront sector.	Drainage and pollution are the main weakness of the area.
Public amenities like public toilet, markets, embankments, service facilities in launch terminals and Ghats etc. are present in several places of the area which creates the opportunity for economic development.	Directly thrown garbage from fish and other permanent or temporary shops, chemical waste from riverside industries make the place unpleasant to the visitors.
Good road connectivity and mixed land use make the area more vibrant.	Facilities provided in recreational and transportation sectors of the area are very limited and landscape design is not satisfactory.
Some of the waterfront area have some facilities like seating arrangement which enhances the quality of the area as a recreational space.	Narrow roads become congested with only a few vehicles like motor cycle/van/ auto rickshaw/auto-van.
Availability of land for expansion. There are many scope of expanding the existing land which can be used for further development.	Buildable lands are unused. There are many lands left unused.

Table 3: Opportunity and threat of the study area

Opportunity	Threat
Bhairab waterfront area has good linkage with Khulna City. A well decorated remodeled railway station will fully be completed by 2019 (KDA, 2018).	Improper drainage system may cause water logging and massive contamination of the river water in future.

Table 3: Opportunity and threat of the study area (Continued)

A tourist information center will be developed in the area which will create more opportunities in future.	Industrial wastes may contaminate water in a larger scale in future.
Scope for creating job sector for the unemployed.	Heavy congestion in the road intersection.
Transforming some portion of the area into fully industrial agglomeration area.	The area is over populated. It may cause social and economic difficulties.

3.2. Cross section of the study area

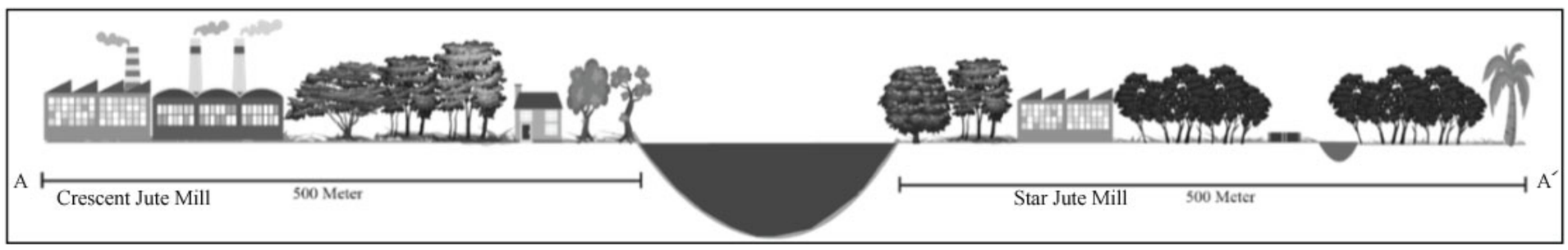


Figure 2: Cross section of the study area (Daulatpur)

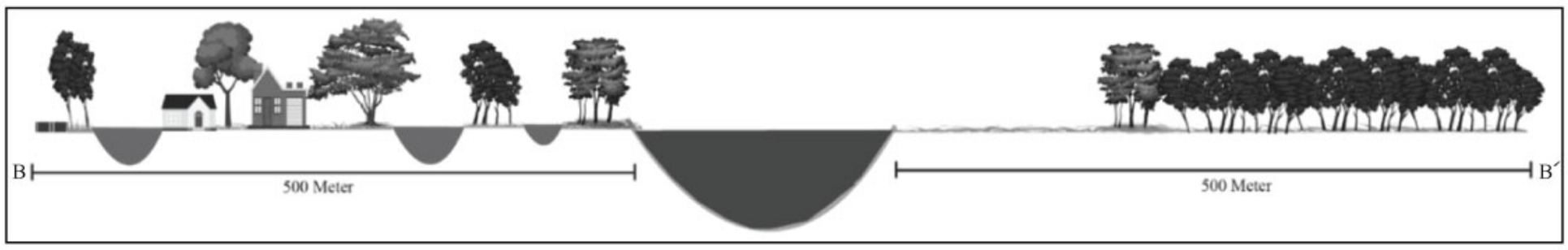


Figure 3: Cross section of the study area (Mirerdanga)

Table 4: Locational reticules of the cross section

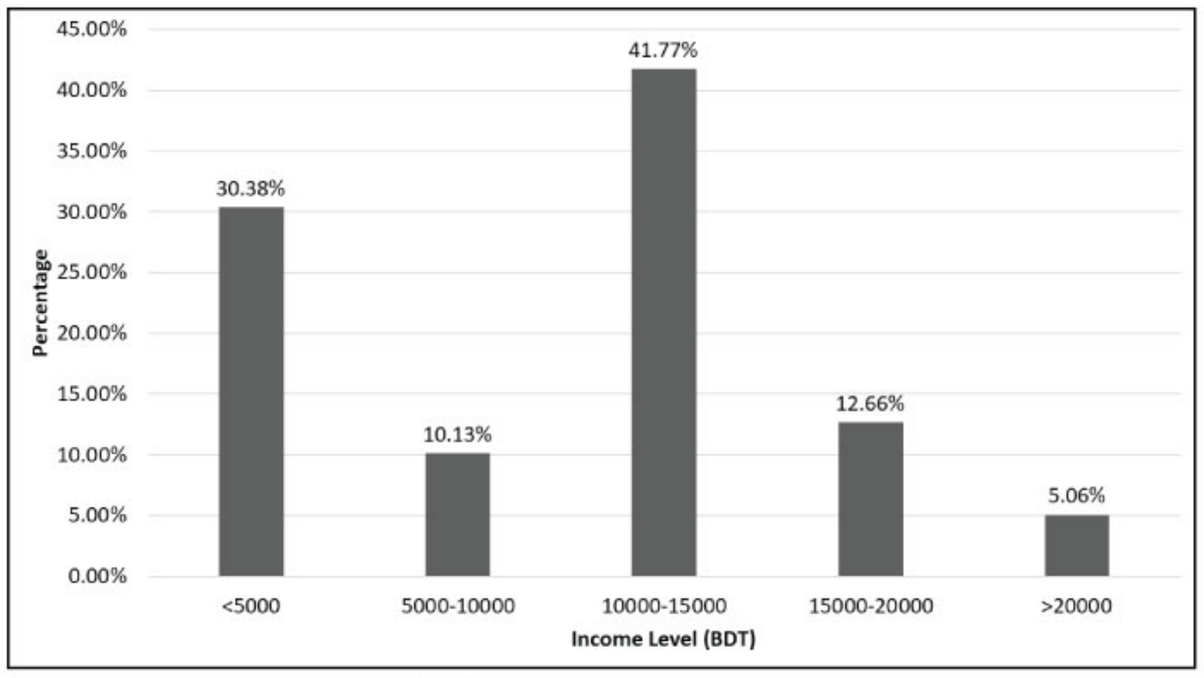
Reticules	A	A´	B	B´
Latitude	22°52'2.03"N	22°52'2.53"N	22°53'31.60"N	22°53'34.48"N
Longitude	89°32'44.57"E	89°33'25.69"E	89°30'45.48"E	89°31'27.40"E

Detailed topographical survey data and satellite images provide the locations, types of structure and land uses in the area of interest (Altinakar & Honghai, 2011). Existing physical scenario of the waterfront area was also analyzed by two cross sections taking 500 meter from both sides of the river in two diverse locations, one is Daulatpur and another is Mirerdanga. The points of the two sections are A, A´ and B, B´ which are shown with their longitude and latitudes in figure 2, figure 3 and table 4. A preliminary conception about different land uses and their inter-linkage are perceived from the cross sections. It was noticed that western part of the river has more land use diversity than eastern part. In the western part, little percentage of vegetation, huge number of industries and settlements are noticeable. The distance between settlement and industries are questionable and necessary buffer has not been provided. Western part shows more water bodies in the cross-sectional areas. On the other side, eastern part shows more vacant lands, more vegetation and some industries. Considering existing condition the cross sectional data helped to provide some effective recommendations to improve the condition of the waterfront areas.

4. DATA ANALYSIS AND INTERPRETATION

4.1. Economic status

Existing economic condition of waterfront area can be considered as an important factor for the po.tential investment and riverfront development functions.



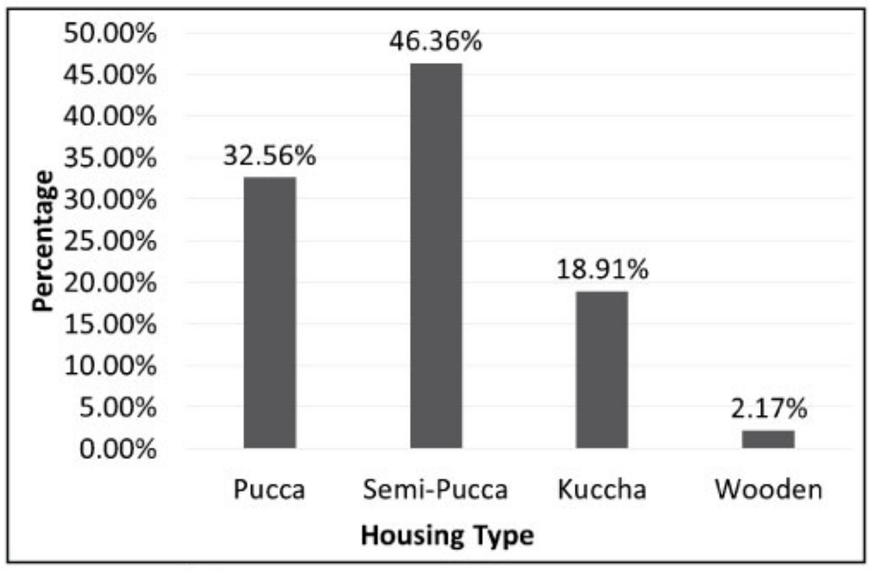
Source: Field survey, 2017.

Figure 4: Income status of the people

Figure 4 shows that most of the households i.e. 41.77% belong to the monthly income range between BDT 10,000 to 15,000. The Drainage Master Plan of Khulna City mentioned poverty line at BDT 6,000 as the monthly household income. It also mentioned poverty line for the hard core poor at BDT 3,000 (KCC, 2012). Only 5.06% households have their household income above BDT 20,000. The above figure reveals that 30.38% households belong to monthly income under BDT 5,000 and live below the poverty line with a miserable condition. It also indicates the income inequality among the local people. If the waterfront is developed through proper urban planning, the poor people will be getting involved in the more economic functions that will reduce the income inequality.

4.2. Social and environmental issue

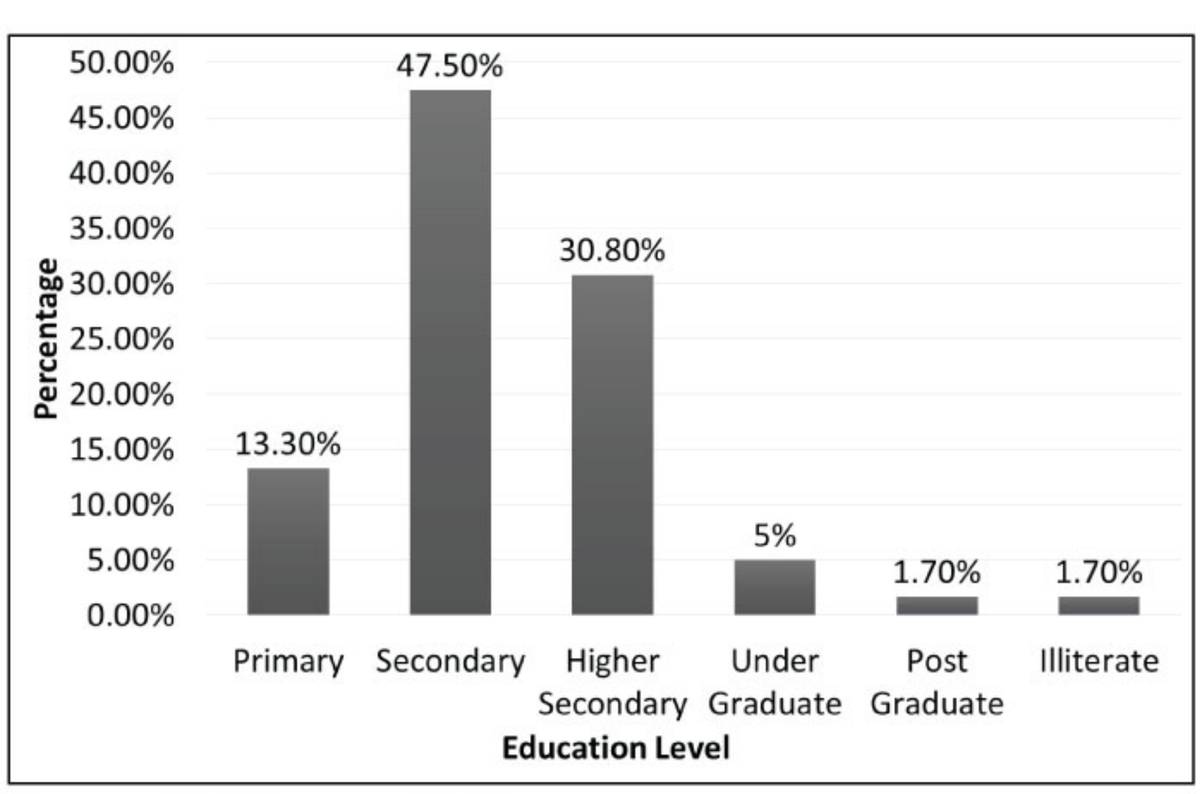
Housing type, educational status, social responsibilities etc. are the indicators of assessing social status of any community. Whereas, water logging and pollution by household and industrial wastes are the major concerns of local environmental condition.



Source: Field survey, 2017

Figure 5: Housing status of the people

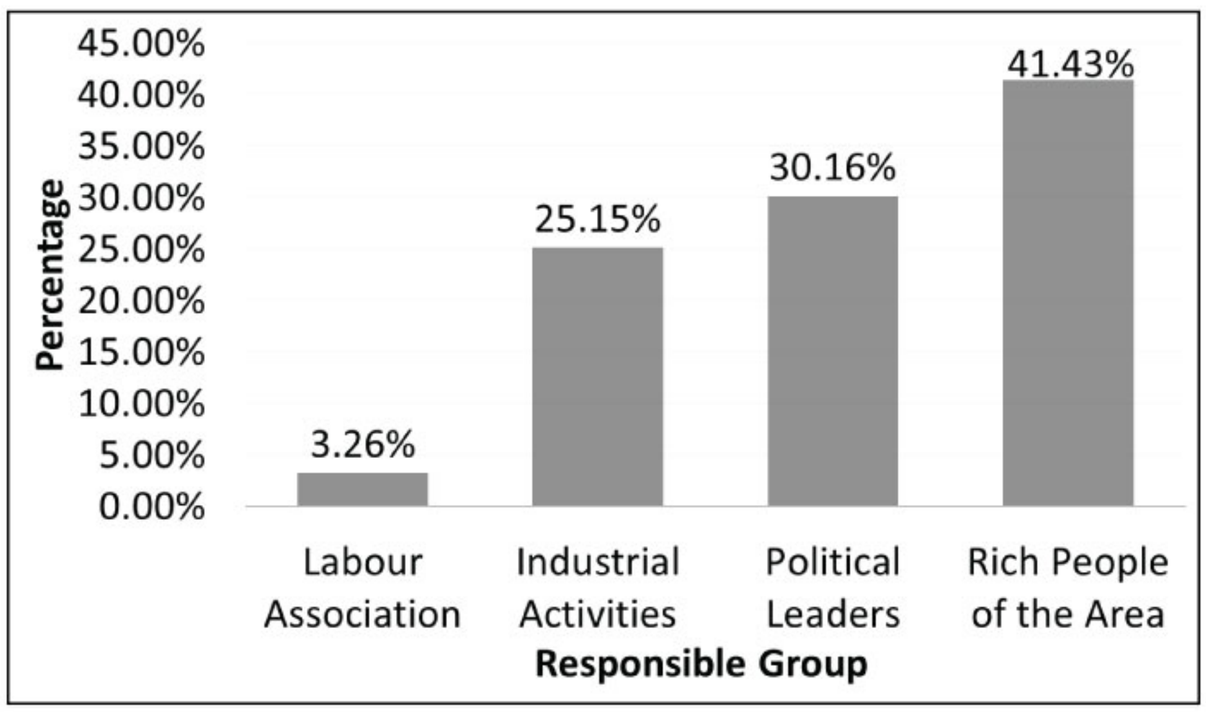
Figure 5 reveals that most of the households i.e. 46.36% of the area live in semi pucca house. Only 2.17% households live in wooden house. The existing income status explains the housing condition which reflects their moderate social status in a greater sense.
It is seen from the figure 6 that majority of the respondents, which is 47.50% have secondary level education.



Source: Field survey, 2017
Figure 6: Educational status of the people

Only 1.70% respondents were found illiterate. Again, the respondents having post graduate education is insignificant i.e. 1.70%. This is also a reflection of their moderate level of living. The local people will be able to be the part of sustainable urban planning and development if their housing status and level of education is enhanced through waterfront development interventions.

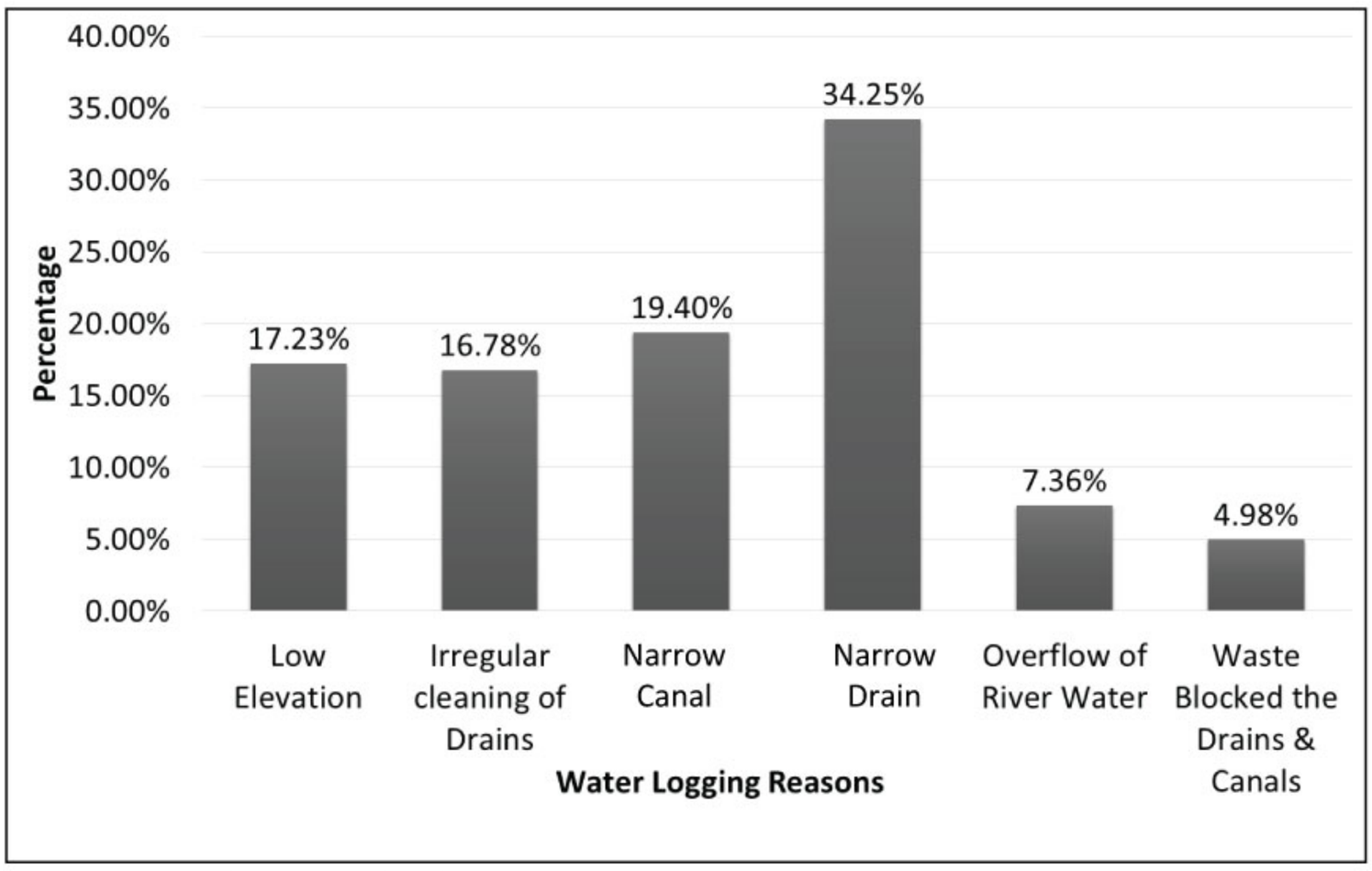
Encroachment is one of the major problems of the riverfront development of Khulna City. Many parties namely labor association, industrial activities, political leaders and rich people of the area are mainly responsible for the encroachment.



Source: Field survey, 2017
Figure 7: Different groups responsible for encroachment

As per the response by 41.43%, 30.16% and 25.15% respondents, rich people, political leaders and industrial activities are respectively responsible for the encroachment of riverfront area (Figure 7). Very few respondents i.e. 3.26% suspects labor association to be responsible for encroachment. Significant amount of potential lands are occupied by these parties. If the encroached land is made free, these can be used for sustainable riverfront development.

According to figure 8, majority of the respondents i.e. 34.25% and 19.40% think that narrow drains and narrow canals respectively are the main reasons for water logging. The whole study area also lacks in proper and adequate drainage system. There exists indiscriminate dumping of solid wastes in the drains and canals which creates drainage congestion and water logging. Irregular cleaning of drains and canals is also causing water logging in the area. Khulna City Corporation (KCC) is the statutory authority for cleaning and maintaining the drains of Khulna City. But, KCC does not clean the drain on regular basis.



Source: Field survey, 2017

Figure 8: Reasons of water logging of the study area

Low elevation of the area was found to be another reason of water logging, as mentioned by 17.23% respondents. Proper drainage system, proper solid waste management, regular cleaning of drains and canals, and city protection embankment etc. as part of waterfront development initiatives can solve the water logging, drainage congestion and environmental pollution problems for the sustainable development of the area.

4.3. Development requirement analysis

Waterfront based recreation and tourism is considered as an important component of urban planning in many of the cities of the world. Water vehicles play a significant role to promote such tourism and recreation.

Most of the respondents i.e. 61.67% expressed that boat with engine is their preferred water vehicle because of its speed and affordable fare. The Sundarbans, the world largest mangrove forest is about 60 kilometers away towards south from Khulna City. Water taxi can be an attractive option for visiting the Sundarbans from Khulna. About 10.33% respondents have mentioned the introduction of water taxi as part of waterfront development components.

Table 5: Preferred water vehicles for the Bhairab waterfront development

Preferred vehicle	Respondents	
	Number	Percentage
Small boat	50	16.67
Water taxi	31	10.33
Boat with engine	185	61.67
Paddled boat	19	6.33
Not necessary	15	5.00

Source: Field survey, 2017

Small and paddled boats are generally used for roaming around the smaller part of a long river of a city region. The respondents have also proposed small and paddled boats for touring the Bhairab River. Many facilities are required for the sustainable development of waterfront. The facilities make the area more attractive, aesthetic, pleasant and vibrant. In the waterfront area the tourists, visitors and city people pass their leisure lime for their mental refreshment and relaxation.

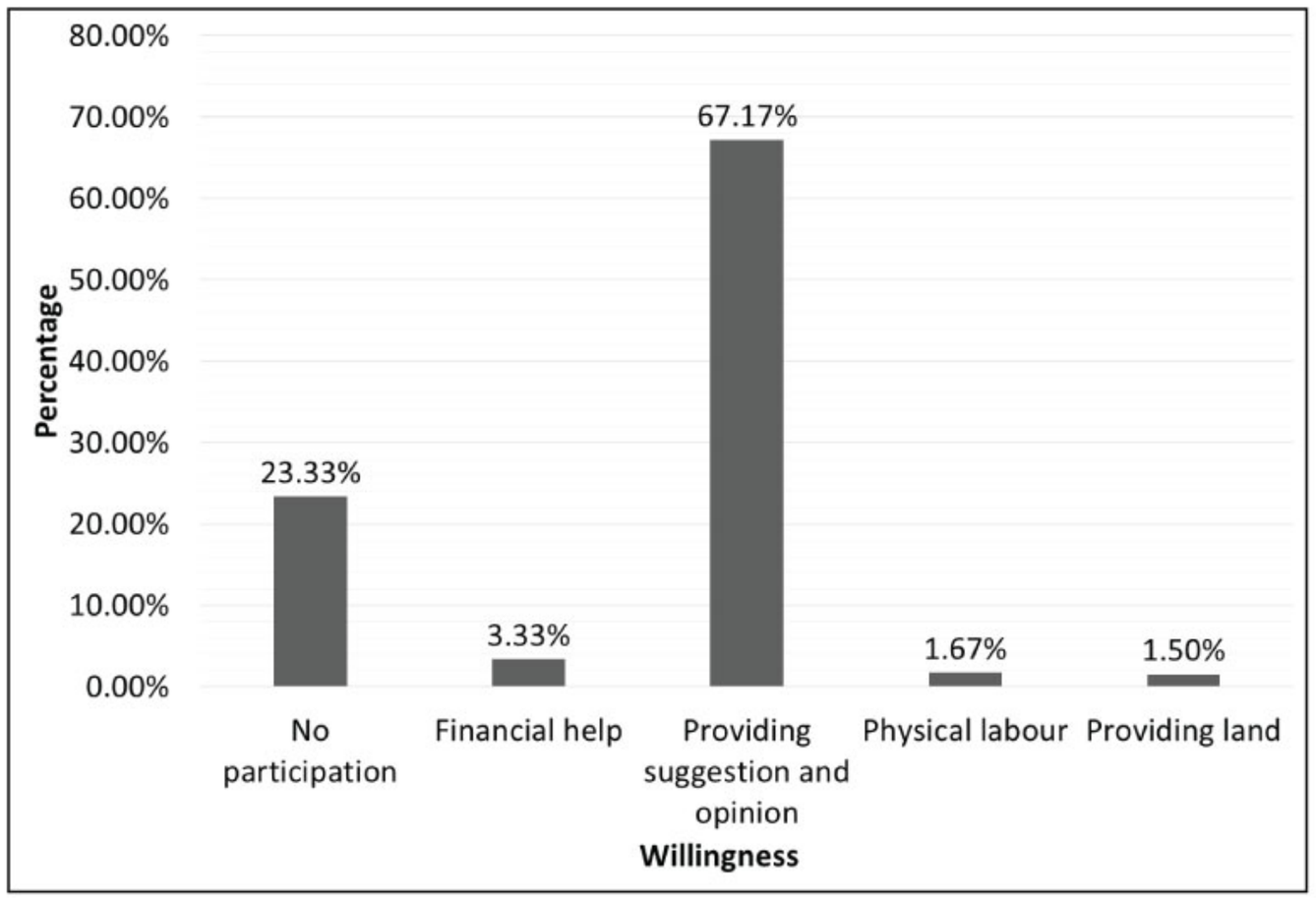
Table 6: Expected facilities for the Bhairab waterfront development

Expected Facilities	Respondents	
	Number	Percentage
Cycling track	67	22.33
Seating benches	79	26.33
Fountain	20	6.67
Docks	25	8.33
Terraces	16	5.34
Restaurant	30	10.00
Shopping center	44	14.67
Decorative lights	19	6.33

Source: Field survey, 2017

Table 6 focuses on the needs and expectations of local people for waterfront development. Among different choices 26.33%, 22.33%, 14.67% and 10.00% respondents mentioned seating benches, cycling track, shopping centers and restaurants respectively as the expected facilities. It was also noticed that very few respondents wanted docks, terraces and fountains. Although a few people proposed decorative lights for the waterfront, it is very crucial for the safety of the visitors.

Participation and support from the local people is very important for the successful implementation of any development project like waterfront development. So, willingness of local people in the waterfront development works was investigated.



Source: Field survey, 2017

Figure 9: Willingness of people's participation in development works

A large number of respondents i.e. 61.17% showed their interest in providing suggestions and opinions for the development of waterfront of Bhairab River. About 23.33% respondents did not show any interest to participate in development works. A negligible number of respondents wanted to provide physical labor, lands or financial support.

5. DISCUSSION

Analysis of income status revealed that the economic condition of the local people is moderate. It can also be interpreted that if waterfront development process generates new sources of employment, it would be beneficial for the poor and unemployed local people. Existing housing condition, though medium is suitable for majority of the people. Educational status of the people is also moderate. Investigation of the reasons of water logging in the area has brought up some insights about the environmental scenario. The area needs proper drainage facility which can effectively prevent waterlogging. Most of the respondents mentioned that encroachment takes place there and it is mainly caused by the local rich people. The local people will contribute in the development process of waterfront of Bhairab River at some level. The facilities they expect such as cycling track, seating bench, restaurant, shopping center and so on for the waterfront development were also reflected in the analysis.

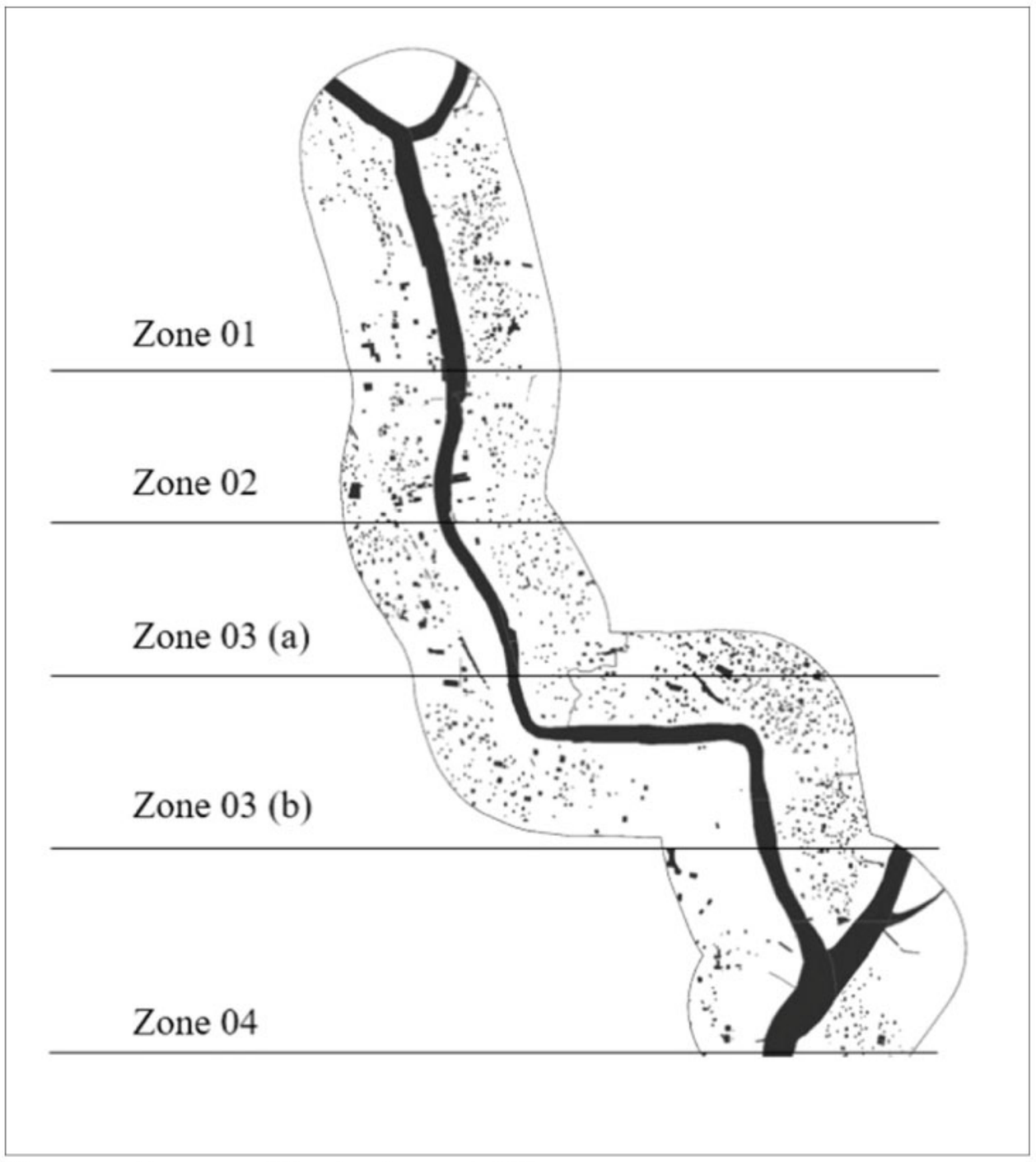
6. CONCLUSION AND RECOMMENDATIONS

The study assessed the existing condition of waterfront area of Bhairab River in terms of socio-economic and environmental perspective. The assessment has proposed some design solutions for making the waterfront area more functional and vibrant for the sustainable urban planning of Khulna City. "The transformation and regeneration of urban waterfronts are related to the image of the city and the reshaping of green spaces in urban structure, which might cause direct or indirect influences on social equity for the distribution of shoreline resources for communities" (Sairinen, 2005).

Recommendations for the entire riverfront area have been given through zonal distribution. The area has been subdivided into 5 zones. Some common recommendations which have been made for all the zones are mentioned below:

1. Quantitative and qualitative improvement of water traffic should be ensured. Water taxi, boat with engine, small and paddled boats etc. will be introduced to effectively reduce the transportation problems among the different parts of the river.
2. Vegetation and buffer zone will be increased. River banks and other vacant places can be used for this purpose.
3. Well established drainage system will be provided to mitigate the water logging problem and pollution will be reduced through proper waste management system.
4. Seating arrangements along riverbank, decorative lights for safety and beautification will be provided.
5. Riverfront development project and its financing will be managed mainly by Khulna Development Authority (KDA) and KCC.

Specification of solutions for different zones are given below:



Source: Prepared by Authors, 2018

Figure 10: Proposed subdivision map of the study area

Zone 01

This zone begins from Barakpur Uttar Para area and ends in Mirerdanga area. A residential zone will be designed in zone 01. Planning standards will be followed in the whole development process. A playground and a park will be constructed in the residential area and the area coverage of these facilities will be fixed considering the standard of RAJUK (Rajdhani Unnayan Kartripakkha), planning organization for Dhaka City. A bridge should be constructed to connect between eastern and western parts of this zone because during summer and rainy season, due to bad weather, the local people face problems while crossing the river. Also, the water traffic should be improved for better connectivity because connectivity influences the attractiveness of an area in a larger scale. This zone is suitable for a residential area as it is far from industrial areas.

Zone 02

Zone 02 covers the area from Mirerdanga to Maniktala. In zone 02, a commercial sector will be organized with existing commercial units. Necessary open spaces and drainage system should be improvised. This commercial sector will include shopping center, restaurant, and corporate branch of different organizations and banks etc.

Zone 03 (a)

Zone 03 (a) includes Maniktala, Raligate, Islambag and Debnagar area. In this zone, small scale industries will be organized. Existing industries will be placed and organized in such way that does not violate the planning rules of industrial area. The industries should compulsorily have proper waste treatment units and necessary buffer zone. Dumping wastes directly into river should be strictly prohibited. Any kind of air, water and noise pollution by the industries should be punishable. Industrial agglomeration will be implemented here which will include only small scale industries. Recreational facilities will be provided and vegetation will be increased as industrial areas need more greenery to control the pollution.

Zone 03 (b)

Zone 03 (b) covers a portion of Daulatpur, Khalishpur and Senhati area. In this zone, a large number of heavy industries are present. For example, Padma Oil, Meghna Oil, Jamuna Oil, Khulna Thermal Power Plant etc. are the important industries here. For heavy industries, waste dumping system and buffer provision should be improvised in larger range and all rules for industrial area should be made mandatory.

Zone 04

Zone 04 includes Khalishpur and Shulpur area. This zone possesses mixed use area. There are some vacant lands, two lakes, some commercial places and some agricultural lands. The proposed design suggests an organized arrangement of these. Vacant lands may be used to accommodate some agro-processing industries which will be helpful to generate employment opportunity for local people. Commercial units should be arranged in more planned way and recreation sector will be developed along with this commercial sector.

The recommendations are expected to be effective for solving the social, economic and environmental problems found out for the waterfront area as all of these are inter-related with sustainable urban planning and development.

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