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Environmental Impact Assessment: Analysis of Bridge Construction Project in Bangladesh

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Abstract

The purpose of this research is to assess the probable positive and negative impacts on the environment for developmental activities and establish environmental management plan for managing the adverse negative impact. In this research, an interaction matrix method was applied to evaluate the expected environmental impacts. Interaction matrices are widely used in environmental impact assessments (EIAs) method, where project activity are shown in the row of the matrix and environmental and social components are presented in the column of the matrix. This research has been conducted at Galachipa sub district of Patuakhali district in Bangladesh where the proposed Galachipa Bridge will be constructed. A total 50 possible affected household were randomly interviewed using semi-structured questionnaire; in addition to, 10 consultations meeting were arranged in order to find out the amount of actual damage of proposed project and how the people will be benefited. Besides this, expert consultations, Focus Group Discussions (FGD), and Key Informants Interview (KII) method be followed. This study revealed that significant numbers of people would lose their agricultural and homestead land due to land acquisition and resettlement site development; in contrast, traffic safety risk will be increased substantially. Additionally, the flora and fauna diversity will be highly affected due to project activities. Besides this, during the construction period, high amount of noise will be generated in an underwater and physical environment that will be highly hampered the aquatic habitats and health of workers and the people of the nearby community. Nevertheless, at the time of the construction, some of the affected people will get short-term employment opportunities. Moreover, the land use pattern will be changed and successful completion of the project will rapidly develop the area. Finally, the researchers were formulated an environmental management and monitoring plan which will help to mitigate the adverse negative impact.

Keywords

Environmental Impact Assessment, Bridge, Management Plan, Mitigation, Bangladesh

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1. Introduction

Environmental Impact Assessment is an anticipatory environmental management tool that attempts to identify and calculated the probable environmental consequences of certain proposed developmental actions [1] and, its purpose is to provide information to the decision maker and the public about the environmental implications of the proposed project activity before the decision are made. It suggests the possible

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measures for preventing the impacts and mitigation plans and ensures sustainability of proposed development actions and conservation of ecosystem [2] EIA has widely proven an effective tool of sustainable environmental planning and management [3]. Often in the past, in developing countries had implemented the development project without any environmental impact assessment studies or hadn't considered the probable mitigation measure [4]. Consequently, such project has not only destructive to the environment but also it has a break down the continuity of sustainable development. From this thinking, policy makers and donor agencies have changed their attitudes and perceptions to environmental issues and problems, and incorporate environmental considerations in the development project in developing country before the project implementation [5, 6]. The first formal EIA system was established on the first January 1970 by the US National Environmental Policy Act (NEPA), which mandated assessment of environmental outcomes of the development project, and at the moment, more than 100 nations have been used the procedure of EIA [7]. In 1990, developing countries in Asia emerged at the forefront practice in developing the world. Now a day, many of these countries have established the planning and managing the EIA rules and regulation of development project [8, 28]. In 1992, the United Nations Conference on Environment and Development in Rio have declared that EIA as a part of the well-being of human and environment [9]. However, the importance of consultation and public participation for environmental decision making and access to justice in environmental matters has been formally recognized in 1998, the Convention on Access to Information [10]. On the contrast, Politicians' are playing a pivotal role for EIA decision-making because of obtaining votes or improve the government's image; as a result, the general interest is not fully considered [11]. Besides this, evaluation of EIA also greater depends on political influences, and non-environmental factors, for instance, stakeholders influence, private expert consultant, delays in processes etc. [12]

The development process in developed and developing countries is now highly depended on the performance of EIA [13] and, its play a pivotal role for making development project environmentally feasible and acceptable [14]. The EIA system has been adopted in developing country later the developed county and the characteristic of EIA in developing country is weak in legal and administrative arrangement, poor quality of environmental impact statement, limited participation of affected community and other stockholders with inadequate implementation of mitigation and monitoring measures [15, 16, 17] but the policy and planning of EIA have been developed day by day [18]

Bangladesh is a developing country with it faster economic transition in last decade and the policy of foreign open market investment has been increased, particularly in industrial and infrastructure sectors which have significant environmental and social impact [19]. The government of Bangladesh has formally introduced the environmental impact assessment (EIA) in 1995 under the Environmental Conservation Act in response to growing environmental concerns and demand from the donors' agencies for better environmental performance [20]. Under this act the Department of Environment (DOE) was established within the Ministry of Environment and Forest as the regulatory body responsible for enforcing the ECA '95 [21] and the guidelines provided in the Environment Conservation Rules 1997 [22]. During the last decade, the government of Bangladesh has been taken huge initiative for improving the communication system in the country; as a result, mega infrastructure project has taken place without paying any attention to the environmental consequences [23]. In contrast, many areas of the country have suffered from environmental degradation and it's hindered the growing sustainable development of the country. From this, the government bodies realize that the development actions could not sustained if the environmental protection was not considered. Eventually, the environmental protection procedure which was introduced in ECA '95 became effective on June 1, 1995 [23]. To meet these requirements, ECR '97 was promulgated. From this rule, the proponent of development project has to conduct EIA for acquiring the Environmental Clearance Certificate from DOE before the project implementation [24]. Depending upon location, size, and severity of pollution loads, projects/activities have been classified in ECR, '97 into four categories: Green, Orange A, Orange B and Red respectively, to nil, minor, medium and severe impacts on important environmental components (IECs) [22]. According to the green category project do not require initial environmental examination (IEE) and EIA. On the other hand, Red category projects, which require both IEE and EIA [24]. The red category project includes the bridge over 100 meters in length, and orange B category project include the bridge less than 100 meters in length [24]. The proposed Galachipa Bridge is more than 500m long. So it is included in the red category. That's why Environmental Impacts Assessment should include the prediction, evaluation, and mitigation of environmental impacts based on the characteristics of the project and an Environmental Management and Monitoring Plan shall be prepared.

The project is located in Galachipa ferry Ghat which belongs to the southern coastal part of Bangladesh. This area deprived of the modern communication facilities; as a result, the economic condition in the project area is not satisfactory.

There has long been a desire of the people of this area to improve the transportation network among Galachipa, Bauphal, patuakhali, and Barisal. From this, the government of Bangladesh has taken an initiative to construct a bridge on Galachipa River at Galachipa ferry ghat area. The proposed Bridge will save both time and money for transportation of people and goods. New employment opportunities will be generated. Now the ferry service has given connectivity with other places. But at the ferry point, people have to wait average one and a half hour or more. After the completion of the bridge, the commercial vehicles will be able to give more trips and people will be able to reach their destination within a short time. The purpose of this study is to find out the adverse environmental impacts during the construction operation and maintenance phase of the project and suggest an effective environmental management plan.

2. Methodology

2.1. Description of Project Location

Proposed Bridge Site is at Ferry Location at 70th km. on Lebukhali-Dumki-Boga-Dasmina-Golachipa- Amragachi Road (Z8806). The name of the ferry ghat is 'Golachipa Ferry Ghat' and connects the Upazila Head Quarter Municipal Town with the regional highway R880. The river width across Ferry Ghat is about 470m. The landing stations are located at an oblique angle with each other. Vehicular traffic movements on the road consisted of buses, trucks, trailers, tractors, microbus, pickups, jeeps, cars, motorcycle, non-motorized vehicles like by-cycle, cart and rickshaws etc. Passenger ships, lunches and various Marine vessels move through the river [25]. The project site lies within geographical coordinates 22°10'36.48"N and 90°24'17.00"E (Figure 1). This Bridge is approximately 253 km from Dhaka. The Bridge traverses the Galachipa River. The Galachipa River takes from Lohalia River near Patuakhali town and flows as Galachipa River. The proposed Bridge will connect Bauphal, Kalaia with Patuakhali district and Barisal division and others parts of Bangladesh.

2.2. Environmental Impact Assessment (EIA) Method

In this research, an interaction matrix method was applied which was developed based on the project activities and environmental components, in order to identify the probable impacts on environmental components. The project activities are divided into three stage such as pre-construction, construction, and operation and maintenance. In the pre-construction stage, activities will include land acquisition and development of resettlement sites, besides this; in construction stage, activities will comprise construction of the main bridge, River Training Works (RTW), construction of approach roads, construction of bridge end facilities, construction of yards and camp, and the post-construction activities include operations and maintenance of the project. On the other hand, environmental components are classified into three parameters such as physical components, biological components, and socio-cultural components

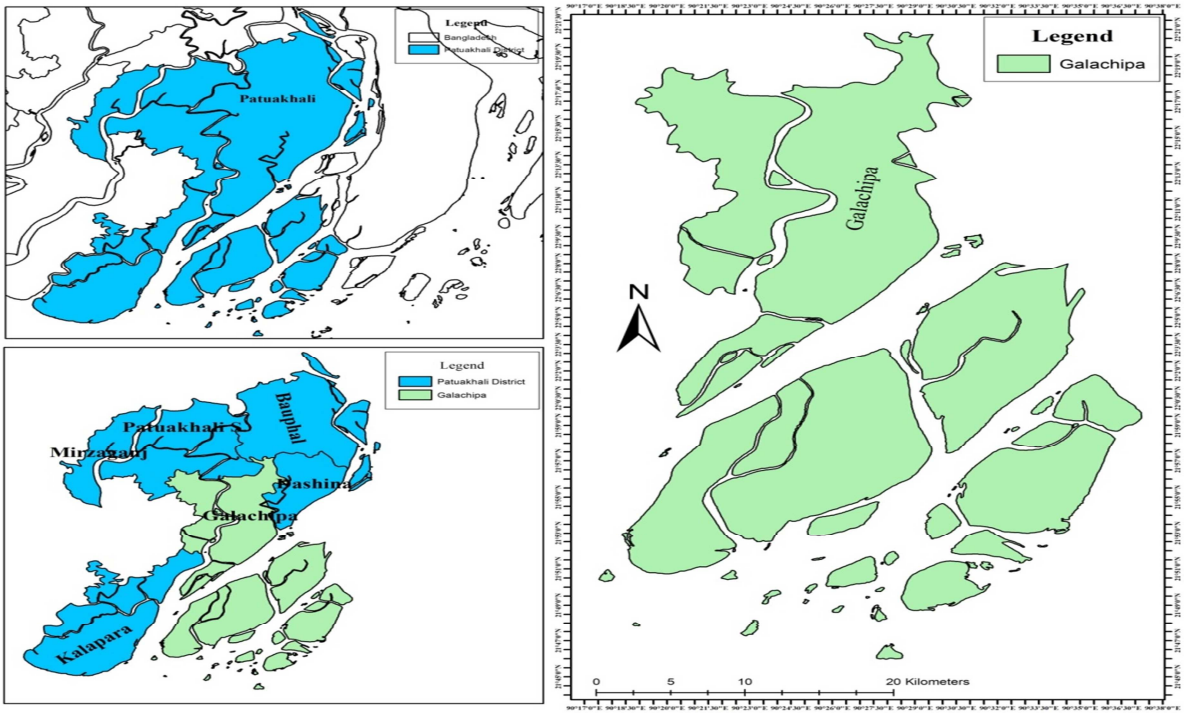

Figure 1. Map (1A) show the position of Patuakhali District in Bangladesh, map (1B) show the position of Galachipa Upazilla of Patuakhali District and map (1C) show the project area [25, 26].

2.3. Procedure for Assessing Environmental Impacts

In order to, assess impacts first of all weighting the environmental components to the overall environment which was based on the consultation among the environmental impact assessment expert members. The weightage of environmental components varies from 1-5 that has been based on the importance of the component in the project setting. Secondly, the degree of impacts on environmental components due to project activities has been measured by qualitative consultations of EIA expert members and the concept and environmental setting of the similar large project, for instance, Jamuna, Paksey, Padma, Paira etc. in Bangladesh. Based on the information and expert opinion, the degree of impact is classified as positive and negative and the impact level is 0- significance or nil, 1- low, 2- medium, 3-high (Table 2). Thirdly, assessing the nature of the impacts on environmental components based on temporal (Short/ Long term and mitigability extent (Partially/ Fully mitigable). Moreover, assessing composite rating value to environmental components based on three variables such as degree, duration, and mitigability of impact (Table 1).

Table 1. Prioritization Procedure for Assessing Key Environmental Impacts.

Negative Impact					
Composite value	**Degree of impact**	**Temporal**		**Mitigation**	
		Short-term	***Long-term***	***Partiality***	***Fully***
-1	Low (-1)	√		√	√
-2	Medium (-2)	√	√	√	√
-3	High (-3)		√	√	

Positive Impact			
Composite value	**Degree of impact**	**Temporal**	
		Short-term	***Long-term***
+1	Low (+1)	√	
+2	Medium (+2)	√	√
+3	High (+3)		√

Furthermore, calculating the impact value for environmental component by using following equation-

$$\text{Impact value} = \text{Weightage value} \times \text{Composite rating scale} \quad (1)$$

Finally, for prioritization and categorization of impacts using the following scale-

Table 2. Prioritization and Categorization of Impacts.

Negative Impact		**Impact value**
	Yellow category or low negative components	-1 to -5
	Pink category or moderately negative components	- 6 to -10
	Red category or highly negative components	> - 10

Positive Impact		**Impact value**
	Light Green category or low positive components	1 to 5
	Dark Green category or moderately positive components	6 to 10
	Blue category or highly positive components	> 10

2.4. Data Collection Procedure

Deriving accurate information is highly depended on the survey method [27, 28]. Data were collected during the months from 1st August 2017 to 1st November 2017. A reconnaissance survey was carried out to ascertain the primary idea about the project area. Data were collected from primary and secondary sources. Primary data were collected by Household questionnaire survey, Consultation meeting of expected affected people at project area, Expert Consultations, Focus Group Discussions (FGD), and key informants interview method. Firstly, a semi-structured questionnaire was used for collecting the information of people who are directly or indirectly affected by the proposed project. A total 50 household survey was done for knowing the information of the affected people. Secondly, 10 consultations meeting was arranged in order to find out the amount actual damage of proposed project and how people will benefit from the project. Thirdly, a various expert consultation meeting was arranged with the expert of this field. Expert was consulted through individual and group meetings including the project panel of experts, selected individuals, and an organization with professional knowledge of EIA process. The meeting was conducted at an early stage of EIA. Expert's consultation has involved the Professionals who have specialized knowledge in wildlife, ecology, river

morphology etc. and senior government officials who are responsible for reviewing the EIA report and making decisions on the environmental clearance. Finally, a key informant is an individual who has a great depth of knowledge about a specific field and can offer perceptive information to the researcher [29] relate to the research questions and problem-solving suggestions related to any problem. In order to know the environmental and socio-economic condition in the project area, the EIA expert team was discussed with the District forest officer in Patuakhali, Upazilla agriculture extension officer, Upazilla chairman, union praised chairman and members as well as the local knowledgeable persons including community representatives, traders, teachers, and political leaders were interviewed individually to know the perception of the project. To fulfill the objectives of the research 30 KII were conducted.

Secondary data were collected from Bangladesh Bureau of Statistics [5], bridge construction authorities, construction manager, project manager, chief engineer of this bridge construction project, Local government and engineering department (LGED) and from relevant articles. On the other hand, the baseline environmental condition of the project area was drawn according to the information collected from secondary and primary data sources through literature review, field investigations, and consultations with different stakeholders.

3. Results and Discussion

3.1. Assessment of Significant Impact

Environmental impacts assessment was carried out considering the present environmental setting of the project area, and nature and extent of the proposed activities. Potential impacts on various environmental components due to different project activities during pre-construction, construction, and operation and maintenance stages have been identified and prioritized through interaction matrix. The project activities will trigger out both positive and negative impacts. In accordance with their magnitude, spatial context, durability and mitigability the impacts have been prioritized as high, medium and low both for positive and negative impacts (Table 2). High and medium positive and negative impacts have been considered as potentially significant. The low priority positive and negative impacts are considered as insignificant as their impacts are short-term and local and are easily mitigable with the adaptation of good construction practices.

3.2. Description of Prioritized Environmental Impacts

3.2.1. Land Acquisition and Resettlement

In order to implement the project a significant number of land acquisition and resettlement will be required. Therefore, this will affect the income and livelihood condition of the people in the project area. In pre-construction stage land acquisition and resettlement will bring a high negative impact (Table 3) because huge amount of land will be required for implementation of the project. However, there will be a high positive impact since all the affected people involuntarily shifted in the resettlement site. During construction stage it will have no significant impact; thus, in the operation and maintenance stage also will have no impact.

3.2.2. Flora Diversity

The project area is abundant with wildlife habitat, various types of trees and homestead forestation which provide food and wood in the local community. In pre-construction stage, a high negative impact (Table 3) will be observed on flora diversity because clearing the sites for starting construction as well as resettlement site development. Nevertheless, a high positive impact will observe when the trees are planting in the resettlement site. During construction fully demolish the construction site; as a result, a high negative impact will fall on the flora diversity. In the time of operation, a high positive impact (Table 3) due to the plantation of a significant number of trees will be planted along approach road and bridge end facility. Roadside green area development will have significant positive impacts in terms of improved landscaping, roadside bird habitats, trapping air pollutants/dust, and reduction in noise level to road surroundings, etc.

3.2.3. Fauna Diversity

The economic condition of the people in the project area is mainly depended on fisheries sector because most of the people are involved in fishing and also a high amount of fish has produced from the homestead ponds. The river in the project area supports the life of important aquatic life such as Hilsa fish, porpoise etc. as well as the pond is highly important for local community people because they get fish from the pond. A high negative impact (Table 3) will increase in pre-construction stage due to filling the pond, flood plain, wetland for resettlement site development. Similarly, a high negative impact will be observed at construction time because filling pond and flood plain for development of project sites. Besides this, at the time of rive training works the river will be affected due to dredging the river bed and Charland and disposal of dredging materials in river water. The aquatic life will be highly affected for improper disposal of dredging materials and due to disturb the aquatic sanctuary. Furthermore, at the time of pile driving activities will affects the fishes, porpoise, and other aquatic life because high underwater noise will be produced. On the other side, in operation and maintenance stage will have no significant impact on fauna diversity.

3.2.4. Waste

A high volume of dredged materials will be generated during the river training works and the time of pile driving and if it directs disposal of river water, as a result, the materials in the river water will influence the water quality and if direct disposal in Charland area will affect the soil quality. In pre-construction timeless dredge material will be generated in resettlement site so, it will have the low negative impact in this phase. But, during the construction stage, a high negative impact (Table 3) due to a high volume of dredge materials will be generated from river training works and when it will dispose of. Besides this, in construction yards near the riverside also produce a high amount of waste which will bring high negative impact on the environment. In the operation and maintenance time, it will have a low negative impact on the environment.

3.2.5. Agriculture

Most of the people in the project area depend on agriculture crop production as their primary livelihood activities. In pre-construction stage, a high negative impact (Table 3) will be perceived due to the acquisition of agricultural land for project implementation. The agriculture dependent livelihood will have no options for produce food for their home, so it will highly affect the poor village people. Likewise, a high negative impact will be experienced people due to clearing the sites for starting construction activities. In operation and maintenance stage will have a medium negative impact.

Table 3. Interaction Matrix of Environmental Impact Assessment.

Project Activities / Environmental and Social Components	Physical Components						Biological Components	
	Water	Air	Soil	Noise	Erosion / Scour	Waste	Flora Diversity	Fauna Diversity
Pre-Construction Phase								
Land Acquisition							-15	-15
Mobilization of construction equipment's and vehicles		-3		-4				
Clearing of sites						-3	-15	-5
Removing of top soils					-4		-5	
Earth filling and compaction	-3		-3	-4	-4			-15
Plantation		6						
Construction Phase								
Main Bridge								
Mobilization of construction equipment's and vehicles		-3		-4				
Dredging of channels to bring barges	-3					-3		-10
Construction of sub-structure	-6			-12		-3		-15
Construction of superstructure	-6	-3		-8		-3		
Disposal of wastes	-6		-3			-6		-5
River Training Works								
Mobilization of construction equipment's and vehicles		-3						
Dredging for slope preparation	-6	-3		-4	-4	-3	-10	-15
Construction of embankment	-6	-6		-8			-15	-5
Disposal of dredge materials	-6		-3		-8	-9		-15
Approach roads								
Mobilization of construction equipment's and vehicles		-3		-8				
Clearing of sites				-4		-6	-15	-5
Removing of top soils					-4	-3	-5	
Earth filling and compaction for road embankment	-3	-3	-3	-4	-4	-6	-5	-5
Black carpeting (bituminous carpet)	-3	-6	-3			-3		
Construction of road structures	-3	-6	-3	-4	-4	-3		
Waste disposal	-3		-3			-3		-5
Bridge end facilities								
Mobilization of construction equipment's and vehicles		-3		-8				
Clearing of sites						-3	-10	-10
Removing of top soils					-4	-3	-5	
Earth filling and compaction	-3	-3	-3	-4	-4		-5	
Development of superstructure				-4		-3		
Waste disposal	-3		-3			-3	-5	-5
Construction yards								
Dredging for development of Construction Yards	-6	-3		-4	-4	-3	-10	-15
Mobilization of construction vehicles/materials	-3	-3		-8				
Clearing of sites						-3	-10	-5
Removing of top soils					-4	-3	-5	
Earth filling and compaction			-3	-4	-4		-5	
Operation of Construction Yards	-9	-9	-3	-8	-8	-3	-5	
Operation & Maintenance Phase								
Main Bridge	-3	-3	-3	-8	-8		15	
River Training Works			-3		12			

Project Activities	Environmental and Social Components	Physical Components						Biological Components	
		Water	Air	Soil	Noise	Erosion / Scour	Waste	Flora Diversity	Fauna Diversity
Approach roads		-3	-9	-3	-8		-3	15	
Bridge end facilities					-4		-3		

Table 3. Continued.

Project Activities	Environmental and Social Components	Socio-cultural Components						
		Land Acquisition & Resettlement	Land Use	Agriculture	Health, Safety and Hygiene	Employment	Gender	Transport / Road Accidents
Pre-Construction Phase								
Land Acquisition		-15		-12		-8	-3	
Mobilization of construction equipment's and vehicles								-4
Clearing of sites				-12	-5	4	3	
Removing of top soils				-4				
Earth filling and compaction			-2	-4	-5	4	3	
Plantation			4					
Construction Phase								
Main Bridge								
Mobilization of construction equipment's and vehicles								-12
Dredging of channels to bring barges					-5			
Construction of sub-structure					-5	8		
Construction of superstructure					-5	8		
Disposal of wastes				-4				
River Training Works								
Mobilization of construction equipment's and vehicles								-12
Dredging for slope preparation					-5	4		
Construction of embankment						4		
Disposal of dredge materials			-6	-4		4	3	
Approach roads								
Mobilization of construction equipment's and vehicles								-4
Clearing of sites				-12		4		
Removing of top soils				-4		4	3	
Earth filling and compaction for road embankment			-2	-4	5	4	3	
Black carpeting (bituminous carpet)					5	4	3	
Construction of road structures			4	-4	5	8	6	
Waste disposal			-2	-4				
Bridge end facilities								
Mobilization of construction equipment's and vehicles								
Clearing of sites				-12	-5	4	3	
Removing of top soils				-4				
Earth filling and compaction			-2	-4	-5	4	3	
Development of superstructure			6		-5	4	3	
Waste disposal			-2					
Construction yards								
Dredging for development of Construction Yards					-5	4		
Mobilization of construction vehicles/materials								-8
Clearing of sites				-12	-5	4	3	
Removing of top soils				-4				
Earth filling and compaction			-2	-4	-5	4	3	
Operation of Construction Yards			6		-10	8	6	-4
Operation & Maintenance Phase								
Main Bridge						4	3	12
River Training Works						4	3	
Approach roads						8	6	12
Bridge end facilities						4	3	

3.2.6. Noise Quality

The noise quality in the project area generally lows except the ferry and launch Ghat. But, when the project construction works will be started, a high air and underwater noise will be generated which significantly affect the aquatic habitat, wildlife, and nearby communities. In pre-construction stage due to the mobilization of construction equipment, construction materials/vehicles for the development of resettlement site will generate noise but it has low effect on the environment. In contrast, a high negative impact (Table 3) will observe at the time of

construction of bridge substructure especially during pile driving, which generates high underwater and air noise levels that affect the aquatic life. Thus, at the time of main bridge superstructure construction, construction of embankment in river training works, mobilizations of equipment and construction materials for approach road, bridge end facilities, and construction yards, during the operation of construction yards will be a medium negative impact. Similarly, a medium negative impact will be experienced in operation and maintenance stage.

3.2.7. Health, Safety, and Hygiene

A large number of skilled and unskilled laborers within and outside the country will be engaged during the construction works, so it will be a great concern issue of health, safety, and hygiene of workers. In pre-construction stage, there are no significant impacts on workers' health, safety, and hygiene but during the construction stage medium, negative impacts (Table 3) will be perceived because at the construction yard due to high labor force the sanitation system will break down. Besides this, during construction time, the activities for construction of substructure and superstructure will hamper the health condition of workers due to high noise and dust emission. In operation and maintenance stage there will no impact on health, safety, and hygiene.

3.2.8. Employment and Poverty Reduction

A huge workforce, both skilled and unskilled will be required for completion of project construction activities. There is a huge potential for employment during construction and operation and maintenance stages as well as from induced economic growth and activities. In preconstruction stage, a medium negative impact (Table 3) will observe because the agricultural employee and the shopkeeper temporarily or permanently lost the employment due to land acquisition. But, some affected people will get employment opportunity in the activities of resettlement site development which have a low positive impact. During the construction period will provide employment opportunity for few labors both skilled and unskilled which will have a medium positive impact. In operation and maintenance stage some skilled workers will get an opportunity for permanently works for maintenance of bridge which will have the medium positive impact. So it will be clear that there will be a poverty reduction in one of the poorest regions of the country.

3.2.9. Transport and Road Accidents

Road transport is a key to overall development. Large quantities of material transport over the road will produce significant risks to traffic safety. In pre-construction stage during the development works in resettlement site will generate some transport related problem as well as accidents but it will have a low negative impact. On the other hand, high negative impacts will be created due to the mobilization of construction equipment and materials from procuring site. At that moment local traffic jam and road accident will be increased. On the contrary, a high positive impact will be perceived due to the connectivity of divisional city to Upazilla.

3.2.10. Erosion/Scour

In the project area riverbanks, both of the sides are very unstable and susceptible to severe bank erosion. During the river training works and construction of substructure of main bridge changes in the erosion and scour. Soil erosion during the construction time will affect the nearby agricultural land and siltation of riverbed. In pre-construction time low negative impact will notice due to soil erosion from the construction of resettlement sites development. Likewise, during the construction time, a medium negative impact will observe in the construction sites. Similarly, a medium negative impact (Table 3) will be seen at pier location due to scour. On the other hand, high positive impact due to the protection of river banks from further erosion through river training works.

3.2.11. Air Quality

At present air quality in the project area is affected by Ferry service and the launch Ghat emission. When the project will be started, at that moment air quality will be affected due to the mobilization of vehicles and construction equipment's, dust from stone/brick which will have a severe health problem of workers. In pre-construction stage in order to development of resettlement site, the construction equipment and materials will mobilize by the construction vehicles which will have low negative impacts. On other hands, development of green areas and other plantation activities in the resettlement sites will have a positive impact on the air quality. During the construction time, due to carrying on construction activities the mobilization and operation of vehicles and equipment, asphalt and concrete plants, and construction yards will be needed which will have a medium negative impact (Table 3). The air quality in the local area will be deteriorated from the emission of vehicles, construction equipment, and dust generated from rocks or stone. Likewise, a medium negative impact will be perceived in operation and maintenance stage due to a high volume of vehicles operation.

3.2.12. Water Quality

The surface and groundwater bodies are highly crucial in the project area because most of the people are dependent on it. The development of resettlement site in pre-construction

stage will have less pollute the surface and groundwater quality, so at this stage have a low negative impact. In contrast, medium negative impacts on surface water quality due to dredging activities for bringing barge, construction of the main bridge, and other structures over water bodies. In operation and maintenance stage there will be no negative impact on surface and groundwater bodies.

3.2.13. Gender

Women in general believed to be a vulnerable group in Bangladesh and their empowerment is crucial for country's development. During construction of resettlement sites in pre-construction stage, a huge number of women workers will hire for development their livelihood condition which will have medium positive impacts. On the other side, in the construction period will provide short-term employment of many people which include women, and hence will have a medium positive impact. Medium positive impacts due to the women are easily going wider markets to sell their products, agriculture produce, and fisheries.

3.2.14. Land Use

The land-use in the project area is mainly for agriculture or floodplains but when the project will be completed changes the land-use pattern due to the filling of floodplains and construction works. With the implementation of the project, the rural areas may get urbanization gradually in the long run and this could introduce secondary impact which might change the existing land use. The low positive impact will notice due to the construction of Resettlement Sites and plantations in pre-construction stage. During the construction time disposal of dredge materials will have a medium negative impact. However, since aesthetic values will be considered for the design of bridge and bridge end facilities, there will a medium positive impact post construction. In operation and maintenance stage there will be no impact

3.3. Environmental Management Plan

Table 4. Environmental Management Plan.

Significant Impacts	Probable Mitigation Measures
Flora diversity	1. Plantation should be done around the resettlement site. 2. To select fast-growing tree species for planting in the resettlement site. 3. The contractor will plant a significant number of tree and grasses along open spaces of the roadside. 4. Disposal of materials in accordance with the dredge material management plan. 5. Establishment of Galachipa projected sanctuary by the project contractor to mitigate the significant impact. 6. Plantation or green areas will be developed around the bridge end facilities and within the open space.
Fauna diversity	1. The contractor should be dug new ponds in resettlement site and tries to increase aquatic habitat. 2. Disposal of materials in accordance with the dredge material management plan. 3. Establishment of Galachipa projected sanctuary by the project contractor to mitigate the significance impact. 4. The contractor will dig the similar pond in resettlement area and also ensure to increase aquatic habitat. 5. Inspect any area of a water body containing fish that is temporarily isolated for the presence of fish, and all fish shall be captured and released unharmed in adjacent fish habitat.
Noise	1. The workers in construction yard will be required to use ear-plugs to offset the effect as noise management at the source levels are expected to be difficult except for the generators where the use of muffler would reduce the noise. 2. Install temporary noise control barriers where appropriate. 3. In order to reduce the underwater noise from pile driving, use vibratory hammer rather than impact hammer. Beside this, use a hydraulic hammer if the impact driving cannot be avoided. In addition to mitigating the Hilsa migration and porpoise breeding schedule monitoring will maintain and if possible delay the pile driving.
Agriculture	1. The contractor will provide compensation in accordance with resettlement action plans. 2. Bring fallow lands under agricultural cultivation. 3. Provide training program for the farmers and technical support to them. 4. To formulate agriculture development plan to increase crop production.
Transport and road accident	1. When construction materials will bring on land transport the construction vehicle will ensure speed limits which will not create accidental risk in public road and construction site. 2. Besides, the contractor should be provided adequate signage, barriers, and flag persons for traffic system. 3. Whereas, the local road will damage badly due to high load construction vehicles moving, so the contractor ensure interrupted vehicles moving as well as temporary construct bypass for reduce local road traffic congestion. 4. Also, repair the damaged local roads to their original condition after project completion. 5. On the other side, when construction equipment's and materials will transport by water channel, ensure less dredging the river bed and char land as well as the dredging materials will release in water in accordance with dredging material management plan.
Air quality	1. The contractor should implement the air quality management plan. 2. Cover hauls vehicles carrying dusty materials in construction site. 3. The contractors will be responsible for careful handling and storages of materials and operation of the equipment in order to reduce the air pollution including dust. 4. Special attention must be given in storage and handling of petrochemicals in order to avoid environmental hazard and risk. 5. The generators will be the major sources of air pollution in the construction yard, since, the exact specification of the generators are unknown at this stage.

Significant Impacts	Probable Mitigation Measures
Water quality	1. Less dredging the river bed and char land, as well as the dredging materials, will release in water in accordance with the dredging material management plan 2. Unused concrete should not be disposed into the river water. 3. Implement waste management plan on the construction yards. 4. All construction materials will be reused, recycled and properly disposed of.

4. Conclusion

The Galachipa bridge project has been proposed by the government of Bangladesh for increasing the communication system in southern part of the country. The project subject to its nature of activities falls under Red category as per ECA, 1995 and requires prior environment clearance from DoE, Bangladesh. Therefore, to get the environmental clearance certificate from DoE, a details environmental impact assessment report, as well as environmental management and monitoring plan, should be formulated. From this mandates, a details environmental impact assessment report as well as environmental management and monitoring plan was formulated. The EIA reveals that there will be both positive and negative impacts due to the construction of the bridge over the Galachipa River. The significant negative environmental and social impacts will have been noticed when the land will be acquired for starting the project construction works as well as at the time of resettlement site development. Alongside, the traffic safety risk such as accidents, congestion will have been amplified during the mobilization of construction equipment and materials by using the local road. On the other side, the flora and fauna diversity will be experienced a significant negative impact because of clearing the project site for the development of resettlement site, construction of approach roads, construction yards, and construction of bridge end facilities. Furthermore, at the time of pile driving for construction of the main bridge, a high underwater noise will be generated which will have a high negative impact on the aquatic habitat in the river. Besides, the activities for preparing the construction materials and at the time of construction of bridge superstructure, a high amount of noise will be produced which will have a high negative impact on the health of workers as well as the people of the nearby community. Moreover, at the time of river training works and construction of substructure such as pile driving, a high amount of dredge materials will be produced and improper disposal of this waste will deteriorate the surface water and soil quality. As a result, the aquatic habitat in the river and agricultural land beside the project area will face serious negative impact. On the contrary, the air quality will be deteriorated during the operation of construction vehicles and equipment at the construction site and the activities of construction yards as well as the construction of bridge substructure and superstructure. Nevertheless, this project will have significant positive impacts for instance; at the time of construction, a huge number of people will get short-term employment opportunity. Additionally, when the project will be completed the land use pattern of the project area will be changed. Besides this, the vehicles will get more trips, so the people will easily reach their destination. Moreover, the economic condition in this area will be rapidly developed. The findings of this research explored that the proposed project will have a significant negative impact due to some construction activities. Therefore, the expert members of this research have been formulated the environmental management plan in different phases (pre-construction, construction, and operation and maintenance) for mitigating the adverse environmental and social impacts. Besides this, a successful environmental monitoring plan has been provided for monitoring the air, water, and noise quality; flora and fauna diversity, waste, traffic safety risk, plantation, and health safety during the construction and operation and maintenance stages. The project will have overall positive impacts and some negative impacts. Most of this negative impacts are mainly construction related which will be mitigated by the successful implementation of the environmental management and monitoring plan.

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