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# ENVIRONMENTAL CRITIQUE ON WATER SECTORAL ENVIRONMENTAL IMPACT ASSESSMENT OF BANGLADESH

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## ABSTRACT

The water resources sector of Bangladesh relies on the Environmental Impact Assessments (EIAs) to assess the possible positive and negative impacts on the environmental and social components of the project affected areas. The motivation of this research was to identify the key environmental components, gaps and lapses of current EIA practices in water resources sector of Bangladesh. Under the motivation, this study has determined the effectiveness of a water resources EIA (Gorai River Restoration Project) for sustainable implication of water resources development and management projects in Bangladesh. Component-based checklist method and effectiveness review framework were used in this study to draw conclusions and to make environmental decisions on the important sections of the studied EIA. Review of the key aspects and the analysis of the effectiveness framework disclosed that the studied EIA is well performed and have considered sufficient information for decision making, but the residual and unavoidable impacts were not identified for all the important environment components in the construction and operation phase. Inclusion of important environmental and social components under different intervention scenarios, consideration of alternative flow regimes, suggestions and analysis of different project interventions ensuring public participation were the key strengths of the studies EIA. The considered environmental issues and aspects of this study can be used as guidelines for the future EIAs under the similar geo-environmental contexts. The developed review framework can be implemented in water resources EIA review process to ensure long-term sustainability of water resources projects.

**Keywords:** EIA, Effectiveness Review Framework, EMP, Water Resources

## 1. INTRODUCTION

An Environmental Impact Assessment (EIA) is a government-mandated prerequisite for the implementation of a project which has a potential for significant impacts on the environment (Glasson *et al*., 1999). Wathern (1990) defines EIA as the assessment of the environmental impacts and it helps to identify alternative options which ensures the project's sustainability both in environmental and socio-economic standpoints. Water resources interventions fall under the red category of industrial activities under the Environmental Conservation Act of Bangladesh (DoE, 1997).

For the water resources projects of Bangladesh, EIA acts as a pre-requisite for the proposed project feasibility and sustainability (WARPO, 2005). EIA Review is the process of checking the standard of an EIA to decide whether the proposed project gains approval and operation or not (UNEP, 2002). In this study, environmental considerations and aspects were reviewed and the effectiveness of the conducted water resources sector EIA were assessed based on the established EIA review methods.

The main objective of this study was to assess the effectiveness of water resources EIA in Bangladesh. The extent of the executed tasks, gaps of the study were identified and summarized considering the environmental and social aspects to ensure an effective EIA in the water resources sector.

## 2. MATERIAL AND METHODS

The effectiveness review framework, component based checklist method and reviews of expert's suggestions were used to summarize the gaps and lapses and to make a

recommendation for the studied EIA (UNEP, 2002). Component-based checklists were prepared considering the main findings of the environmental baseline and detailed EIA were thoroughly reviewed using three classes (C: Complete, M: Moderate and P: Poor) with explicit remarks (FPCO, 1992).

Scoping was scrutinized considering the relevant impacts, key factors and reasonable alternatives (Saha, 2007). Analysis of the major environmental impacts, indirect and cumulative impacts, suggested mitigation measures with monitoring arrangements and the contingency and compensation plan were reviewed sequentially under the effectiveness review framework method (UNEP, 2002). Consultations with the EIA practitioners (15) and experts (8) were conducted to verify the review results and to justify the applicability of the studied EIA under the proposed project options. Following Sadler (1996), this study rated the identification of deficiencies, critical shortcomings, remedial measures and decision making on a scale of A (well performed) to F (very unsatisfactory) and considered the '*Triple A*' test of appropriateness (coverage of key issues and impacts), adequacy (impact analysis) and applicability (effectiveness).

## 2.1. Overview of Gorai River Restoration Project (GRRP)

Gorai River is the main distributary of supplying fresh water in the south-western part of Bangladesh (Mirza, 1998). Seasonal flow (November to May) of the Gorai River has been declining for the last twenty years and further decrease in dry season flow will lead to the rapid siltation at the mouth of the Gorai River. After signing the Ganges Water Treaty (GWT) with the Government of India (GoI), Government of Bangladesh (GoB) asked the World Bank (WB), the Government of Netherlands (GoN) and other donor agencies to assist the implementation of GRRP. For this reason, a mission was undertaken in September, 1997 and March, 1998.

The GRRP area covers about 1.616 million hectares of land area which falls between the latitude of 21° 30′N to 24°N and longitude of 89°E to 90°E. The Gorai River off-takes from the Ganges River is as the northern boundary and the southern tip of the Sundarbans is the southern boundary of the GRRP area.

The GRRP was planned to start in 2001 under the auspices of Bangladesh Water Development Board (BWDB) with the funding support from the GoB, WB and the GoN (DHV-Haskoning and Associates. 2000). The overall objectives of the proposed GRRP are to prevent environmental degradation in the southwest region, the coastal belt and to save the Sundarbans (the largest mangrove of the world) by undertaking the restoration works of the Gorai River ensuring supply of fresh water flow in the wet season and augmenting flow during the dry season (BWDB 1998). The proposed project will improve agricultural and fisheries production and navigation through mitigating adverse environmental effects due to salinity intrusion. The major components of GRRP are (a) river training works at the Gorai mouth and the Ganges approach to the Gorai off-take, (b) restoration of the Gorai River distribution system, (c) community development and (d) participation and institutional capacity building for maintaining the restored river system while ensuring sustainable water distribution and use.

GRRP includes investigation of every part in its preliminary stage including the design, river training works and a program of maintenance dredging to augment the flows of the Gorai River. Proposed GRRP will update and supplement technical, social, environmental and economic assessments and will incorporate lessons learned from the recurrent dredging activities which is carried out under the priority work programme of the Government of Bangladesh. The proposed GRRP will be conducted on the basis of the project appraisal by the GoB, World Bank and other bilateral donors (BWDB, 1998). Therefore, the EIA of this proposed study was conducted by the multidisciplinary team of EGIS-II, an environmental organization and a Trustee of the Government of Bangladesh, before the initiation of the project activities.

The main objectives of the studied EIA were to assess the positive and negative impacts on the environment due to the priority construction and river training works for the flow restoration and to prepare an environmental management plan to monitor and mitigate any forthcoming adverse impacts on natural environmental and social life due to the proposed project interventions. The EIA study was carried out in the priority project area of the Gorai River, the Gorai Corridor and the Southwest Impact Zone and areas which are directly or indirectly impacted by the GRRP (EGIS-II, 2000b).

## 2.2. Detailed EIA of GRRP

Three flow regimes were considered due to the environmental standpoint with minimum flow of 60 $m^3/s$, medium of 100 and 150 $m^3/s$ (high) with average flow of 130-135, 175-180 and 230-235 $m^3/s$ respectively in the dry season. The annual flow volume would increase from 9,000 $Mm^3$ under Future-Without Project

(FWOP) to 39,460 $Mm^3$ under the low flow regime in the future with-project (FWIP) condition.

The changes in salinity affected area were found to

be quite significant under the FWOP condition from 97.944 to 199.316 $km^2$ (9 to 18% Direct Impact Area) at the low flow regime consideration. Different project options (**Table 1**) were suggested by DHV-Haskoning and Associates, including river training works and dredging at one or more channels of the Ganges, near the Gorai-off take and in the Gorai River itself (DHV-Haskoning and Associates, 2000).

Among the different options (A1 to A7), A1 has the least intervention in physical, biological and social aspects, A2 to A5 options have structural interventions, A6 and A7 have included extensive dredging but may create environmental degradation and are not economically feasible. Sundarbans has reflected much more negative impacts under the FWOP condition. Under the FWOP condition, 12% of the GRRP area will be under the low salinity zone in which timber productivity will decline and the rest of the area will be under the high salinity zone, fish habitat will deteriorate, an imbalance in prey-predator relationships will emerge, breeding grounds for fresh and saltwater fishes will be diminished or disappear, which will result in an imbalance in ecosystem functioning.

Under the FWIP condition, 33% of the Sundarbans forest will come under the low salinity zone which will benefit the floral and wildlife composition, fish population and biodiversity will improve, flushing of lagoons will support good seasonal vegetation succession, increased flow of dry season water will be increased about 10%, land reclamation will be possible, socio-economic development is estimated with the increased agricultural and fishing activities, 190% improvement in fresh water and shrimp farming, greater availability of fresh water (ground and surface), positive impacts on the health of the people and the surroundings of the south-west region of Bangladesh. Among the negative impacts of FWIP condition, private acquisition will result in the land loss of 500 households, 32% reduction in shrimp farming and increased vulnerability of riverbank erosion in other parts but not at the structural sites.

The Environmental Management Plan (EMP) included a mitigation plan for different project phases, a compensation plan (land acquisition, land requisition, erosion) and a contingency plan (pre-construction, construction and operational phase). Important steps of the mitigation plan included a stipulation that the minimum possible amount of land is to be used and the affected people are to be compensated properly. The enhancement plan included measures that will ensure derivation of the intended benefits. Components of the enhancement plan covered plantation program, restoration of connectivity of rivulets with the Gorai River and excavation of fish migration routes.

The monitoring plan for the GRRP prepared to monitor changes taking place due to the restoration of flow through the Gorai River. The EMP summarizes hydrologic, soil, agricultural, ecologic and social monitoring programs. Dividing the total DIA of GRRP into a number of management units was established based on the commonality of interests regarding management of water resources (EGIS-II, 2000b).

**Table 1.** Proposed project options (A1 to A7) with the associated interventions (Source: DHV-Haskoning and Associates, 2000)

| | Options | | | | | | |
|---|---|---|---|---|---|---|---|
| Intervention | *A1* | *A2* | *A3* | *A4* | *A5* | *A6* | *A7* |
| Ganges guide bund | | | | | + | | |
| Ganges cross bund | | | | + | | | |
| Ganges groynes | | + | | | | | |
| Ganges/Gorai flow divider | + | + | + | + | + | | + |
| Ganges/Gorai revetment | + | + | + | + | + | | + |
| Ganges/Gorai vanes | | + | + | | | | |
| Gorai groynes (Right bank) | + | + | + | + | + | | |
| Gorai revetment | + | + | + | + | + | | |
| Gorai groynes (Left bank) | + | + | + | + | + | | |
| Kumarkhali groynes | + | + | + | + | + | | + |
| Capital dredging of the Gorai channel | + | + | + | + | + | + | |
| Recurrent dredging of the Gorai channel | + | + | + | + | + | | + |
| Deepening and narrowing of the Gorai chainage 0-30 plus revetments to protect the Gorai River banks | | | | | | | + |

## 3. RESULTS

Feature-based review results of the requirements, limitations and recommendations of EIA of GRRP are summarized in the review matrix (**Table 2**). The result section contains the major inclusions in the EIA study and the recommendations are suggested considering the results from the effectiveness review framework and component-based checklist methods and the decisions are done using Sadler's rating scale (Sadler, 1996).

**Table 2.** Review matrix of gaps, lapses and recommendations for the EIA of GRRP

| Feature | Review results | Recommendations | Decision |
|---|---|---|---|
| Preambles | The scope and limitations of the study and main con-sultants' names or organizations were not provided (ADB, 1993) | The scope and limitation of the study and a brief review of similar projects should be included to analyze the overall project situation. | A (competently performed) |
| Policy, legal and administrative framework | Existing environmental conservation act, 1995 was not highlighted (DoE, 1997). | Policies relevant to the important environmental components should be analyzed to illustrate the legal and administrative framework | C (satisfactory) |
| Approaches and methodologies | Major discussion of the used methodologies was not included. Overview of used guidelines was not given and major data gaps (primary and secondary) not discussed (ADB, 1993) | Brief discussion of the methodologies and used guidelines will be more informative and effective for decision-making. | C (satisfactory) |
| Project options | Project options did not include additional information (about land requirement, resources, labor force and investment cost for each options) and hierarchy and schedule of the interventions is not provided in the detailed EIA report. | Complete project description considering ancillary essential information should be added to give the overall idea about the project description and implementation. | B (well performed) |
| Environmental and social baseline | Chemical and biological properties of the surface water were not provided in the baseline section. Interventions of the previous projects are not considered (WARPO, 2005). | Surface water chemical and biological properties should be measured to define the current water condition. Base condition and dataset of each component should be used to analyze the possible affected area by the project interventions. | A (thoroughly performed) |
| Alternative flow regimes | Uncertainty of flow regime was not considered. | Flow regimes should be considered with the seasonal and annual fresh water availability. As the upstream water supply is uncertain due to the construction of Farakka Barrage, alternative flow regimes should be considered with existing water availability (Mirza, 1998). | B (well performed) |
| Environmental and social impacts of different options | Critical evaluation, positive and negative impacts were not highlighted individually for every single option (among the seven different options). Key data gaps and opportunities for environmental enhancement were not considered. Residual impacts were not highlighted separately. Cause and effect relationships between planned project activities and the environmental components were considered in few aspects. | Key data gaps should be incorporated in section. Cause and effect relationship should be explained in all the aspects of environmental and social perspectives. | B (well performed) |
| Environmental and social impacts of selected option | Component-based residual impacts on natural environment of the selected option were not highlighted. Uncertainty of selected options and its impacts on environment and social components were not discussed separately (FPCO, 1992). | All the residual, unavoidable and uncertain impacts should be considered. | B (well performed) |
| Environmental and social management plan | Mitigation measures and technical aspects of the project were not discussed separately. Staffing and management options were not included in the detailed EIA. | All the plans (mitigation, enhancement and contingency) should be emphasized equally. Residual impacts should be discussed individually. Management options and staffing should be given. | B (well performed) |
| Environmental and social monitoring plan | No major gaps and lapses were found. | Phase diagram of monitoring activities for each component will give the overview of the monitoring plan. | A (thoroughly performed) |
| institutional framework | No major gaps and lapses were found. | Institutional framework should be placed with environmental management plan (WB, 1991). | A (thoroughly performed) |

## 4. DISCUSSION

In the EIA of GRRP, beneficial and adverse impacts are explained under the Future-Without Project (FWOP) and Future-With Project (FWIP) conditions for each of the proposed project options emphasizing construction and operation phases (EGIS-II, 2000b). Risks of adverse impacts were evaluated properly with an impact matrix (Canter, 1996). The project has impacts on environmentally sensitive areas, endangered species and their habitats and on aesthetics. All these impacts are considered for different project options and specifically for the selected options.

Comparing the FWOP and FWIP conditions, the "Without Project" scenario is not recommended because the Gorai River needs extensive human interference to restore its water flow during the dry season. The GRRP is necessary due to its environmental and social benefits to the surrounding area and about 96.7% of the stakeholders of the GRRP area shared their positive opinions during the participatory sessions (EGIS-II, 2000b).

Seven different options in various locations were suggested in the feasibility study of GRRP (DHV-Haskoning and Associates, 2000). No similar project implemented at the proposed GRRP site in the recent past. The unavoidable adverse impacts on the natural environment (ecology and biodiversity) were discussed for the construction and operation phase in the studied EIA. Concerns expressed by likely affected people are considered and the impacts were reviewed to assess the exact impacts on environmental and social components. The detailed EIA of GRRP addressed the environmental and social concerns adequately in all significant stages of the EIA process (EGIS-II, 2000b).

Proposed mitigating measures were reasonably feasible and the EMP was found effective for proper decision-making. Important environmental and social monitoring programs (e.g., hydro-morphological, surface and groundwater, soil, ecological and social monitoring programs) were included in the EIA of GRRP. Residual impacts on natural environment were conflated in defining the mitigation plan and unavoidable impacts on the environment (especially on ecology and biodiversity) were discussed with the contingency and compensation plan, but not discussed in separate sections (FPCO, 1992).

### 4.1. Rating of EIA of Gorai River Restoration Project

Considering the key aspects with crucial environmental and social issues, the EIA of GRRP was graded as "B" (well-performed), based on the Sadler's (1996) rating scale. The EIA of GRRP was well- performed and no major task was left incomplete in the detailed EIA and the studied EIA has sufficient information for better decision-making in project approval and implementation.

### 4.2. Lessons Learned

Impact area consideration of the EIA of GRRP was carried out considering the Gorai River corridor and priority project area. The direct impact area was specified considering surface and groundwater which is a good remark of proper scoping and bounding.

Consideration of Important Environmental Components (IECs) and Important Social Components (ISCs) in the Environmental Baseline facilitated the visualization of the overall FWOP and FWIP conditions and improve the understandability of the apparent impact assessment. IECs included hydrological (water level, discharge, salinity), morphological (planform analysis, sediment transport), aquifer system, groundwater level, soil and agricultural (cropping pattern, crop production and damage, agricultural inputs), fisheries (both capture and culture) and ecological parameters. ISCs included demographic data, land distribution and agricultural arrangements, income and quality of life (Education, Health, Nutrition, Water Supply and Sanitation).

Seven different alternative project options considering three different flow regimes (high, medium and low) provided the alternative coping scenario with the changing water conditions (**Table 1**). Reliable data sources of secondary information, national databases for secondary data and up-to-date environmental (RS and GIS) and social techniques were used in the methodologies and have given an overview of the environment and social impacts on the direct impact area.

Environmental and social impact statements considered both FWOP and FWIP conditions for seven different options including separate discussion (environmental and social consequences and land requirements) for each of the components. The selected project options facilitate decision making and improve the understanding of the FWOP and FWIP scenarios. Categorized environmental and social management (mitigation, contingency, compensation and enhancement plan) and the monitoring plan were structured considering all the important environmental and social components and provide a strong basis to determine future environmental and social scenarios.

The involvement of existing institutions and nine local level management units were found useful to gather local knowledge and opinion to make the assessment and

project sustainable. Risk analysis of environmental and social impacts was performed using an impact matrix. Ubiquitous public participation was found in all the major steps of environmental impact assessment of GRRP. The overall study was conducted following the National Water Policy (NWP) of Bangladesh, therefore, all the major environmental and social components and issues should be considered in the detailed EIA (MoWR, 1999).

Canter and Canty (1993) studied the significance of impact determination of many international water resources EIA experiences (especially American and European) but the focus was on the identified impact that can be mitigated, planning a baseline and monitoring programs. The highlight of the studied EIA was for the significant impact determination, a hierarchy of significance determination criteria considering the geographic situation, project type and size, environmental problems due to the project interventions were considered under the defined sections (**Table 2**).

This EIA review study was developed underlying the fifteen (15) evaluation criteria identified by Thompson (1990) who reviewed twenty four (24) established EIA methodologies and suggested a coherent approach to EIA for significant impact determination. Based on the past success of integrated river basin management in China (Sun, 1994) and Africa (Scudder, 1994), Barrow (1998) came up with the evaluation criteria for integrated river basin management concept and management in the UK and suggested SEA, ecosystem auditing and setting regional environmental management system and the outcomes of these studies used as guidelines to ensure the robustness of EIA review.

Momtaz (2002) stated the EIA process in Bangladesh and reviewed an EIA of drainage rehabilitation projects based on the EIA framework of Modak and Biswas (1999) and a qualitative analysis was done under the broad categories but in this review study, the rating scale was used for every single components in the checklist and also included the important evaluation criteria considered by Momtaz (2002) to make the study more applicable for the other sectoral EIAs.

The established review framework was cross-checked with the defined criteria and issues discussed under the two famous European directives, Water Framework Directive and the Strategic Environmental Assessment Directive (Carter and Howe, 2006). The requirements discoursed in those directives (e.g., collection of baseline data, assessment of alternative options and policies, mitigation and monitoring programs, consultation and public participation) were thoroughly reviewed for the studied EIA and found adequate with no missing information for proper decision making.

The review framework and the decision-based checklist incorporated all the effectiveness dimensions used by Hirji and Ortolano (1991). They checked the EIA effectiveness for four water resources interventions in Kenya, namely, Masinga Dam Project, Munyu Dam Project, Kiambere Dam and Tana Delta Irrigation Project. The Tana Delta Irrigation Project had some similarities with the GRRP. The environmental and social issues discussed for the Tana Delta Irrigation Project were thoroughly checked and compared with the GRRP to ascertain the review results. Used EIA review criteria by Sadler (1996) used in this study also checked with the defined speculations by Hirji and Ortalano (1991) followed by Ortolano *et al.*, 1987, to ensure the effectiveness of this EIA review. All the environmental and social considerations of the studied EIA comprised with the defined speculations of Ortolano *et al.*, 1987.

The review criteria under the checklist methods covered all the important environmental criteria suggested by Colley *et al.*, 1999, their developed EIA review package was used to analyze twenty eight (28) EIA reports of South Africa (Sandham and Pretorius, 2008) and to review the EIA qualities of Egypt (Badr *et al*., 2011), for eight European countries (Barker and Wood, 1999) and for the Scottish forest sector of the UK (Gray and Edward-Jones, 1999). The review results from the used checklists methodologies and expert opinions and the results using the review framework developed by Colley *et al.*, 1999 came up with the same result (A: Well performed; Colley *et al.*, 1999). The review results from this study is comparable to other established and experimented EIA review methodologies implemented in environmental sectors all over the world and it showed similar results which increase the applicability of using descriptive and decision driven checklist review methodologies to review large scale water resources EIA studies.

Consideration of environmental and social components under different flow regimes with the associated impacts, delineation of proposed alternative options, detailed environmental management and monitoring plans and overall public participation made the EIA of GRRP a noteworthy EIA to follow for the future Environmental and Social Impact Assessment studies in Bangladesh and for other areas under the similar geo-environmental context.

## 5. CONCLUSION

Key aspects of an EIA were reviewed to assess the effectiveness of the studied EIA. The four main themes of the EIA of GRRP (quality, content, environmental management plan and conclusions) were thoroughly reviewed in this study and the detailed EIA was found well performed with no major tasks left incomplete. The EIA provided sufficient information for the relevant decision makers who are responsible for deciding whether or not to implement the GRRP. The analysis of the possible impacts were conducted using the descriptive, decision-focused checklists and expert suggestions but environmental cost-benefit analysis could give more insight of impact prediction, assessment, decision making and to communicate the results much more efficiently to the decision makers but unfortunately environmental cost benefit analysis was not conducted in this study due to the confidentiality of the project documents.

The GRRP is highly recommended to be implemented due to the present flow condition of Gorai River and its associated present and future environmental and social impacts. Furthermore, the EIA of GRRP is a model for the other Environmental and Social Impact Assessments of the water resources sector in Bangladesh and for the water resources development and management projects under the similar geographical and environmental contexts. The review matrix developed under this study can be used and improved integrating other EIA review methods to crosscheck the effectiveness of EIA in achieving long-term environmental sustainability for the water resources projects.

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