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PERFORMANCE EVALUATION OF BURAGHAT RUBBER DAM PROJECT IN IRRIGATION DEVELOPMENT AT HALUAGHAT IN MYMENSINGH

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Abstract

Rubber Dam is a latterly developed hydraulic structure which is usually built to impound surface water for a single purpose i.e. irrigation, flood control etc. In 1995, Rubber Dam projects were first commissioned in Bangladesh with the technical co-operation of the Institute of Water-resource and Hydropower (IWHR), China, as it is very convenient and cost-effective technology for irrigation. After implementing, it is very crucial and challenging task to study the suitability and effect of Rubber Dam in irrigation development. This study attempted to evaluate the performance of Buraghat Rubber Dam project (BRDP) and to identify the constraints embroiled to its efficient water management at Haluaghat Upazilla of Mymensingh District. The performance is evaluated by means of some technical parameters including Command area efficiency (CAE), Management performance ratio (MPR), Water-use efficiency (WUE) and Benefit-cost ratio (BCR). It is observed from the study that the CAE of scheme-1 and scheme-2 of the project is 30.71% and 27.14% respectively and MPR is 0.019 and 0.021 in that order indicating substandard. Furthermore, the study revealed that the WUE of both schemes is 32 kg m^{-3} and 37 kg m^{-3} respectively. However, BCR of the same is 1.50 and 1.52, which has found to be quite reasonable. Therefore, a considerable number of performance constraints of the Buraghat Rubber Dam irrigation project are identified to achieve the targeted fruitful outcomes.

Introduction

Bangladesh is a thickly populated agro-based country of South Asia. Irrigation plays a vital role in stimulating countries agricultural productivity as well as overall economic growth. However, continued water scarcities in the recent years have severely limiting irrigation facilities. Over withdrawal of groundwater through tube wells to meet the ever increasing irrigation demand and drinking water facilities has already created serious health hazards by means of arsenic contamination and other adverse environmental impacts. Therefore, surface water conservation and rainwater harvesting have become feasible options mitigating water crisis through minimizing excess withdrawal pressure on groundwater especially during dry season irrigation. Under these circumstances, Rubber Dam has evolved as a cost-effective hydraulic structure for surface water conservation of medium and small rivers. Rubber Dam is a new type of hydraulic structure as compared to the conventional gated structures like sluice gate, regulator, barrage etc. China is the pioneering country where Rubber Dams have been used successfully in small and medium rivers over the last 50 years (1960s) as the cheapest hydraulic structure.

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Rubber Dams have wide prospect in utilizing surface water for irrigation, hydro - power generation, flood control, pisciculture, water retention for aquifer recharge, reducing or preventing sea water intrusion into fresh water areas, protect low-lying coastal areas from tidal flooding, environmental improvement and recreation purposes.

The Dam structure consists of four parts: rubber bag, anchorage, foundation and pump house (filling and emptying system) as shown in Figure 2. Body of the Rubber Dam frequently termed as Dam bag is made of rubber reinforced by oven synthetic fabric. The reinforcement provides the tensile strength with rubber acting as the adhesive and water proofing element. The rubber fabric is a multi-layered fabric made of synthetic fiber (usually nylon), which is rubberized on one or both sides and coated, with plastic film. The thickness of the three-ply fiber reinforced rubber fabric is 8 mm. The fabric is quite flexible and exhibits good wear-resistance characteristics.

Rubber Dams are placed across channels and streams to raise the upstream water level when inflated and generally being bolted with a concrete foundation erected from the river or channel bed. A layer of stainless steel mesh or ceramic chips can be embedded in the surface layer to reduce or prevent vandal damage. Anchorage of rubber membrane can be made using concrete wedge blocks or steel clamps with anchor bolts. Rubber dams can be filled with water, air or both. Air filling is quicker but needs relatively sophisticated pumping and pipe-valve system. Water filling is relatively slow but ordinary pumps can be used with less complicated pie-valve system. Capacity of pump for filling or emptying depends on operational need of the dam. Air filled dams require low pressure typically 4 to 10 psi. The present trend suggests an increased use of air filled membranes because they can be inflated or deflated more rapidly, and they are less affected by freezing conditions. According to form of dam tube, they are classified into pillow like dam and inclined or slope dam.

Water is a vital and costly input for crop production. Since it is limited, every drop of water should be utilized properly for optimum yield especially for rice production. Therefore, in order to minimize irrigation cost and for the proper utilization of water, the Rubber-Dam irrigation project on Buraghat River under Haluaghat Upazila of Mymensingh district was planned earlier in 2004 but actually implemented in 2007. In the light of aforementioned issues, some specific objectives were considered to conduct this study and these are: (i) To determine the command area efficiency (CAE), management performance ratio (MPR), water-use efficiency (WUE), and benefit-cost ratio (BCR) of the project (ii) To identify constrains involved in the project and finally some recommendations were given for efficient water management of the BRDP.

Literature review

Salameh (2004) carried out a study on the Karama Dam with a capacity of 55 Mio m^3, which was constructed in 1995 on Wadi Mallaha in the Jordan Valley area with the aim of storing water for irrigational uses. The study findings expressed that the dam fails to collect water after nine years of its construction because there are no sources available to fill it. Dam reservoir was extremely saline (20,000 micro S/cm). Reservoir bottom collapses owing to dissolution of salts took place and large amounts of water were lost to the underground. Equipment of pump water for irrigational uses has been corroding, and the government is paying the depreciation, capital, and running cost of a fiasco project.

Lowitt (2002) discussed the construction and cost benefit analysis of the Optima Dam project located in Optima town in the central part of the Oklahoma Panhandle. This project was justified on the basis of its multiple purposes: flood control, probable irrigation, municipal water supply, silt control and recreation. The project was reconsidered in 1962, restructured in 1966 and completed in 1978. Unfortunately, flat lands, low runoff and high evaporation of the semiarid Panhandle made the area poorly suited to reservoir construction.

Ali and Wooldridge (1997) assessing the performance of G-K (Ganges-Kobadak) project, a large-scale irrigation scheme in Bangladesh with the command area of 1.25,000 ha. The study shows that the agricultural production in the command area has increased significantly under the project. However, project performance has deteriorated with time. The project has undergone major rehabilitation works aimed at overcoming physical constraints to the control of water distribution.

Dutta (1985) carried out a study on on-farm water management of 100 nos. of minor irrigation projects in Ghatail-Kalihati-Gazipur-Pubail area of Bangladesh. The study revealed that, the water loss in the deep tube-wells, shallow tube-wells and low-lift pump irrigation projects might be as high as 17%, 27% and, 21% of the pumped discharge per 100 meters length of the canal. The study also expressed that, the water loss relatively low in the canals, which were maintained well. Bhuiyan (1977) conducted a research work on "Evaluation of constrains to efficient water utilization in small scale irrigation schemes in Bangladesh." The study identified that, failure of pumps, poor maintenance of water distribution systems, pool, location of pumps and inefficient layout of canals, management performance of co-operatives are the key constraints against efficient water utilization. Lacks of motivation, inadequate credit facility, poverty, influence of pressure group etc. were some of the problems relating to irrigation water use.

Sarkar et al. (2001) evaluates the performance of Rubber Dam project in irrigation development at Nalitabari, Bangladesh on the basis of some performance indicator. The study disclosed that, the performance indicators like command area efficiency ranged from 58.45 to 85.34% with an average value of 63.91% management performance ratio varies from 0.012 to 0.114 with an average value of 0.028. Yield efficiency swayed from 33 kg m^{-3} to 54 kg m^{-3} with an average value of 41.8 kg m^{-3}. Overall agricultural benefit was augmented under that project where benefit-cost ratio ranged from 1.26 to 1.39 with an average value of 1.34. Miranda (1988) published that, the acceptable range of management performance ratio was 0.75 to 1.50 in irrigation practices in crop diversification project in Indonesia & Philippine. Haq et. al. (1985) reported that, the command area efficiency was 60% and 90% percent in Kharip-i and Kharip–ii season respectively, in the selected territories in G-K (Ganges-Kobadak) project.

Materials and methods

Study area

The location of the project area lies approximately between $25^0$7'N and $25^0$9'N latitude and between $90^0$22'E and $90^0$25'E longitude and positioned in south side of Buraghat River. The Buraghat River originated from Garo-hill (Meghalaya pradesh) of India and streams to the south side of the Haluaghat Upazilla. The total irrigable land under the studied project is about 700 ha (1729 acres). But actual area covered by the project is about 200 ha (494 acres). The topography of the study area is mostly flat which consists of 30 percent highland, 40 percent medium high land and 30 percent medium low land. The western and eastern part of the study area comprises of sandy sediments, elsewhere the deposits are predominantly clay, loamy, clay and sandy loam with pH ranges from 5 to 6.5. The reaction of the soil is highly acidic to low acidic. Climate in this area is cool, rainy and cool summer. Farmers under this project usually cultivated High Yield Varieties (HYV) of Boro rice. A few HYV of wheat and some vegetables are also cultured under the schemes of the project.

Salient features of the Buragh at Rubber Dam

The salient features and specifications of BRDP are given in Table 1.

Table1. Salient features and specification of BRDP

Dam features		Specifications
Length of Rubber Dam	:	30 m
Dam height	:	3.5 m
Maximum retention	:	3.5 m
Length of concrete floor	:	27 m
Dam body		
☐ Material	:	Reinforcement Rubber
☐ Shell thickness	:	8 mm
☐ Thickness of Cover	:	3 mm
Bridge	:	30 m
Guide bunds	:	8 km (Earthwork)
Approach road	:	2 km
Pump house	:	1 no. [for filling & emptying dam bag]
Bag filling time	:	12-15 hrs.
Pump Capacity	:	100 m^3/hr.
Scheme life	:	(15-20) yrs.

Figure 1. Typical view of Rubber Dam

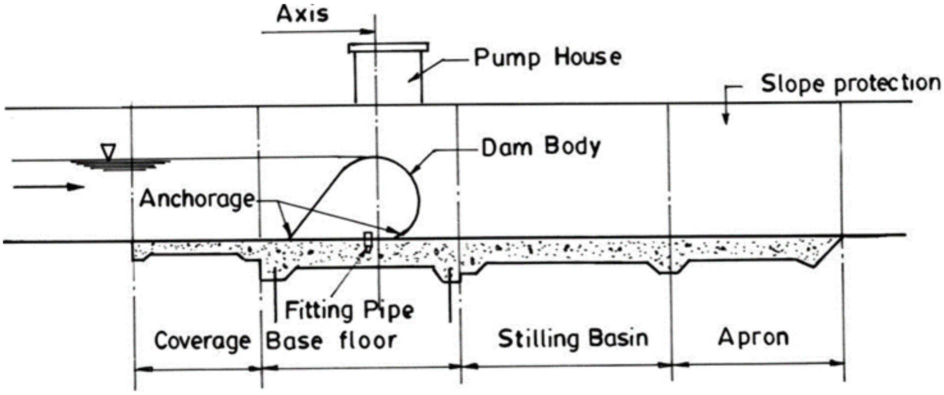

Figure 2. Schematic view (cross-section) of Rubber Dam

The irrigation schemes under BRDP are executed by Irrigation and Water Management Co-operatives (IWMC). It is formed with twelve executive members including chairman (1 no.), secretary (1 no.), joint secretary (1 no.) and general members (9 nos.) for various dealings. Water charge for BRDP was fixed at Tk. 2470.00 per hectare and usually, the rate has been settled by its executive committee on the basis of total investment cost. The general meeting normally held in the last week of every month in the association office.

Data collection

Data were gathered from Local Government Engineering Department (LGED), Mymensing has well as Irrigation and Water Management Co-operatives (IWMC) of BRDP situated in Gazir Bhita, Haluaghat, intended to the assessment of existing management practices of the schemes. Congregated information was then justified through non-formal field inspections and interviews with secretary and joint secretary of IWMC and farmers. The data are presented herein:

- Approximate discharge: 1.13268 m^3s^{-1}
- Type of irrigation system: Gravity Flow.
- Size of the Inlet structure (Main canal): Rectangular; (Width: 1.5 m, Height: 1.8 m)
- Length of main canal: 1700 m.
- Nos. of Secondary canal: 3
- Size of Secondary canal : Rectangular; (Width: 0.75 m, Height: 1.0 m)
- Area covered by Main canal: Surjopur village and Gazir Bhita village (Total = 86 ha).
- Similarly Three Secondary canal covers: Uttar Nolkora village, Katolmari village and Purbo Somalia Para village (Total = 114 ha).
- Capital of IWMC: Tk. 244560 (1 USD≈78 BDT).

Theoretical considerations

The theoretical considerations were reviewed by Molden and Gates (1990) and Molden et al. (1998).

Command Area Efficiency (CAE)

It is the ratio of actual command area to the potential command area and expressed in percentage.

$$\text{Command Area Efficiency} = \frac{\text{Actual Command Area}}{\text{Potential Command Area}} \times 100$$

Management Performance Ratio (MPR)

It is the ratio of total volume of water supply to total volume of water demand.

$$\text{Management Performance Ratio} = \frac{\text{Total Volume of Water Supply, m}^3}{\text{Total volume of Water Demand, m}^3}$$

$$\text{Total volume of Water Supply} = \text{Actual discharge capacity} \times \text{Total operating time}$$

$$\text{Total volume of Water Demand}$$

$$= \text{Irrigation water requirement for crops} \times \text{Actual command area}$$

Water-use Efficiency (WUE)

It is expressed as the rate of biomass produced (or harvested yield) per cubic meter of water used.

Benefit-Cost Ratio (BCR)

It is the ratio of gross return to total cost.

$$\text{Benefit Cost Ratio} = \frac{\text{Gross Return}}{\text{Total Cost}}$$

Total Cost includes cost of seed or seeding, fertilizer, plough, labor, insecticides, tax, and organization maintenance in Tk. per hectare.

Gross Return: It includes the value of crops and Straws in Tk. per hectare.

$$\text{Net Return} = (\text{Gross Return} - \text{Total Cost})$$

Results and discussion

Command Area Efficiency (CAE)

Command area efficiency of scheme-1 and scheme-2 of the BRDP are tabulated in Table 2. Command area efficiency depends largely upon irrigated area and potential command area. Actual command area depends on wide variety of factors like farmer's involvement in irrigation, interest for cultivation, regular maintenance of water conveyance system, favorable soil conditions, efficient water management practices etc. The lower command area efficiency had occurred due to lower discharge from rubber dam reservoir, considerable amount of water losses from the conveyance system, which is at about 40% and poor water management practices in the irrigation system.

Table 2. Command area efficiency of the BRDP

Sl. No.	Name of irrigation schemes	Irrigated area, (ha)	Potential Command area, (ha)	Command Area Efficiency, (%)
1	Scheme-1	86	280	30.71
2	Scheme-2	114	420	27.14

Management Performance Ratio (MPR)

The management performance ratio (MPR) indicated (Table 3) that both schemes of BRDP were poorly performed due to higher farm canal density; lower operating times and delayed starting of irrigation activity. The discrepancy of MPR denoted that there was great scope to get better water management practices in these existing schemes of the project.

Table 3. Irrigation water management performance ratio of schemes of the BRDP

Sl. No.	Name of irrigation schemes	Name of the village under the scheme	Distribution pattern	Total volume of water supplied (including conveyance loss) (m^3)	Total volume of water demand (m^3)	MPR
1	Scheme-1	Surjopur , GazirBhita	Main canal	4377694	220160000	0.019
2	Scheme-2	Uttar Nolkora, Katolmari and Purbo Somalia Para.	Secondary canal	5802990	273600000	0.021

Water-use Efficiency (WUE)

Water use efficiency of both schemes under the rubber dam project ranges from 32 to 37 kg m^{-3} with an average value of 34.5 kg m^{-3} (Table 4). Higher yield efficiency could be attained reasonably by providing training on effective irrigation planning and better water management practices to the farmers.

Table 4. Performance of Water-use efficiency of schemes of the BRDP

Sl. No.	Name of irrigation schemes	Irrigated area (ha)	Average yield (kg/ha)	Total volume of water supplied (including conveyance loss) (m^3)	Water-use efficiency (kg/m^3)	Average Water-use efficiency (kg/m^3)
1	Scheme-1	86	6131	4377694	32	34.5
2	Scheme-2	114	6263	5802990	37	

Benefit-Cost Ratio (BCR)

Benefit-Cost ratios of both schemes of the Buraghat Rubber Dam Project (Table 5) were reduced in consequence of mounting total cost and decreased gross return. Effective marketing system should be developed with the intention that, farmers can sell their product at more competitive price.

Table 5. Performance of benefit-cost ratio of schemes of the BRDP

Sl. No.	Name of irrigation schemes	Total cost (Tk. /ha)	Gross return (Tk. /ha)	Net return (Tk. /ha)	Benefit-cost ratio
1	Scheme-1	53549	77805	26920	1.502
2	Scheme-2	52610	77237	25027	1.519

Performance constraints of irrigation schemes of BRDP

This investigation identified some performance constraints of the Buraghat Rubber Dam irrigation schemes. The constraints involved were identified through inspecting physical condition of the sluice gate, river as well as canal situation of the project site and assessment of information collected from the farmers. Various constraints includes: there are no drainage facilities to remove excess water, insufficient storage of water, leakage problem, siltation problem, high conveyance loss in the canal, conflicting interest of water suppliers and water users, factional conflict among IWMC members and beneficiaries, unfamiliarity of Rubber Dam technology, lack of consciousness regarding irrigated agriculture and defective water charge collection system.

Conclusions and recommendations

The study was directed with the aim of appraising performance of the Buraghat Rubber Dam Project (BRDP) on the basis of some performance indicators. It was found from the study that the Command area efficiency of the BRDP is not adequate. The smaller value of Command area efficiency (CAE) shows that considerable amount of land are yet to be brought under irrigation by optimizing management practices. The Management performance ratios (MPR) were lower than the acceptable range of MPR and the Water-use efficiency (WUE) of the schemes were better. However, Benefit-Cost ratio (BCR) of the same was quite reasonable. Therefore the following recommendations are drawn to improve the performance of the irrigation schemes under this project

- Training facilities focused on modern agricultural technology should be increased for concerned personnel.
- Crop diversification could be added into crop-based irrigation as this cropping system might assure better project performance through extending command area.

- Irrigation canals should be lined with stable materials to reduce leakage and conveyance losses. Farmers should take care of wastage of water by filling ditches, ponds and burrows in the canal bunds, run-off in the drain and overtopping the canal bunds.
- Suitable crop calendars should be developed and appropriate irrigation schedules should be prepared in relation to the varying water needs of crop at different stages of growth.
- The main and distribution canal systems should be controlled by yearly re-excavation to get proper function.

References

Ali N.M. and Wooldridge R. 1997. Rehabilitation to operation - a question of sustainability, Asian regional symposium on maintenance and operation of irrigation drainage schemes for improved performance, China, pp.101-109.

Bhuiyan S.I. 1977. Evaluation of constraints to efficient water utilization [of rice] in small scale irrigation in Bangladesh. In IRRI Saturday Seminar, College, Laguna (Philippines).

Dutta S.C. 1985. Physical and technical aspects of water management of minor irrigation schemes under different institutions in two areas of Bangladesh. In Bangladesh Agricultural University, Mymensingh, Evaluating the Role of Institutions in Irrigation Programme. Department of Irrigation & Water Management, workshop proceedings, IWM-11.

Haq K.A., Islam M. N. and Sattar M. A. 1985. Evaluation of large Irrigation systems. In international Seminar on "Methodologies to Evaluate the Performance of irrigation system", BARC, Dhaka, Bangladesh.

Keiser J., de Castro M.C., Maltese M.F., Bos R., Tanner M., Singer B.H. and Utzinger J. 2005. Effect of irrigation and large dams on the burden of malaria on a global and regional scale. The American J. Trop. Med. and Hygn. 72(4): p-392-406.

Lowitt R. 2002. Optima dam: A failed effort to irrigate the Oklahoma panhandle. Agricultural history, Berkeley, USA: University of California Press. 76 (2): p-260-271.

Miranda S.M. 1989. Irrigation management for crop diversification in Indonesia, the Philippines and Sri Lanka. A Synthesis of IIMI Research Technology, Colombo, Sri Lanka.

Molden D.J. and Gates T.K. 1990. Performance measures for evaluation of irrigation-water-delivery systems. J. Irri. and Drain. Engg. 116 (6): p-804-823.

Molden D.J., Sakthivadivel R., Perry C.J. and De Fraiture C. 1998. Indicators for comparing performance of irrigated agricultural systems, Research report, Vol. 20. International Water Management Institute (IWMI), Colombo, Sri Lanka.

Salameh E. 2004. The tragedy of the Karama Dam project/Jordan. Acta Hydrochi. et Hydrobio. 32(3): p-249-258.

Sarker K.K., Wang X.Y., Islam N., Xu C.L. and Qiao X.D. 2011. Performance evaluation of the rubber dam project for irrigation development. Scientific Res. and Ess. 6(22): p-4700-4707.