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Full Length Research Paper

Participatory Water Management and Rural Development: A Case Study of Small-Scale Water Resources Development Projects in Bangladesh

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Agriculture and fisheries are dependent on water; hence, integrated approach in water management involving local stakeholders is the key to solve the food and water crisis for today and future. In Bangladesh, major small scale water resources development interventions are undertaken by Local Government Engineering Department (LGED) Bangladesh, under its Small Scale Water Resources Development Projects (SSWRDSP) to facilitate mainly the plant crop production and rural employment generation. The subproject level operational field is basically the floodplain area which is also the major natural fisheries resource base of the country. The research takes an eclectic approach, using both quantitative and qualitative methods in information gathering. It reviews relevant external secondary data sources and internal SSWRDSPs field data. The primary sources included extensive field visits, household survey for beneficiaries and Water Management Cooperative Association (WMCA) interviews of a specific sub-project that made significant impact in increasing cereal and fish productions. Transcripts of field visit, field notes and relevant literature are analyzed on the basis of themes, patterns and data of interrelationships among those that addressed the research goal. This paper describes the augmentation of crop and fish production and thus, rural socio-economic development complied with the participatory water management process prevailing in Bangladesh with its future prospect.

Key words: Participatory approach, sustainable development, food production, fish production, employment generation.

INTRODUCTION

Bangladesh is mostly situated on flood plains, and hosts a network of about 230 rivers and innumerable canals and water bodies. However, the country is blessed with fertile land and very prosperous water resources (Islam, 2000). In contrast to the wet season, rainfall during the dry season is low and unreliable (Ravenscroft, 2003). Lengthy localized rainfall often creates floods due to poor drainage (Siddiqui, 2000). Bangladesh is predominantly an agricultural country and the national economy is significantly dependent on agricultural production (ICID, 2000). Land and water are thus the two most vital resources for agricultural development, but both are very scarce due to high population density (Islam, 2000; Conway, 2000). Accordingly, water management during the dry season will primarily rely upon appropriate exploitation and allocation of the resource. The Bangladeshi National Water (BNW) policy has adopted the sustainable water management approach during the dry season which is primarily concerned with the proper operation and allocation of water resources (MoWR, 1999). The Bangladeshi Water Development Board (BWDB) and the Local Government Engineering Department (LGED), Bangladesh are the principals responsible for large and small scale water resource management across the country (MoWR, 1999; ICID, 2000).

Developing countries, including Bangladesh are experiencing a critical crisis for essentials, such as food, water, shelter, energy and health (Roome, 2002). To attain the country's food demands for 2050, agricultural crop production will need to increase by 3 times, and historically, agricultural irrigation has been the most suitable way of enhancing crop production (Avery, 2002). On the other hand, man has been taking fish from nature for millennia, and millions still rely on fishing and fish for their socio - economic well-being and development.

However, without a strenuous effort at the community level to improve fisheries management, there will be a reduction in this protein source as well as foreign exchange (WB, 2004).

Moreover, labor absorption capacity in the formal sector of the economy is inadequate in comparison with the size and growth of the workforce in Bangladesh (Chowdhury, 2010). Agriculture is the largest sector of rural employment generation since it creates opportunities for about 60% of the national labor force (Hossain, 2008). This paper attempts to establish the fact that participatory approach in surface water management is the most sustainable way to meet crop and fish production and thereby generate employment.

LOCAL GOVERNMENT ENGINEERING DEPARTMENT (LGED) AND ITS INVOLVEMENT

The LGED, Bangladesh started its activities in the early 1960s and encouraged involvement by increasing farm/non-farm production through surface water management by implementing the Thana Irrigation Project (TIP) (GoEP, 1962). As part of the objectives of TIP, LGED started the Canal Digging Program (CDP) in 1979 to de-silt sediment filled channels to boost-up water storage capacity of channels for irrigation and fisheries (IWRMU, 2008). In parallel to CDP, under the Rural Employment Sector Program (RESP), LGED initiated small-scale water resource development schemes to increase agricultural and fisheries production and rural employment generation between 1986 and 1996. These projects were implemented successfully with local stakeholder participation (MPIUS, 1998), but due to lack of an institutional framework and capacity building with respect to projects maintenance and management committees and the lack of integration of different disciplines, potential benefits were not realized.

Taking lessons from the performance of these water resource development projects, the LGED facilitated sustainable use of water resources, with full participation of local stakeholders, in conformity with the National Water Policy (NWP). To improve socio-economic conditions including crop production by more efficient use of surface water, LGED started Small Scale Water Resources Development Sector Projects (SSWRDSP) (LGED, 1995). The NWP was given the mandate of implementing flood control, drainage and irrigation (FCDI) projects to increase crop production and employment generation (MoWR, 1999). The first SSWRDSP was undertaken between 1995 and 2002 with an aim of sustainable growth in agricultural production in 37 districts (LGED, 1995). The main objectives of the SSWRDSP were to enhance agricultural and fisheries production and to take effective steps in poverty alleviation through improving surface water resource management (LGED, 1995).

With the success and gathered experience from the first SSWRDSP, LGED started a 2nd phase and implemented 300 sub-projects in 61 districts (LGED, 2010a). The 3rd phase commenced in 2010 under the Participatory Small Scale Water Resources Sector Project (PSSWRSP). The PSSWRSP is currently implemented in all the 64 districts of the country (LGED, 2010b). An additional SSWRDSP funded by JICA, implemented by the LGED from 2008, covered 15 districts of greater Mymensingh, Sylhet and Faridpur (LGED, 2010c).

Most of the irrigation schemes have multiple objectives, such as flood control, water drainage, environmental protection and fisheries development, which are often difficult to measure quantitatively or indeed qualitatively (ICID, 2000). Major water management objectives of the SSWRDPs are to create hydraulic infrastructures to facilitate plant crop production. Flood management (FM) infrastructures, protective embankments and regulators, were created for protection of the plant crops from flood or for reclamation of land for plant crop cultivation (LGED, 2010a).

Under the SSWRDPs, a fisheries program was operated to mitigate the adverse impacts of the water management interventions on the value of fisheries potential of the sub-projects (LGED, 2001).

OBJECTIVES AND METHOLOLOGY

1. To surface the initiatives of the Local Government Engineering Department (LGED) in food security through surface water management with participatory approach.
2. To present the state of the art of the participatory surface water management process in sustainable socio-economic development by increasing crop as well as fish production and thereby generate employment in the rural Bangladesh.

A detailed and systematic approach was followed to achieve the objectives of this study. A broad review of external secondary data sources associated with the topic that included water and food production, irrigation, gender and development, employment generation, surface water management, etc., and internal SSWRDSPs which includes the sub-project based field data obtained for formulation, implementation and performance evaluation of SSWRDSPs was made. Pre-project data were compiled from sub-project appraisal reports while the monitoring and evaluation data were drawn from the Management Information System (MIS), the LGED's Integrated Water Resource Management Unit (IWRMU) and various project reports. Field information was gathered with the support of the SSWRDSPs and through LGED's IWRMU using post-project completion reports.

Primary sources included extensive field visits, household surveys and sub-project beneficiary and WMCA interviews. Field workers of Non Governmental Organizations (NGO) were also involved in the surveys and interviews. As the author is a fulltime employee of the LGED, he was posted to the IWRMU as a Senior Assistant Engineer (Operation and Maintenance) and was also in-charge of the MIS unit of LGED's IWRMU; as such, he had the opportunity of partaking in every step of the sub-project implementation cycle. Transcripts of field visits, field notes and relevant literature were analyzed on the basis of themes, patterns and data on interrelationships among those that addressed the research goal.

Participatory approach of the SSWRDSP

Participatory approaches in Integrated Water Resources Management (IWRM) for agriculture present eco-friendly farming as well as sustainable surface water management for agricultural and fisheries production systems (Roome, 2002). LGED has developed a very innovative framework of participation for addressing local people's views in development initiatives in water sector (LGED, 2009). The local people participate in all stages of the project cycle. After completion of the sub-project, the WMCA takes the responsibility of operation and maintenance of the sub-project infrastructure (LGED, 2009).

Framework of participation

The overall participatory process adopted by LGED is a combination of two parallel but interrelated processes:

1. “Institutional” involving software elements and
2. "Technical" involving hardware elements.

The whole cycle of the subprojects development process is sub-divided into four distinct stages as presented subsequently (LGED, 2009).

Stage 1: Identification and feasibility

In consultation with local stakeholders, the union Parishad (Council) commences sub-project proposals. With the approval of the Upazila development coordination committee, the LGED Upazila engineer forwards proposals to the IWRMU. The IWRMU pre-screens the proposal through: (1) participatory rural appraisal (PRA) and (2) feasibility study (FS). Each subproject is reviewed and approved by the District Level Inter-agency Project Evaluation Committee (DLIAPEC).

Stage 2: Design and institution building

Following the approval of DLIAPEC, engineering design and the establishment of a Water Management Association (WMA) are completed. The process of establishing a WMA is initiated under the legal framework of the Cooperative Societies Act (National Parliament of Bangladesh, 2001). The contracted NGO facilitator creates awareness, generated local enthusiasm in the local water resource systems, promotes membership enrolment and assists in collection of beneficiary contributions and conflict resolution. The WMA is registered with the Department of Co-operatives (DoC) and becomes a Water Management Cooperative Association (WMCA). The IWRMU undertook engineering design work in consultation with stakeholders for their approval. To sign the implementation agreement, the WMCA must have achieved: (1) enrolment of at least 70% of beneficiary households; (2) collection of beneficiary contributions equivalent to an annual O&M requirement, deposited in a joint account by LGED and the WMCA and (3) approved plans in consultation with people affected by the environmental mitigation and resettlement (land acquisition) (MoWR, 2000).

Stage 3: Construction and first year O&M

The WMCA forms an O&M sub-committee and prepared schedules, beneficiary list and maps and plans comprising operating guidelines, and maintenance and resource mobilization plans. The IWRMU provided on-the-job training that helps WMCA to (1) undertake annual inspections, (2) identifies maintenance needs, (3) prepares and implements annual O&M plans and (4) collects O&M fees (ADB and LGED, 2009). Sub-project infrastructure is handed-over to the WMCA one year after completion. The WMCA received support of agricultural extension and fisheries departments to prepare agriculture and fisheries development plans (ADB, 2008).

Stage 4: Sustainable operation and maintenance

This stage started after sub-project handover and continues throughout its lifetime. Continuous monitoring and support was provided by the LGED’s IWRMU and other partner agencies. The WMCA and O&M committee receive regular training so that they can out O&M of the sub-project. The WMCA prepare O&M plans, undertook routine maintenance works and collected O&M fees from direct beneficiaries in proportion to their land area benefited by the sub-project (LGED, 2009).

RAMPUR (SP13070) FLOOD CONTROL AND DRAINAGE (FCD) SUBPROJECT: A CASE STUDY OF SUCCESS

Subproject location and concept

The "Rampur FCD” sub-project is located in the Boro Harispur union under the Sadar Upazila in Natore district of Bangladesh. The mean monsoon water level in the river adjacent to the subproject is 11.98 m public works datum (PWD). The land levels in the sub-project area vary between 11.00 and 13.00 m PWD. Though the water level data does not support the premise that there is much flood damage in the area, farmers stated that floods usually enter the beel (large swampy area) area almost every year from the Narod river via the Rampur khal (large irrigation canal, that also function as a reservoir) causing heavy damage to aman (a seasonal paddy crop) crops. Another problem in the sub-project areas was the scarcity of water during the winter season for irrigation and fisheries. Since 1964 to 1965, local communities have constructed earthen cross dams every year at Rampur channel to trap water for irrigation as well as for fisheries. The cross dam is to be cut open before the onset of monsoon (rainy season). Farmers use to mobilize about Tk 100,000 by collecting money from land owners to build the dam. Often the cross dam washed away by early monsoon flash floods causing damage to farmers crops and properties, and they had to rebuild the dam to resume irrigation. Local communities submitted a proposal to the executive engineer, Natore LGED through a union Parishad resolution which was transmitted to SSWRDSP LGED on 29 January, 1997 for a water regulator (WR) sub-project with a gross area of 210 ha, intended to retain water for supplementary and winter irrigation by constructing a regulator across Rampur khal. The proposal was field verified through reconnaissance visits for technical and social soundness, participatory rural appraisal to find out broader community support and commitment for longer term sustainable operation and maintenance, and it was accepted for a feasibility study. The feasibility report that supported the key elements for this subproject was**:** subproject type are FCD and WR, subproject gross area of 370 ha, net area of 310 ha and the concept was to control flooding from the Narod river through Rampur khal and retain water for supplementary and winter irrigation by one regulator across Rampur khal at the location of existing culvert and improve drainage by re-excavating 1.9 km of khal.

The detailed design was finalized in direct consultation with the beneficiary's organization "Rampur Water Management Cooperative Association". The Project was expected to reduce the natural migration of fish during the breeding season and to lead to some loss of production from the floodplain fishery. At the same time, an increase in fish culture production was expected as a consequence of the improved control of water during the flood and dry season.

Table 1. Implemented component.

Name of works	Size/length (km)	Estimated cost (Tk)	Implementation cost (Tk)	Physical progress (%)
Re-excavation of Rampur khal	1.9	66,336	70,419	100
Embankment re-sectioning	1.4	406,056	402, 659	100
O&M Shed	9.00 × 5.00 m	2,23,590	222,279	100
Rampur khal regulator	1 Vent - 1.50 m × 1.5 m	2,034,034	2,170,750	100

Table 2. Budget and expenditure for O&M activities.

Year	Fund at hand (Tk)	Budget estimate (Tk)	Actual expenditure (Tk)
2002	65,540	9,500	11,100
2003	74,548	17,020	15,160
2004	85,442	26,654	24,550
2005	108,430	28,600	27,510
2006	133,634	42,000	39,000
2007	163,334	34,100	31,300
2008	195,832	12,000	11,300
2009	229,830	26,000	24,000
2010	265,950	28,000	26,500

Development of the water management association (WMCA)

The local community totally supported the sub-project development and fulfilled all conditions required before signing the implementation agreement. The sub-project benefited area was about 212 ha belonging to about 400 farm families. The community raised the required amount of capital (Tk 48,340) as O&M funds and deposited to an account jointly operated by the WMA chairman and LGED Natore. By the date of signing the implementation agreement, the association enrolled about 345 members. Construction of the structure and re-excavation of the khal (channel) commenced in the dry season of 1999. The construction of the water infrastructures were completed by March 2002 and the water regulator functioned in the same year. The community benefited highly from winter season irrigation through conservation of water by the water control structure; saving the aman crops from flood; and by increasing fish production through controlling of water during flood and winter. Their membership increased from 345 to about 1900 over ten years. As an income-generating activity, the WMA started a microcredit program and disbursed an amount of at Tk 1.8256 million by the year 2010 to an estimated 457 persons of which 336 were male recipients and 121 females. They have already realized Tk 1.536 million returns. Different trainings were arranged and provided to the WMA members so that they can become capable in undertaking O&M of the completed infrastructure. IWRMU is now responsible for providing training to WMA members to improve their skills in various aspects, such as agriculture, fisheries and subprojects maintenance. The W MA has purchased 0.23 ha of land and constructed an office building. However, the components that were implemented in this study are shown in Table 1.

SUBPROJECT IMPACT AND DISCUSSION

Re-sectioning/re-excavation of 1.9 km khal and construction of one regulator protected the subproject area from flooding and create opportunities for winter irrigation. Additionally the sub-project increased the fish production by facilitating water conservation.

WMCA operation and management (O&M)

The WMA has illustrated a unique role in self sustaining operations, maintenance and water management activities. They have mobilized local resources through field water distribution tariffs and spent in yearly routine O&M activities. The association spent different amounts of money in different years (Table 2) in maintaining the regulator at re-shaping the khal and developing field irrigation distribution networks.

Impact on crop production

Participatory water resources management in the sub-project area has generated local enthusiasm for each water resources system to increase crop production. Access of farmers, fishers, landless and women to information and their influence on the sub-project O&M have increased. This has created opportunity to increase crop production in the completed sub-project areas. A major contributing factor to food production is the expansion of cropped area. Due to sustained use of conserved water, the irrigation area increased about 35% yearly, and with respect to the year 2002 to 2010, it increased by 183% (Table 3) resulting in incremental cereal and non-cereal production.

Table 3. Cropped area (hectare).

Study year	Cropped area (cereal + non-cereal)			
	Pre-monsoon	Monsoon	Winter	Total
2002	35.5	52.7	222.5	310.7
2003	79.0	98.5	250.6	428.1
2004	112.0	150.2	272.8	535.0
2005	158.9	180.5	280.2	619.6
2006	173.9	230.1	285.4	689.4
2007	245.2	255.2	290.1	790.5
2008	287.6	293.4	293.2	874.2
2009	291.0	297.6	298.5	310.7
2010	280.9	297.1	302.2	428.1

Table 4. Pre- and post-subproject crop production.

Study year	Cereal crop production (tons)			Non-cereal crop production (tons)		
	Pre-subproject	Post- subproject	Increment (%)	Pre- subproject	Post- subproject	Increment (%)
2002	814.0	871.9	19.3	1436.0	1805.5	25.7
2003		931.5	6.8		2567.4	42.2
2004		1249.3	34.1		2943.6	14.7
2005		1524.9	22.1		3794.2	28.9
2006		1705.5	11.9		4502.1	18.7
2007		1975.3	15.8		4991.2	10.9
2008		2172.8	10.0		5665.0	13.5
2009		2455.3	13.0		6009.2	6.1
2010		2846.2	16.0		6630.3	10.3

The combination of subproject operation and floodwater management by the participation of local stakeholders released constraints on land use during the wet and dry seasons, increased cropping intensity with the use of high-yielding varieties (HYV), increased cultivated areas and yields per hectare. The increased rice area enhanced rice production 3 fold and non-rice crop increased more than 4 fold. It is exciting that the Rampur sub-project is well maintained and farmers are now in high spirits as their production has increased significantly (Table 4).

Improved water management by the beneficiaries has also resulted in the diversification of crops with increase in cereal and non-cereal production (Table 4). Increases in cereal production are due to greater rice cultivation during the monsoon season. On the other hand, more pulse, oilseed, vegetable and spice cultivation has been accomplished in the dry season contributing to increase in non-cereal productivity. The access of the rural poor has improved through share cropping and increased land productivity. The farm laborer benefit from increased demands and higher wage rates.

Impact on fish production

Constructed sluices allow fingerlings to enter into the khals during the monsoon season and this assist in fish culture during the dry season. The sluices have been designed with low head to provide fish-friendly conditions. Taking this opportunity, the subproject beneficiaries increased fisheries production in flood-plains and permanent water bodies. Compared with production before the Project, the total output of fish increased to 61 tons from 37 tons within the period 2002-2010 (Table 5).

Enhanced fisheries production in floodplains and adoption of modern technology provided opportunities for local laborers. The situation is much less clear for traditional fisher families, where gains have been experienced by some and losses by others. It is likely that traditional fisher families (who are almost always among the poor in any community) have benefited most where they have been able to participate in fish culture activities.

Employment generation

Employment opportunity that relates to the SSWRDSP earthworks sub-project was provided to local landless people including poor women for labor contracting societies (LCSs). Implementation of this sub-project under SSWRDSP required construction or rehabilitation

Table 5. Impact on fish production.

Study year	Fish production due to changes		Total fish production
	Floodplain (tons)	Permanent water bodies (tons)	
2002	+36.0	+1.0	+37.0
2003	+10.0	+37.0	+47.0
2004	+7.0	+42.0	+49.0
2005	+3.0	+41.0	+44.0
2006	+1.5	+47.0	+48.5
2007	-7.0	+43.0	+36.0
2008	-6.0	+51.0	+45.0
2009	-8.0	+64.0	+56.0
2010	-5.0	+66.0	+61.0

Table 6. Labor employment during construction.

Item	Length (km)	Total earthwork (thousand m^3)	Labor employment (thousand person)
Embankment construction/rehabilitation	1.4	27.5	11.1
Canal re-excavation/excavation	1.9	15.1	6.2
Construction of regulator	Implementation cost TK 2,170,750		0.20
Total labor employed per day during construction			17.5 thousand

of 1.4 km of embankment, re-excavation or excavation of 1.9 km of canal and construction of water control infrastructures in subprojects areas (Table 6). This provided labors temporary employment opportunity for 17500 people (Table 6).

Expansion of cropped area has significantly contributed to labor demand. International Commission on Irrigation and Drainage (ICID) stated that the projected employment up to 2020 will continue to make agriculture the major source of employment, absorbing over 40% of the labor force (ICID, 2000). Among the three crop seasons, opport-unity for labor use is the highest during the monsoon season (ICID, 2000). About 49.0% of the annual labor uses in the country are during this season, as compared to 31.4% during the pre-monsoon season and 19.6% during the dry season. Higher use of modern inputs raises the demand for rural labors, since crop production is rarely mechanized in Bangladesh (Quasem, 2002). The poor landless segments have better employment opportunities in construction and maintenance works of irrigation schemes (ICID, 2006). SSWRDSP provides opportunity for double and triple cropping on the same land in the sub-project areas. These changes are labor intensive, which increases labor demand and even creates year-round demand for labor. Labor requirement also increases in fisheries production. Increased crop production also creates more labor engagement opportunities throughout the year. Increased cropped area, use of high-yielding seed varieties (HYVs) and crop management now require more farm labor (Table 7).

Before implementation of the subproject only 5 fishermen were in the subproject area, but at present 50 fish farmers are cultivating fish, about 370 laborers are engaged in fishing from February to July as compared to 5 laborers during the pre-subproject period. An estimated one-third of this labor force is employed full time and the remainder for 10 days a month throughout the fish farming period (MIS, 2011). Crop and fisheries production now engages more family labors and requires additional hired labors in the sub-project area (Table 7). Moreover, tree plantations along the re-sectioned embankment provide employment opportunities for destitute women. The landowners contribute to subproject O&M costs through the WMCA.

SUBPROJECT EVALUATION

Evaluation of the projects has been undertaken by different agencies at different times. Bangladesh University of Engineering and Technology (BUET), Bangladesh Institute of Development Studies (BIDS) and WL I Delft Hydraulics and the Netherlands jointly evaluated the project. In addition, the Implementation

Table 7. Labor employment in crop and fish production.

Study year	Crop production			Fish production		
	Pre- subproject	Post- subproject	Increment (%)	Pre- subproject	Post- subproject	Increment (%)
2002	13500	16064	19.0	444	626	40.9
2003		20980	30.1		642	2.6
2004		24530	16.9		506	-2.7
2005		31365	27.9		607	19.9
2006		36540	16.5		462	-23.8
2007		40982	12.2		576	24.7
2008		46140	12.6		582	1.04
2009		48905	6.0		586	0.7
2010		55908	14.3		594	1.37

Monitoring and Evaluation Division (IMED) under the Ministry of Planning, Bangladesh also evaluated the project and their findings are very much positive. In general, the evaluation agencies concluded that SSWRDSP has shown a very encouraging progress in developing socio-economic conditions that includes crop production, fish production and employment generation in the sub-project area (BUET-BIDS-Delft-Hydraulics, 2003; IMED, 2005). The ultimate success and effectiveness of public water resources management projects depends on the people's acceptance and ownership of each of the sub projects.

RECOMMENDATIONS

1. Other organizations who are engaged in agriculture extension should follow the participatory approach as illustrated by the SSWRDSP of LGED to make their projects more effective for sustainable development.
2. Local wisdom combined with theoretical knowledge could represent social engineering practices in resolving unique water resources problems which can bring about food security, employment opportunities and social security for the poor farmers in rural Bangladesh as well as in other developing countries.
3. The positive pro-fisheries approach of the SSWRDSP could be a very benign effort to save the declining natural fisheries of the country.

C o n c l u si o n

The Rampur sub-project of Sadar Upazila, Natore is a unique example of a small-scale water resources sub-project. The stakeholder's participation in water re-sources management enhances and stabilizes agricultural and fisheries production and increases employment opportunities in the Rampur area. Moreover, the access of local people to land and water improves through increased productivity. Stakeholder's participation strengthens the role of the local people in the water management system, and they became integrated into the mainstream of economic production systems. Their participation moreover, increased the chances of generating local enthusiasm for the maintenance of infrastructures. Almost all the 400 farm families engaged in the project have changed their lives and living standards by the support of the Rampur WMA. The sub-projects reflect the type of impact LGED has had on many communities throughout Bangladesh within the sub-projects established under the SSWRDSP. This paper demonstrates that sustainable water management practices can bring food and social security for the poor farmers and fishers and employment opportunity in rural Bangladesh as well as showing potential for application in other developing countries.

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