SURFACE WATER MANAGEMENT FOR LOCAL DEVELOPMENT AND POVERTY REDUCTION: A CASE OF BANGLADESH

GESTION DE L'EAU DE SURFACE POUR LE DEVELOPPEMENT LOCAL ET LA REDUCTION DE LA PAUVRETE : CAS DU BANGLADESH

Kamrul Ahsan*

ABSTRACT

Bangladesh receives huge amount of uncontrolled water during the monsoon season from 1.72 million square kilometers (M km^2) of catchment area distributed over the countries of India, China, Nepal, Bhutan and Bangladesh (only 8%), causing floods over 10 to 60 percent of the total area of the country every year. Also, there is water scarcity during the dry season causing hardship to agriculture and fisheries. These contrasting situations are the major problems for water resources development and management in Bangladesh.

Small Scale Water Resources Development Sector Project (SSWRDSP) of Local Government and Engineering Development Departments (LGED) helped in water resource development and management at the local level with the participation of village based organizations to increase agriculture and fish production. Rice is the staple food and fish is the main source of protein in the country. The project provides small scale water management infrastructures at the local level like construction of embankment and sluice gates, excavation of canal, ponds & ditches etc., to keep the area flood-free, conserve water for dry season and drain excess water where necessary. In its first phase, the project was implemented at 280 sites in the comparatively poorer western part of the country. The village organizations (sub projects) paid a part of the total cost of necessary infrastructure development for ensuring their ownership.

The above endeavour has increased agriculture and fish production and created employment scope. Enhanced income from the project enables poor people to accumulate capital and pay for social services, run and maintain the water management sub projects on their own, develop linkages with Nation Building Department (NBDs) at the upazila (sub district) level for getting their supports and services particularly skill training and inputs. The poor people

* Director (Research), Bangladesh Academy for Rural Development (BARD), Kotbari, Comilla, Bangladesh (kamrul_61@yahoo.com)

get credit facilities from the organization and adopt Income Generating Activities (IGAs) like poultry raising, kitchen gardening, livestock rearing, beef fattening, plantation, etc.

Key words: *Surface water management, poverty reduction, small scale water resources development sector project, Bangladesh.*

RESUME

Le Bangladesh reçoit une énorme quantité d'eau non contrôlée de 1,72 millions de kilomètres carrés (M km2) lors de la saison de mousson du bassin versant des pays tels que l'Inde, la Chine, le Népal, le Bhoutan et le Bangladesh (seulement 8%), provoquant chaque année des inondations sur 10 à 60% de la superficie totale du pays. Aussi, il existe une pénurie d'eau lors de la saison sèche causant des difficultés dans les domaines de l'agriculture et de la pêcherie. De telles situations différentes causent des problèmes majeurs pour le développement et la gestion des ressources en eau au Bangladesh.

Le Projet à petite échelle pour le Développement des Ressources en eau (SSWRDSP) des Départements du Gouvernement Local et du Développement d'Ingénierie (LGED) a soutenu au niveau local le développement et la gestion des ressource en eau avec la participation des organisations du village pour augmenter la production agricole et la production de poisson. Le riz est la nourriture de base et le poisson est la source principale de protéine du pays. Le projet fournit les infrastructures de la gestion d'eau à petite échelle au niveau local telles que la construction des endiguements, des vannes à écoulement rapide, le creusement du canal, les étangs et les rigoles etc, pour protéger la région contre les inondations, conserver l'eau pour la saison sèche et évacuer l'eau excédentaire. Dans sa première phase, le projet a été mis en oeuvre dans 280 sites dans la région occidentale la plus pauvre du pays. Pour assurer leur contrôle, les organisations du village (sous projets) soutiennent une partie du coût total du développement d'infrastructure nécessaire.

Ledit effort a augmenté la production agricole et la production de poisson, et a créé l'emploi. Le revenu provenant du projet permet aux pauvres d'accumuler par leur propre moyen le capital et de l'utiliser pour les services sociaux, de diriger et de maintenir les sous-projets de la gestion d'eau, de développer les liens avec le Département de la Construction de Nation (NBD) au niveau d'upazila (sous-quartier) pour obtenir le soutien et le service tels que la formation de compétence et les contributions. Les pauvres obtiennent les facilités de crédit de l'organisation et adoptent les Activités pour générer le revenu (IGA) telles que la volaille, le potager, l'élevage du bétail, les plantations, etc.

Mots clés: *Gestion de l'eau de surface, atténuation de la pauvreté, Projet à petite échelle pour le Développement des Ressources en eau, Bangladesh.*

1. INTRODUCTION

The geographical area of Bangladesh, located between 20 ° 34' and 26 ° 38' N latitude and between 80° 01' and 92° 41' E longitude, is 147,570 km^2 of which land and water cover 130,168 km^2 and 17,402 km^2, respectively. The country is a deltaic plain, criss-crossed by several mighty rivers like the Ganges, Brahmaputra and Meghna and their tributaries and

distributaries. It is fenced by the Bay of Bengal on the south and by India on the north, east and the west. There is a small strip of frontier with Myanmar (Burma) on the southeastern edge, which is one of the wettest regions of the world. Bangladesh experiences a tropical monsoon characterized by rain bearing winds, warm temperatures and high humidity.

There are four main seasons in Bangladesh namely, the pre-monsoon (March-May) when the highest temperatures, cyclonic storms and sometimes heavy rainfall occur, especially in May; the monsoon (June-September) of high rainfall; the post-monsoon (October-November) with low rainfall; and the cool and sunny dry season (December-February). The mean annual temperature is about 25° C, with extremes of 4 and 43° C. Humidity ranges between 60% in the dry season and 98% during the monsoon. About 80% of the total rainfall occurs in the monsoon and the average annual rainfall over the country varies from 1480 to 4338 mm (BBS, 2010).

Floods occur during the monsoon, caused by huge water inflow from 92% of the catchment area lying outside the country: in India, China, Nepal and Bhutan and finally draining into the Bay of Bengal. Flood also takes place due to heavy rainfall within the country. The flood water recedes slowly from the comparatively low lying areas and damages the crops there. About two-third of the cultivable land is prone to flood damage every year. Thus improving water management through flood control and drainage is crucial to increase food production and strengthen the agriculture based national economy.

The total cultivable land in Bangladesh is 8.774 million hectares (Mha). In 2008-09, total irrigated area in the dry season was 6.05 Mha and the irrigated rice produced was 18.0 million metric tons (MMTs). Total food grain produced in 2009-10 was 33.8 MMTs (GoB, 2009). Increased rice production through irrigation and functioning of farmers' organizations started in Bangladesh (the then East Pakistan) in the late nineteen sixties through "Thana Irrigation Programme" of the government in the minor irrigation sector. The coverage of minor irrigation is over 90% of the total irrigated area. The current production is about 33.8 MMTs of rice (irrigated rice alone is 18.0 MMTs) per annum as against about 10 MMTs per annum in the nineteen sixties.

The irrigation system in Bangladesh comprises major irrigation and minor irrigation. In major irrigation, huge water is diverted from rivers to canals where from farmers get water either by lifting or under gravity. In minor irrigation farmers use Low Lift Pumps (LLPs), Deep Tube Wells (DTWs) and Shallow Tube Wells (STWs) to lift surface and ground water for irrigation. Almost 90% of irrigation coverage is under minor irrigation schemes. The expansion of irrigation is considered as an important issue of the Government's strategy in agriculture development. Future growth in agriculture is dependent on expanding the area under irrigation (GoB, 1995).

Fish and Fisheries are extremely important for Bangladesh. The climate is also suitable for fish production. The development of fisheries sector during the early plan periods remained slow. But government's investment in fisheries research during the 3rd and the 4th Five Year Plans brought substantial increase in fish production, which has attained a high average annual growth rate of 8.9% in the 3rd year of the Fifth Five Year Plan (1997-2002). It has the potential to go up further from the current annual fish production of 1.66 MMTs to 3.0 MMTs with proper policy support approach and strategies. Bangladesh has extensive and vast inland open water bodies and marine fishery areas. The inland open waters had a major

share in fish production till 1960s (about 80%) and used to provide nutrition and employment to a large number of the poor segment of the rural population. The situation has now been reversed and has become alarming as a consequence of modification and degradation of inland open water fisheries habitats leading to loss of their potential and aquatic biodiversity (Mazid, 2002).

The Government of Bangladesh in its National Water Management Plan has given emphasis on rice and fish security improvements. Agricultural intensification and a large increase in fish production were considered as essential parts of it. In addition, it expected to achieve a steady economic growth rate of 6% up to the next 25 years (GoB, 1995).

1.2 Poverty Situation: Poverty reduction has got the top most priority in the development plan. The intensity of poverty has been reduced in Bangladesh with the efforts made over the last three decades but still its depth and severity persists. This is a big challenge mainly for resource constrains and poor management of available resources. Bangladesh has so far implemented five 5-Year Plans and one 2-Year Plan and a 3-Year Poverty Reduction Strategy (PRS) Rolling Plan after its liberation in 1971. The efforts of these plans were to accelerate economic growth and reduce poverty. They resulted in significant progress in poverty reduction. According to the Cost of Basic Needs (CBN) method used in the survey, the incidence of poverty at the national level declined from 56.6% in 1991-92 to 40.0% in 2005. Poverty in Bangladesh has a rural face. In 2005 the rural poverty rate was 43.8% and the urban poverty was 28.4% (GoB, 2009). Enhancing income of the poor is considered as a priority to reduce the magnitude of their poverty. Increasing agricultural production helps a lot in enhancing income and getting working scope in rural areas.

Increasing agricultural production through using available surface water management and by creating people's ownership in development works were the main issue of Small Scale Water Resources Development Sector Project of Local Government and Engineering Department (LGED) and the works have been implemented in two phases.

1.3 Introduction of Project: The Small-Scale Water Resources Development Sector Project (SSWRDSP) was implemented during 1997-2002 in its first and 2002-2009 in its second phase with the objective to achieve sustainable increase in agricultural production and income of the small farms in the project areas, which in turn, has an impact on poverty reduction of the area through surface water management. All the development works have been implemented keeping village as the focal point. These village based organizations are called sub projects. The project areas are located in western Bangladesh (where the standard of living was much lower than that in the eastern half). These achievements through the project can be categorized into three outputs: (i) Beneficiary Participation and Water Management Association Development, (ii) Development of Small-Scale Water Control Systems and (iii) Institutional Support for Small-Scale Water Resources Development. The Second SSWRDSP commenced in 2002 and completed in 2009. This has developed 275 subprojects in 61 of 64 districts of Bangladesh. The Project supported the development Water Management Cooperative Associations (WMCAs) that include landowners, land operators, women, fishermen and other vulnerable groups. The WMCAs have social and technical capital to undertake small-scale water resources (SSWRs) subprojects and improve the system of operations of water control structures.

1.4 Rationale of Forming Small Scale Water Management Associations (SSWMCAs): The country is largely rural, with more than 50% of its labor force employed in the agriculture sector. The relative contribution of the agriculture sector in percentage to the economy has been gradually declining as other sectors like manufacturing, trade and services gain more importance. The agriculture sector's share of the GDP declined from 28.7% in 1990 to 20.83% in 2008-09.

The productivity of land and labor is constrained by delayed rainfall during the dry season and floods during the monsoon season. These constraints and the potential for increasing agricultural production was highlighted in the national plan of the government and emphasized the need for improving and upgrading surface water use with small-scale flood control and drainage schemes as necessary components.

Irrigation in Bangladesh is mainly dependent on ground water sources. But over extraction of ground water has already caused decline of the water table. It is difficult to get ground water within suction lift in almost all parts of the country in the dry season, a situation that did not exist two decades ago. It is apprehended that arsenic contamination in ground water is a consequence of its over extraction. So, it is suggested to use surface water as much as possible.

The vast plain land of the country is faces flood over 10 to 60 percent of the area every year in the monsoon and scarcity of water in the winter. Drainage congestions is conspicuous either in monsoon or round the year. These problems are location-specific in terms of their types and magnitudes. Macro level interventions of constructing long flood control embankments and supporting structures although brought immediate benefit in some cases but proved to be disastrous in a number of cases. Besides, this type of development works did not enjoy peoples' involvement and hence, there was no sense of belongingness of them to the developed facilities. Therefore, it was felt that identifying local needs and adopting development interventions with people's participation could be best done through village based organizations, by providing the adequate funds. Linking these village organizations with the Nation Building Departments (NBDs) at the *Upazila* (sub district) level for getting and using available supports and services of NBDs efficiently was considered as the important tool of sustainability of these organizations and its development. The Local Government Engineering Department (LGED) adopted Small Scale Water Resources Development Projects (SSWRDP), constructed small water control structures and developed management mechanisms of surface water through these village-based organizations and these organizations were called as sub projects. This second phase of the project covered 61 out of 64 districts of the country. Only three hill districts of Chittagong were not included in the project.

1.5 Objectives: The main objective of this intervention was to improve socio economic condition of the villagers with the optimum use of available water resources through management development and ensuring people's participation. The specific objectives of the project include: (i) develop village based water management society and ensure participation of the villagers in planning and developing water management with due consideration to the rural poor; (ii) provide institutional supports for Small-Scale Water Resources Development; and (iii) develop small scale water control systems according to the local needs for improving the socio economic condition of rural people.

The objective of this paper is to assess the achievements of the project considering local development and poverty reduction.

1.6 Methods: Basic data of this paper has been collected from a report of the project on SSWM project of LGED. In addition, other relevant documents of the project were consulted. Discussions were made with a number of cooperators under the project.

A total of 273 subprojects out of 280 had been completed in the first phase of the project and these are now under operation. The completed subprojects were mainly a combination of Flood Control and Drainage (FCD) (58%), Drainage (DR) (17%), and Water Conservation (WC) (16%). Out of 273 sub projects 22 were randomly selected for assessment. This paper has been prepared on the basis of the findings of these sub projects.

2. RESULTS AND DISCUSSIONS

2.1 Formation of Water Management Cooperative Associations (WMCAs): The name of this village based organization was given as Water Management Cooperative Associations (WMCAs). The WMCAs were established and registered under the Cooperative Society Act of Bangladesh[1] and follow the Cooperative Society's rules for institutional structure, management & maintenance of accounts and records; and annual auditing of accounts. This was formed with the participation of all villagers irrespective of land holding sizes, professions and gender. A management committee is formed in each of the WMCAs with the direct vote of general members. Thrift deposits for capital accumulation by all members were ensured in weekly meeting of WMCAs.

As per cooperative society rules, WMCAs hold elections every 3 years and regular Annual General Meetings (AGMs) where completed annual audits are presented. The functions of the management committee include (i) organizing the beneficiaries of the subprojects, including their participation and sharing the O&M activities of the infrastructure; (ii) helping their members in IGAs through micro credit programmes; and (iii) facilitating training of their members. Nineteen out of the 22 subprojects have active management committees, which functions regularly[2].

The WMCAs have various functional subcommittees such as the O&M, agricultural, micro credit/loan, and women's subcommittees. Some of the WMCAs have village committees for closer connectivity with the beneficiaries. WMCAs have both paid employees and volunteers.

The members of WMCAs must purchase at least one share in the cooperative[3], which may be of the value between TK 10 and Tk 100. In addition, each member is required to contribute each month to a savings account, usually Tk 10 but up to Tk 100, depending on the WMCA by-law. This organization has been working as the platform for local development of the area by integrating various development works of different NBDs on sustainable basis.

1 WMCAs are formed under the Co-operative Society Act and its rules and regulations. In particular, Rule 2(2) was amended in 2001 to include a definition under which water management associations may be established as cooperative societies, the members of which are beneficiaries of water resources projects.

2 As of March 2006, the total number of members of the 280 WMCAs had reached to 106,653, around 75% of whom were male.

3 In most WMCAs, the maximum number of shares one can buy is limited to between 10 and 100, although in some cases shareholdings allowed up to the maximum of 20% of total share capital per member.

2.2 Household Involved with the Project: The total number of households in the selected subprojects was 14,789 of which the beneficiary households were 10,828. The beneficiary households include members involved with the societies and house holds get benefit from sub projects like getting irrigation facilities, water conservation facilities etc. (Table-1).

Table1. Number of Households, Beneficiaries and WMCA Membership of Selected Subprojects

Subproject	Total House-holds	Beneficiary House-holds	WMCAs Membership		
			Men	Women	Total
Nabaganga (FCD)	746	448	495	914	1409
Ichali (WC)	683	683	316	215	576
Bagchar-Badurgacha (FCD)	359	359	328	154	482
Jabusha Beel (FCD)	1,090	1,090	619	97	716
Kaikubunia-Chinguria (FCD)	278	341	222	94	316
Ramkrishnapur (DR)	587	490	333	57	390
Mitain-Naldanga (FCD)	531	435	483	99	582
Ershaimari (WC)	323	313	210	108	318
Baranurpur (WC)	317	305	216	127	343
Brahar (FCD)	1,010	810	476	197	673
Lohagara Khal (FCD)	1,284	1,234	665	221	886
Moranadi (WC)	824	445	128	64	192
Nakdaha-Alaikumari (WC)	400	318	136	54	190
Haridhara (WC)	591	363	231	84	315
Charolkathi Beel (FCD)	182	152	162	76	238
Purba Mohanpur (FCD)	542	461	216	107	323
Agrani (CAD)	2,000	1,379	736	206	942
Dudhai Bhanpur (WC)	755	264	284	50	334
Bankeshor-Nebutala (DR & WC)	780	239	241	40	281
Rampur (FCD)	400	100	270	69	339
Kumarer Beel (FCD)	750	380	137	15	152
Dighapatia (FCD)	357	219	204	98	302
Total	**14,789**	**10,828**	**7,108**	**3,146**	**10,254**

Sources: Local Government Engineering Department; Operations Evaluation Mission.
CAD= Command Area Development, FCD= Flood Control and Drainage, WC = Water Conservation, WMCA = Water Management Cooperative Association.

2.3 Land Holding Sizes of Members: The total number of households in the selected sub projects was 10,828 of which 4721 belong to poor category. Landless Farmers do not have

anything left after meeting up all expenditures for their families due to very limited income from agriculture and also have less food compared to need. The members were dominated by landless poor (43.6%). Marginal and small farmers constituted 25.0 and 16.1 percent respectively. Comparatively well-off medium and large farmers constituted 15.0% only. Enhanced income for adopting the development interventions of the project in agriculture goes to all categories farmers through cultivating of crops under in a changed situation like increasing cropping intensity, adopting share cropping, selling of labor, petty business of agriculture input & output etc.

Table 2. Distribution of Landholdings of Cooperative Members of Sub Projects (percent)

Subproject	Beneficiaries in Percentage				
	Landless (0-0.2 ha)	Marginal Farmer (0.21-0.6 ha)	Small Farmer (0.61-1.0 ha)	Medium Farmer (1.01-1.99 ha)	Large Farmer (>=2 ha)
Nabaganga (FCD)	21	41	23	14	1
Ichali (WC)	37	23	23	11	6
Bagchar-Badurgacha (FCD)	27	30	23	15	4
Jabusha Beel (FCD)	43	24	19	9	5
Kaikubunia-Chinguria (FCD)	36	22	22	12	7
Ramkrishnapur (DR)	42	26	16	10	6
Mitain-Naldanga (FCD)	70	20	6	3	1
Ershaimari (WC)	10	32	20	29	8
Baranurpur (WC)	32	26	23	15	5
Brahar (FCD)	56	12	14	13	6
Lohagara Khal (FCD)[a]					
Moranadi (WC)	60	25	9	5	1
Nakdaha-Alaikumari (WC)	40	24	19	12	5
Haridhara (WC)[a]					
Charolkathi Beel (FCD)	31	34	22	8	6
Purba Mohanpur (FCD)	46	21	14	9	9
Agrani (CAD)	42	24	17	11	6
Dudhai Bhanpur (WC)	50	40	8	1	1
Bankeshor-Nebutala (DR & WC)	66	13	9	1	2
Rampur (FCD)	33	40	13	11	3
Kumarer Beel (FCD)	47	19	15	12	7
Dighapatia Beel (FCD)	83	4	6	6	2
Average	**43.6**	**25.0**	**16.1**	**10.4**	**4.6**

Source: Integrated Water Resources Management Unit of the Local Government Engineering Department CAD = Command Area Development, DR&WC = Drainage and Water Conservation, DR = Drainage, FCD = Flood Control and Drainage, ha = hectare, WC = Water Conservation.

[a] Results of feasibility study were not available from Integrated Water Resource Management Unit

2.4 Micro Credit Support: Micro credit plays a vital role both for reducing the magnitude of poverty and having incremental income for the well-off families. The society accumulates capital mainly from thrift deposits of its members and business of the organization. Both poor and non poor take micro credit from the societies for their own. Inadequate fund in this regard is a major problem in almost all organizations under the project. Societies allocate micro credit to their members depending on the availability of fund, requirements and nature of IGAs of the members. Agriculture practices like irrigated rice production, fish culture, fishing net preparation, poultry & livestock raring, purchasing of van, plantation of fruits trees, purchasing of sewing machines etc. were found the common IGAs lead by micro credit in these organizations.

Table 3. Micro Credit Disbursed and Realized, 2007.

Subproject	Total Value (Tk.)	Repayment (Tk.)
Nabaganga (FCD)	29,201,000	24,507,243
Ichali (WC)	671,951	547,450
Bagchar-Badurgacha (FCD)	705,750	610,320
Jabusha Beel (FCD)	414,500	295,430
Kaikubunia-Chinguria (FCD)	258,000	186,840
Ramkrishnapur (DR)	NA	NA
Mitain-Naldanga (FCD)	144,000	57,000
Ershaimari (WC)	110,000	116,416
Baranurpur (WC)	460,000	447,300
Brahar (FCD)	703,900	530,319
Lohagara Khal (FCD)	436,150	458,371
Moranadi (WC)	80,000	NA
Nakdaha-Alaikumari (WC)	NA	NA
Haridhara (WC)	51,400	45,650
Charolkathi Beel (FCD)	371,500	258,000
Purba Mohanpur (FCD)	158,400	73,340
Agrani (CAD)	2,829,750	1,898,750
Dudhai Bhanpur (WC)	234,000	NA
Bankeshor-Nebutala (DR & WC)	125,500	85,500
Rampur (FCD)	1,476,918	992,385
Kumarer Beel (FCD)	NA	NA
Dighapatia (FCD)	88,500	55,120

Source: integrated Water Resources Management Unit of the Local Government Engineering Department

Members also have access to micro credit of the nationalized banks and NGOs and also private banks, which the Government of Bangladesh has recently brought into the package of nationalized banks to provide agricultural credit to the farmers. The amount of credit is small in majority cases. But the members are interested to take credit from their own organization

because it is simple and they can pay back in installments and can have a part of the interest at the end of the year as dividend.

The project provided extensive training to the beneficiaries on subproject implementation like structures of water management, relevant cooperative rules, making WMCAs work, basic management training, various livelihood activities (such as seasonal vegetables and seed production, integrated farm management and poultry development). The beneficiaries were also trained in fish production techniques and pond fish culture and fingerling production.

Credit lead IGAs were monitored by the societies so that the members can timely repay the installments and also can have benefit from the same.

The poor (both male and female) participate in the weekly meeting and take part in discussions relating to the development works and welfare activities of the society. They gradually learn speaking in the meeting and over time, take part in debate on development issues.

2.5 Development of Agriculture: Agriculture and fisheries got the main emphasis under the project. Added income from higher cropping intensity and crop production, assured employment, fish production etc., played the key role in getting more income, capital formation and poverty reduction of the area. Small water management structures helped in creating congenial environment to control flood, conserve water and drain excess water to ensure sustainable growth in agriculture and fisheries. These helped the rural poor to become a part of development process, improve their condition and come out of the vicious cycle of poverty.

In 2002, aggregating for all subprojects, cereal production was 22,217 MTs, which was increased to 192,789 MTs in 2010. The data also show significant increases in non cereal production with an average of over 15,000 MTs per year. On the other hand non cereal crops, which mainly include potato, jute, pulses oilseeds and vegetables increased remarkably (Table-5).

The project could produce a significant amount of rice and non cereal crops. It has helped farmers with timely plantation and switching to high-yielding varieties—which required water management and control and more inputs than other traditional. The project supported beneficiary farmers in maintaining and improving soil productivity, crop diversification and integrated pest management for sustainable crop production.

Table 5. Increase in Production, 2002-2010

Season	2002		2004		2010	
	Cereals	Non-cereals[a]	Cereals	Non-cereals[a]	Cereals	Non-cereals[a]
Winter	22,217	114,143	158,674	107,413	192,789	130,507
Pre Monsoon	14,865	28,825	35,730	30,593	43,412	37,170
Monsoon	49,576	18,516	47,967	20,891	58,280	25,383
Total	**86,658**	**161,484**	**242,371**	**158,897**	**295,098**	**193,060**

Source: Integrated Water Resources Management Unit of the Local Government Engineering Department
[a] Non cereals are a diverse group of crops and amount therefore should be treated as indicative only.

The winter rice production increased many folds due to getting water in the dry season in the project areas. Government has given top priority in National Agriculture Policy (NAP) of the country and provides all sorts of input supports to increase rice productions particularly irrigated rice productions in winter season and supplementary irrigation in non rice crops round the year.

2.6 Development of Fishery: The fish production increased as a consequence of control of water during the flood season and making it available for dry season use. The total production of fish was 2,072 MTs in 2004 and 3,811 MTs in 2010. The project reduced the natural migration of fish during the breeding season and led to some loss of production from the floodplain fishery through reducing flooded areas and flood depth in many places. For the whole project, there was an increase of about 6,700 in the number of those cultivating fish and an overall increase on floodplain fisheries. The impact of the project on the livelihood of fish producers was difficult to assess because of the lack of reliable baseline data. The situation was average for traditional fisher families, where gains have been experienced by some and losses by others. Traditional fishermen families (who are generally the poorest in any community) were less benefited as squeezing trend of flood plain fishery. So, some poor fishermen adopted other jobs such as daily laborer, van puller, petty traders with support of micro credit in a number of sub projects areas.

Table 6. Impact on Fisheries due to Project Interventions

Item	2002	2004	2010
a. Fisherman			
Change in number of Genuine fishers	268	82	14
Fish cultivators	2,053	5,604	6,712
b. Production			
Incremental production (tons)	1,712	2,072	3,811
c. Perception of overall impact on livelihood (%)[a]			
Fishers			
Improved	25.5	46.4	96.5
Deteriorated	23.4	16.7	3.5
NA	51.1	36.9	-

Source: Integrated Water Resources Management Unit of the Local Government Engineering Department

a. These figures show the percentage of fishers/cultivators who believed that their livelihood either improved or deteriorated as a result of the Project.

Fishing as a source of livelihood was affected seriously in the selected WMCAs. Gradual reduction of water bodies in the dry season and barriers of water control structures interfered with the natural breeding places in the flood plain. Many of the fishermen community had to change their main vocation and maintained fishing only as a part of their livelihood in many sub projects. In selected WMCAs the number of fishermen depending on fishing in natural streams for their livelihood decreased from 268 in 2002 to 14 in 2010. Many of them become daily wage earners, become members of WMCAs & took part in earth works and deposit money from their income. They took micro credit for IGAs. On the other hand cultured fish

in ponds and ditches become very popular for higher profit. Cooperators cultivated fish in their own ponds or in rented and leased ponds for certain periods. The data available the incremental production of the subprojects that took place in 2002 was 1,712 MTs and 3,811 MTs in 2010. In national level the growth of fishery is about 7% where cultured fish plays the key role (GoB, 2007). About 97% of the villagers in 2010 involved with cultured fishery believe that their livelihood developed with the project interventions as they could adopt improved methods of fish cultivation in comparatively safe environment (project intervention protected them from flood) and also conserve water for dry season use in many places of the project area.

2.7 Capital Formation and Poverty Reduction: The subprojects have generated both direct and indirect benefits. Direct benefits included improvements in small-scale water resources management such as flood control and relief from drainage congestion resulting in increased crop production and opportunities for fish culture. Indirect benefits were derived mainly from micro credit activities and included, poultry farming, kitchen gardening and livestock rearing and fattening. The subprojects also generated employment for the poor in the orchards and in water transportation. The project has established safe conditions for increased investment by households in both agricultural and nonagricultural activities. As a result, WMCA management committees and members were in the track to an improvement in their income and standard of living.

Both landowners and the landless have benefited from the project. In the selected subprojects, the intensification of agriculture increased the demand for farm labor and generated more employment for the poor and landless. Better household incomes make it easier for poor households to take advantage of education, health and other social services in their villages.

The sub project involves poor people in earth cutting works mainly for building embankment, excavation works and supporting works of infrastructure constructions. Ensure force deposit of a part of their earnings from their daily earnings help in capital formation. The organization provides credit to the poor to involve them in IGAs. These IGAs are monitored by the organization. Members of managing committee of the organization keep contact with NBDs at the Upazila level and take opportunities like training and other supports and services available there. In addition, available short duration IGAs are supported to the poor from the relevant organizations when opportunities are available. Money available from interests of disbursed credit among the members of a society along with profit of the businesses, irrigation water distribution & fishery activities of the organization are distributed among all the members at the end of the year as dividend.

Table 5. Capital Formation of Members of Selected WMCAs, 2007

Subproject	Total Capital	Capital/Member
Nabaganga (FCD)	3,731,282	2,648
Ichali (WC)	246,760	428
Bagchar-Badurgacha (FCD)	653,687	1,356
Jabusha Beel (FCD)	372,360	520
Kaikubunia-Chinguria (FCD)	159,520	505
Ramkrishnapur (DR)	86,235	221
Mitain-Naldanga (FCD)	200,940	345
Ershaimari (WC)	161,280	507
Baranurpur (WC)	213,645	623
Brahar (FCD)	248,860	372
Lohagara Khal (FCD)	225,483	255
Moranadi (WC)	148,900	776
Nakdaha-Alaikumari (WC)	104,000	547
Haridhara (WC)	108,895	346
Charolkathi Beel (FCD)	141,380	594
Purba Mohanpur (FCD)	72,680	225
Agrani (CAD)	431,100	NA
Dudhai Bhanpur (WC)	223,088	668
Bankeshor-Nebutala (DR & WC)	63,440	226
Rampur (FCD)	721,048	2,127
Kumarer Beel (FCD)	18,450	121
Dighapatia (FCD)	84,080	278

Source: Integrated Water Resources Management Unit of the Local Government Engineering Department

2.8 Motivational Programmes: The WMCAs adopt motivational programmes like sending kids to the schools, vaccination of kids, using sanitary latrines, use of safe drinking water etc. For vaccination of babies the association provides necessary contacts with health department at the *upazila* and a arrange venue for that.

The society encouraged its members to adopt cheap affordable water sealed latrines. The rings and slabs are now available in village markets and even a few associations prepared the same in their office premises and sell to its members at a cheaper price. The association helps members in getting safe drinking water where ground water is arsenic contaminated. It includes advises how to get safe drinking water with boiling and filtering and linking them getting better technologies available under the initiatives of Department of Public Health Engineering, research organizations and NGOs.

2.9 Women Development: Women accounted for around 31% of the total members of the WMCAs in the selected subprojects. Women were more visible in their respective communities, as they now contribute in terms of the WMCAs' activities. The management committee of each WMCA had 3–4 women members. Even a woman in a sub project chairs the managing committee. Women are now actively participating in the overall management and decision-making process in their respective WMCAs.

2.10 Environmental Issues: Under the project, an environmental monitoring program was established. Three regional and eight greater district laboratories were set up for monitoring any changes in the water quality in 11 selected subprojects. Several parameters were monitored to assess water quality, including the pH, nitrate & arsenic levels for groundwater and pH, dissolved oxygen & calcium chloride hardness for surface water. Laboratory technicians were trained in the use of the laboratory equipment. Based on the last water quality test, it was observed that improvement has taken place in increasing the amount of oxygen of sample surface water[4].

The subprojects designed and constructed fish-friendly structures and adopted improved systems for sluice gate operation to facilitate fish migration during critical periods.

2.11 Lessons Learnt: The project experienced a number of lessons with regards to WMCAs. The experiences includes: (i) Good WMCAs have direct & tangible benefits; good & strong leadership; and higher income-generating activities with having better position to perform good O&M activities of the infrastructures. (ii) All landowner particularly large and medium landowners had a positive view about WMCAs. Large farmers of respective WMCA facilitate O&M activities. Small & marginal farmers and the landless poor considered WMCAs as good sources of micro credit which is cheaper than the same available from NGOs. (iii) Interruption of providing training activities after the end of the project would undermine the sustainability of the project (iv) The combination of skill training and support with micro credit facilities are useful package to sustain WMCAs and its activities. (v) Good monitoring systems supported with training programmes could ensure timely outputs of IGAs. (vi) Successful project implementation requires good relationships and interactions with local government, Department of Agricultural Extension (DAE), Department of Fisheries, Department of Cooperative (DoC) and other agencies. The project developed good coordination mechanisms and thus obtained inputs and supports from NBDs at the Upazila level for project beneficiaries.

3. CONCLUSIONS

Bangladesh is a flood plain of vast catchments areas in India, Nepal, Bhutan and China. Over ninety percent of catchments area exists outside the country. So, huge amount of water of the catchments areas passes through Bangladesh to the Bay of Bengal in the wet season. The country suffers from excess water which causes 10 to 60 percent flooding of the total land area of the country in wet season and shortage of water in dry season. The increasing demand for diversified & extensive use of water of natural streams in the countries up causes serious scarcity of water in Bangladesh in dry season.

4 In 2005, 11 sampled subprojects, 4 recorded an increase in nitrate levels. This could be due to an increase in the use of fertilizer in some subprojects. Also, due to the inadequacy of laboratory reagents and consumable chemicals, the use of old kits/reagents for testing may have led to unreliable results.

Small Scale Water Resources Development Sector Project (SSWRDSP) of Local Government and Engineering Department (LGED) started in 1997 at its first phase with the objective to increase agriculture production and income of smallholder farms in subproject areas and help in poverty reduction. The subproject is generally formed in one organization in one village. This organization develops small scale water resource infrastructures like construction of embankment & sluice gate, installing pump set where necessary and excavation of canal & ponds etc. to save agriculture land from flood in the rainy season and at the same time conserve water for dry season agriculture and fish production. All the infrastructures are built up on the basis of need of the locality and with the joint efforts of project and village organization for ensuring ownership of local community. This village organization has special programme for the poor of the area to reduce the magnitude of their poverty through creating employment scope and ensuring force savings of a part of their income. The project was implemented in 280 subproject area in the western region of Bangladesh in its first phase where susceptibility of poverty is higher. The second phase of the project started in 2002 and completed in 2009.

A total of 280 sub projects had been carried out under the project of which 273 was completed and are operating. These sub projects were mainly a combination of flood control and drainage (58%), drainage (17%) and water conservation (16%). The other sub projects were either combination of drainage and water harvesting or of drainage and irrigation structures or command area development.

It was evident from evaluation that the project i) could increase agriculture (over 15,000 MTs per annum) & fish production (250 MTs per annum) and ii) made farms efficient in resource utilization & employment generation in the project area. Increased crop and fish production have generated tangible benefits for the WMCAs such as poultry farming, kitchen gardening, livestock rearing & beef fattening, tree plantation and employment generation for the poor. Better household incomes enaable poor household to take advantage of education & health and social services in their villages. In addition, the rural poor could access credit through the micro-credit programme of WMCAs. Another important achievement of the project was to institutionalize the participation of beneficiaries in small scale water development activities of the area. The linkages build up with Department of Agriculture Extension (DAE), Department of Fisheries (DoF), Department of Cooperative (DoC) etc., at the sub district (*Upazila*) level helped these organizations to build their capacity in terms of getting training and other support and services on a sustainable basis.

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