A Critical Look at Efficacy of Mega Water Development Projects and its Impact on Crop Productivity in the Southwest Region of Bangladesh

Robin, T. A.[1], Ahammed S. S.[2], Rabbani, K. A.[2*], Khaleque, M. A.[2], Datta, D.K.[3]
[1] *Save the Children International, House CWN (A) 35, Road 43, Gulshan 2, Dhaka 1212, Bangladesh*
[2] *Department of Environmental Science, School of Environmental Science and Management, Independent University, Bangladesh, Plot 16, Block B, Aftabuddin Ahmed Road, Bashundhara, Dhaka -1229, Bangladesh.*
[3] *Environmental Science Discipline, Khulna University, Khulna 9208, Bangladesh*

Abstract

There have been many flood control or water development projects in Bangladesh with varying degrees of success. The stated objective for most large scale flood control projects is in increasing cultivated area which in turn is expected to increase the agricultural yield. The aim of this paper is to critically analyze whether mega flood control projects done in the southern region of Bangladesh has had any effect on the stated objective of increasing rice yield. It can be expected that flood control protection would lead to more cultivated area and should show an increase in rice production. Rice productivity has decreased since 1990 in this region even after an increase in the agricultural yield and more significantly, the flood control protected areas. A historical description of three phases of mega water development projects in the southwest region of Bangladesh is also given for context and the relationship with rice productivity has been discussed.

Keywords - *Water Resource Management, Flood Control, Crop Productivity, Bangladesh, Agriculture.*

I. INTRODUCTION

Water management is a crucial factor in flood prone areas and is a challenge in many parts of the world. In Bangladesh, external agencies like the World Bank have taken the lead role in funding water management projects with the main goal of economic development and food security (Tunstall et al. 2004). Most of these projects are structural measures but recently there have been very slow adoption of non-structural measures (Biswas 1997; Luo et al. 2015). Until very recently water management practice by government institutions like the Bangladesh Water Development Board (BWDB) and Local Government Engineering Department (LGED) emphasized only on the structural solution without paying due attention to non-structural water management (Alexander et al. 1998). This has led to questions on the adequacy and effectiveness of these massive-scale structural interventions, or "mega projects" that have been implemented in the country. Mega water development projects typically include a several districts of an area and directly affect thousands, if not millions of people. In most, if not all these projects, the stated objectives include increasing rice production as one of the main aims. Very little follow up or post project review has been done on these mega water development projects to assess if the project has indeed led to an increase in rice production for the region.

The southwest region of Bangladesh is one of the most important rice production areas of the country and almost 13% of the total rice production in Bangladesh comes from this region (BBS). At present, the major water management issues affecting rice production in the southwest area are acute shortage of surface water in the dry season (Adel 2002); wide-spread flooding, primarily from the Ganges and the Lower Meghna (Islam 2006) and drainage congestion in the polder areas and salinity intrusion from the coast (Nishat 1993). Added to this is the increase in frequency and intensity of droughts due to global climate change and this has had an effect on plant growth and crop yields (Ashikuzzaman 2008; Robertson et al. 2018) . The main rice variety grown in the southwest region of Bangladesh has traditionally been *T. Aman* with a recent interest in *Boro (BBS ; Biswas et al.)* . The harvest of *T. Aman* typically takes place during late fall and winter and is the most common harvested rice in Bangladesh.

This paper investigates the effects of mega water development projects on agricultural production in the

southwest region of Bangladesh, namely the Satkhira, Khulna and Bagerhat districts. A historical perspective of the mega projects in the region are provided together with the effect of the projects on rice production. Very few studies have been done on the impact of structural management on agricultural production and the present study looks at the efficacy of such large-scale projects.

II. METHODOLOGY

This study was based on the data collected for the southwest region of Bangladesh and secondary data on water/flood control projects, both in Bangladesh and China. Historical data on crop production of the region was collected from Bangladesh Bureau of Statistics (BBS). Information on water development projects of Khulna were collected from the Library of the National Museum, and Bangladesh University of Engineering and Technology (BUET) and from books, websites, and project reports from subdivision office of Water Development Board. Data for China was collected from National Bureau of Statistics of China (China 2018). Basic maps on polder and land use of southwest region of Bangladesh including Khulna were taken from CEGIS and others and are generated using ArcGIS software (ver 9.4). The country wise data of Bangladesh and China was collected from the official web sites of Food and Agricultural Organization of the United Nations (FAO 2018).

III. RESULT and DISCUSSION

A. History of Surface Water Management in Southwest Bangladesh

It is known that all major water development projects always bring both positive and negative impacts on the deltaic environment and a historical assessment of water management policies is important (Pal et al. 2011)**.** The water management system in the southwest of Bangladesh was mostly concentrated on the various types of structural solutions – the Coastal Embankment Project (CEP) of 1960, Khulna Jessore Drainage Rehabilitation Project (KJDRP) of 1994 and Town Protection Project of 2000 were the major large scale water development projects of this region. The main objectives of these projects were bringing self-sufficiency in food grain production, controlling the flood and preventing saline water intrusion. Based on the strategic objectives of the projects, the development trend of this three districts can be categorized into three phases- Phase-I (Controlled flood and management (1961-84)), Phase-II (Floodplain and drainage development (1978-1994)) and Phase-III (Riverbank and town protection activities (1996-2006)). The main purpose of Phase I was to reduce the depth of flooding or eliminate, through "controlled flooding", any untimely floods. Coastal Embankment (1960) Project financed by the Asian Development Bank (ADB) was the major intervention in surface water system to optimize the agricultural yield production. East Pakistan Water and Power Development Authority (EPWAPDA) executed the giant construction activities. The key summary and major construction of the projects under Phase I are summarized in Table 1.

Under Phase I, 4,45,640 hectares of land in Satkhira, Khulna and Bagerhat districts was covered by such type of flood control and drainage projects (Hamid 1991). Bangladesh Water Development Board (BWDB 2008) reported that in Satkhira district 161,121 hectare land is covered by 9 polder area and 1,05,513 hectare of land in Bagerhat district. The total project cost was about Tk.137.1194 crores (BWDB 2004). The year wise embankment constructed from 1961 to 1984 is shown in Figure 1. In Satkhira district almost every upazila is covered by polders and four upazilas of Khulna district are covered by polders. From 1961-1972, 248.78 km embankments were constructed in Paikgacha and 233.64 km in Dumuria upazila of Khulna district. The Madhumoti, Betna and Chunar rivers of Satkhira and Bagerhat districts were also altered by those embankments. The main failures and omissions in Phase I were increasing river bed and water logging problems in floodplain areas of Khulna and Satkhira district. Also the lack of security of life and property and low socioeconomic developments were the major concepts that interfered in the water development process during the post-independence period of Bangladesh.

TABIL 1: Completed projects in Khulna, Satkhira and Bagerhat districts (BWDB 2004, 2006, 2008)

Districts	No. of projects	Embankment (km)	Sluice gate	Regulator	Project duration
Khulna	24	788.41	14	328	1961-1985
Satkhira	9	676.17	232	-	1961-1983
Bagerhat	10	387.48	-	162	1966-1984

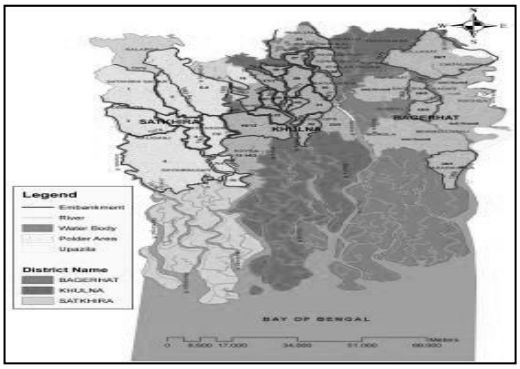

Fig 1: Year wise embankment construction during phase I of water development

Under Phase II, the Khulna Jessore Drainage Rehabilitation Project (KJDRP) (1994) of Khulna district and Beel Development (1978) of Satkhira district were the major water development interventions. The key summary and major construction of the projects are presented in Table 2. This floodplain and drainage development project covered 83,367 hectare land of Satkhira and Khulna districts. Most of the bridges and sluice gates were constructed in the upstream of Shibsha, Koyra and Rupsha rivers which are located in this region.

TABLE 2 Floodplain and drainage development projects from 1978-1994 (BWD, 2006, 2008)

District Name	No. of Project	Embankment (km)	Regulator	Sluice gate	Road (km)	Bridge	Project Period
Khulna	3	173.03	7	33	60	31	1978-2002
Satkhira	2	-	-	8	-	16	1978-1987
Bagerhat	-	-	-	-	-	-	-

In Phase III, river bank erosion were identified as major water management problem in southwest region of Bangladesh. River bank erosion and rupture in embankment in *Sharonkhola* upazila of Bagerhat district was the highest ranking environmental problems of 1990s (Ashikuzzaman 2008). As a consequence, the secondary towns flood protection project was launched by Bangladesh Water Development Board (BWDB). The primary goals were to find improve and appropriate solutions for erosion protection and to ensure a relatively flood-free and secure living environment in selected area. The key summary and major construction of the projects are presented in Table 3.

TABLE 3: River bank and town protection projects (1996-2007) (BWDB 2004, 2006, 2008)

District Name	No. of Project	Embankment / Embankment Protection (km)	Permanente Slope Protection (Meter)	Regulator	Project Period
Khulna	1	6.5	-	8	1996-2000
Satkhira	2	2.447	445	-	1998-2007
Bagerhat	5	21	1202	23	1998-2006

B.Rice production and cultivated area of southwest region of Bangladesh

One of the objectives of the mega projects outlined above is the expected increase in cultivated area in the southwest region of Bangladesh which in turn was expected to lead to an increase in rice production. The main rice variety grown in the southwest region of Bangladesh has traditionally been *T. Aman* with a recent interest in *Boro* production (18). (Figure 2)

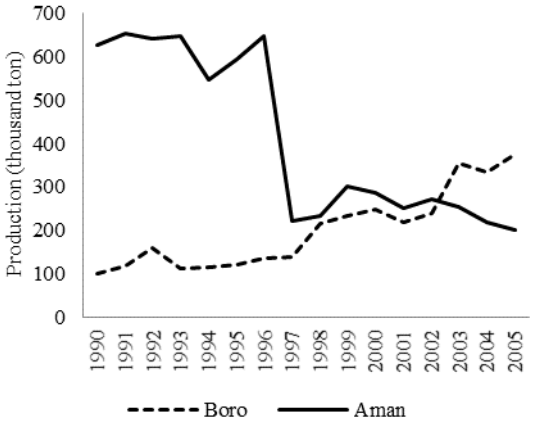

Fig 2: T. Aman & Boro production in Southwest of Bangladesh

To give context to the rice production before and after megaprojects, it should be noted that the average *T. Aman* production from 1948 to 1960 was 414 thousand tons (Hamid 1991). In phase I, the average annual *T. Aman* production increased to 463 thousand tons. There was construction of about 36 polders, which covered around 373 thousand hectares of land in greater Khulna districts (Table 1, 2, 3). The cumulative FCD coverage increased from 6.7 thousand hectares to 452 thousand hectares during 1961-85 (Phase I) (Hamid 1991).

But after 1990, the *T. Aman* production decreased dramatically reaching a production of 175 thousand tons in 2014 (Figure 3). This is in contradiction to the stated objectives of the mega projects, specially the projects conducted during this period (Phase II and Phase III) which claimed that one of the prime objectives was to increase *T. Aman* production in the area. It has been claimed that the Khulna-Jessore Drainage Rehabilitation Project (KJDRP), which was a project during Phase II, by itself has produced 124 thousand tons of food grain in Khulna district with an investment of 150 crores (BWDB 2006). The main reason for the decrease in rice production is the decrease in cultivation area, which also decreased dramatically after 1990 to 80 thousand hectares in 2014 (Figure 3). There has been a steady decline in cultivation area suitable for *T. Aman* plantation despite there being an increase in FCD protected area. The increase in FCD protected area should have meant an increase in cultivable area for *T. Aman* and increased production but this has not been the case in the

southwest region of Bangladesh (Figure 4). It can be speculated that the reason for the reduction in cultivable land is due to loss of soil fertility due to salinity intrusion. Incidentally, one of the aims of the megaprojects was preventing saline water intrusion, so this soil fertility loss could be a direct consequence of undertaking poorly designed structural measures. However, more studies need to be done to ascertain the reasons for the decrease in cultivable land in the southwest region of Bangladesh. It is also interesting to note that the yield of *T. Aman*, i.e. the amount of rice production per hectare of cultivable land has actually increased over the years (Figure 2). There was an improvement in the use of high yielding varieties (HYV) of *T. Aman* to increase production and inputs are correlated with the net production (Fatema and Miah, 2011). Besides that, since 1993 *Boro* has been showing increasing trend in annual production (Figure 2). The expansion of irrigated cultivation and increasing supply of HYV in dry season improve the status of *Boro* cultivation (Deb et al, 2009).

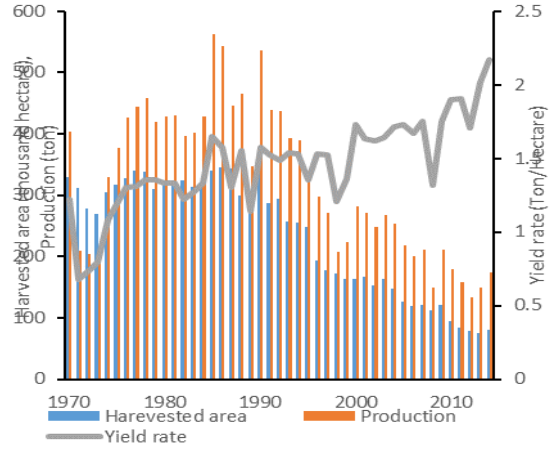

Fig 3: Comparison of *T Aman* cultivation area, production and yield in southwest region of Bangladesh

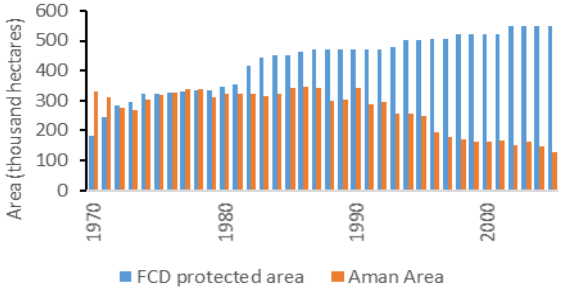

Fig 4: Comparison of FCD protected area and *T Aman* cultivation area in Southwest Bangladesh

The situation in the southwest in Bangladesh is noteworthy, especially if compared to the scenario in China. There are many similarities between China and Bangladesh – both suffer from floods, both have high population densities and both the economies have rice as the most important staple of the country (Alexander et al. 1998; Haque 2006; Mia and Islam 2005; Nishat 1993; Peng et al. 2009). Since 1949, the Chinese government has initiated and funded different measures for flood control and management (Luo et al. 2015). The failures of these projects have been argued (Islam 2006; Luo et al. 2015; Zhang and Liu 2006) but rice production in China has more than tripled in the past five decades mainly due to increased grain yield rather than increased cultivated area (Peng et al. 2009). Figure shows that, since the mid-90s, FCD protected area (or dyke protected land area) in China was higher than cultivated area which is similar to the situation in southwest Bangladesh. However, the reason for this is not so clear, specially since there seems to be a sudden increase in FCD protected area after 1995 (Fig 5). It is evident from Figure 6 that when comparing the national rice production figures of China, Bangladesh and the southwest region of Bangladesh from 1985 to 2014 that the rice production have steadily increased for both nations but decreased dramatically for the southwest region of Bangladesh.

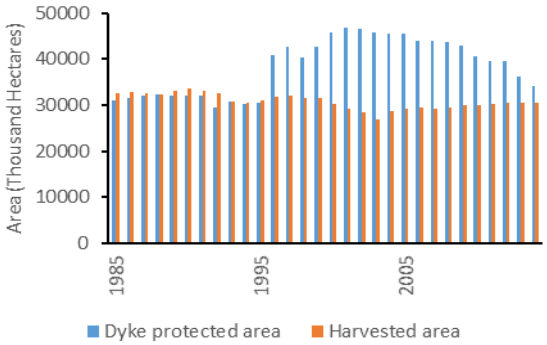

Fig 5: FCD (Dyke protected area) and rice cultivation area in China

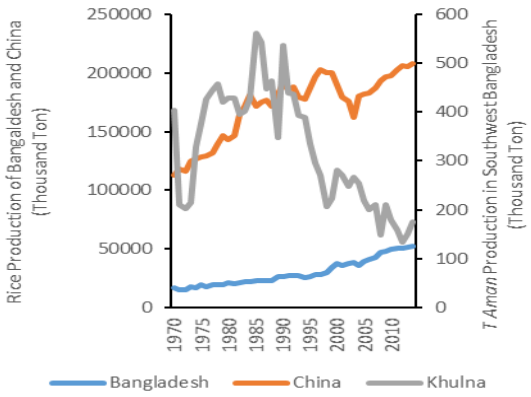

Fig 6: Rice production in China, Bangladesh and southwest region of Bangladesh

IV. CONCLUSION

Surface water resource management in the southwest region of Bangladesh have historically relied on structural engineering projects. The historical development trend of water management projects in this area can be categorized into three phases. The first phase started with the Coastal embankment project (1960) that constructed most of the embankment and hydraulic structures. In the second phase, water development projects mostly depended on floodplain management to solve water logging problems. The third phase consisted of riverbank and town protection activities. FCD coverage in Southwest part of Bangladesh in three different phases of development presents asymmetric contribution in increasing agricultural production. There is insignificant increase in average annual *T. Aman* production during post development period (after 1971). As a result FCD projects could not bring any impressive results in increasing *T. Aman* paddy production. On the other hand total rice production of Bangladesh shows an increasing trend. Hydrological functions of floodplains, which provide the basis of agricultural production, have degraded due to structural projects. As a result, average return-to-investment ratio for these mega FCD projects is of no consequence and have not achieved their objectives. Future projects should consider the long term impact of structural measures and include non-structural measures for sustainable development of the area.

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