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Water Management in Flood Control and Drainage Systems in Bangladesh

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ABBREVIATIONS/ACRONYMS

BARC	Bangladesh Agricultural Research Council
BMDA	Barind Multipurpose Development Authority
BWDB	Bangladesh Water Development Board
DC	Deputy Commissioner
DDCC	District Development Coordinating Committee
DTW	Deep Tubewell
EPWAPDA	East Pakistan Water and Power Development Authority
FAO	Food and Agriculture Organisation
FAP	Flood Action Plan
FCD	Flood Control and Drainage
FCDI	Flood Control, Drainage and Irrigation
FFW	Food-for-Work Programme
FPCO	Flood Plan Coordination Organisation
GoB	Government of Bangladesh
GPP	Guidelines for People's Participation
HYV	High Yielding Variety
IFAPRM	Independent Flood Action Plan Review Mission
IOV	Inspectie Ontwikkelingssamenwerking te Velde (Inspection Development Cooperation)
IWM	Improved Water Management
LGED	Local Government Engineering Department
LLP	Low Lift Pump
MoWR	Ministry of Water Resources
MPO	Master Planning Organisation
NCA	Net Cultivable Area
NGO	Non-Government Organisation
OC-LOC	Occupation-Location
O&M	Operation and Maintenance
PAP	Project Affected People
R&HD	Roads and Highway Department
RRA	Rapid Rural Appraisal
RWMA	Rapid Water Management Appraisal
SDO	Surface Drainage Outlet
SRP	Systems Rehabilitation Project
STW	Shallow Tubewell
TDCC	Thana Development Coordinating Committee
UP	Union Parishad
WM	Water Management
WMA	Water Management Areas
WMI	Water Management Issues
WM-Block	Water Management Block
WM-System	Water Management System

GLOSSARY

Aman	Main monsoon season paddy crop planted during the monsoon and harvested after monsoon (November-December).
Aus	Late dry season/early monsoon paddy crop planted before the monsoon (March-April) and harvested during the monsoon, in June-July.
Beel	A low-lying depression in the floodplain that generally contains water throughout the year, a small lake or backswamp.
Boro	Winter (dry) season paddy crop planted in December-January and harvested in April-May.
Breach	A naturally occurring break in an embankment admitting water.
Bundh	A small earthen embankment or dam.
Compartmental bundh	A minor embankment inside a flood protected area that serves as a second defence against flooding.
Cross dam	A body of earth placed across a *khal* or river for retaining water.
Culvert	A structure that connects two waterways and passes underneath a road or railway.
Done	A traditional irrigation device made of wood and having the shape of a canoe. It is usually 3 m long and open at one end. The other end is attached with a rope to a fulcrum that has a weight on the country side. The device is operated by a person stepping on and off the closed end, which makes the canoe dip in the water (river or canal) and then be lifted by the weight. Each load lifts some 85 litres, which flows onto the land through the open end.
Drainage regulator	A regulator placed in an embankment with only flap gates on the river side.
Embankment	A wall or ridge of earth that serves to protect an area from flooding or to carry a road or highway over low ground.
Fall boards	Boards placed in slots or grooves in the pier walls of regulators or sluices to close the vents for maintenance purposes or for water retention.
FCD system	All the areas in the floodplains of the rivers in Bangladesh and in the coastal plains utilised by humans and containing some or all of the following infrastructure: *khals*, *beels*, cross dams, canals, embankments and regulators. Although irrigation is often practised in FCD systems they do not qualify as irrigation systems as the infrastructure in FCD systems does not provide the same level of control over the flow of water from source to field as in irrigation systems.
Flap gate	A swinging gate on the river side of a regulator or sluice vent that automatically closes when the outside water level rises above the inside water level.
Free board	Vertical distance between the top of an embankment and the highest normal water level.
Flushing sluice	A sluice designed to admit water into a protected area. A type of regulator with only vertical lift gates on the river side.
Haor	An extensive depression between the natural levees of rivers, which is shaped like a saucer, with a deep central part permanently under water, found in the north-east of Bangladesh.

Irrigation inlet	A pipe through an embankment for the entry of irrigation water. Also called a pipe inlet.
Khal	A natural channel, minor river or a tidal creek.
Kharif	The cropping period during the wet season (May through October), divided into *kharif-I* and *kharif-II*.
Khas	Land owned by the state.
Kalashi	A BWDB employee engaged in patrolling, guarding and operating a regulator.
Maintenance	Actions taken to prevent or repair the deterioration of water management infrastructure and to keep the physical components of a water management system in such a state that they can serve their intended function.
Monsoon	The rainy season, starting in June and ending in October.
Natural levees	Low ridges parallel to a river course. They are higher near the river and gradually slope away from it.
Operation	The manipulation of water management infrastructure to control hydraulic conditions (water levels and discharges) in a water management system.
Participation	A process through which stakeholders influence and share control over development initiatives and the decisions and resources which affect them.
Participatory water management	The control of water in a water management system to obtain the objectives of that system, through adequate operation and maintenance of the water management infrastructure on the basis of transparent and systematic procedures for planning, budgeting, implementation and monitoring on the basis of decision-making processes in which water management stakeholders are actively involved and have a final say.
Partition dyke	A small, contiguous body of earth surrounding a salt or shrimp production area to prevent the entry of saline water into paddy fields.
Rabi	The cropping period during the dry season (October through May).
Regulator	A structure built to control water flow across an embankment at the head of a *khal* or a structure built in a river or *khal* to control water. Water is controlled by flap gates, vertical lift gates, fall boards or a combination of these.
Shrimp inlet	A flushing sluice with a vertical lift gate on the river side and a flap gate on the country side for allowing the entry of saline water into a protected area for shrimp or salt production.
Sluice	A structure to convey water through an embankment only. For the rest it is the same as a regulator.
Stakeholder	An individual whose livelihood is directly affected by a water management system, be it positively or negatively.
SRP	The Systems Rehabilitation Project, financed by the World Bank, the European Union, the World Food Programme, the Government of the Netherlands and the Government of Bangladesh, started in 1990 and ended in May 1998. Its broad objective was to enhance agricultural production through the rehabilitation and improved operation and maintenance of Flood Control and Drainage systems under the management of the Bangladesh Water Development Board. Towards the end of the project, its objectives were to sustain agricultural production, incomes and standards of living achieved

	on 35 rehabilitated FCD systems. This was to be achieved through preparing the systems for operation and maintenance through participatory management involving the stakeholders.
Submersible embankment	An embankment whose crest level is designed below the highest normal river water level.
Surface sluice	A structure located in an embankment but not on the outfall of a *khal* to drain pockets of drainage congestion. Also called a surface drainage outlet or surface drainage sluice.
Thana	The administrative unit of local government above the union level, consists of three to ten unions.
Union	The lowest unit of government in Bangladesh.
Union Parishad	Elected council at Union level.
Urgi	A traditional irrigation device consisting of a bamboo basket with ropes attached to it on both sides. Two people dip the basket into a water body and then swing it onto the land.
Water control structure	A concrete structure consisting of a fixed weir (sometimes with a provision for fall boards) built in a *khal* to retain water. Also called a water retention structure.
Water management	The intervention of humans in the manner in which surface and/or ground water is captured, conveyed, utilised and drained in a certain area; it is a process of social interaction between stakeholders, each employing different methods, resources and strategies, around the issue of water control.
WM-Block	A hydrologically independent unit with respect to water conveyance in a FCD system – usually a regulator with associated *khals*.
Zamindar	A feudal landlord.

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One of the results of the longstanding commitment of the international community to the water sector in Bangladesh was the formulation and implementation of the Systems Rehabilitation Project. Through this project, which ran from 1990 to 1998, the World Bank, the European Union, the Government of the Netherlands and the World Food Programme provided the Bangladesh Water Development Board with financial and technical assistance for developing and institutionalising improved water management concepts and procedures. The concepts developed by the project placed people's participation, rehabilitation, operation, maintenance and the monitoring of progress and quality control in a coherent and workable framework. We, the authors of this report, were privileged to work in this project as members of the technical assistance team, for a combined period of nearly 10 years. This team was financed by, and this report was prepared under the auspices of, the Netherlands Development Agency (NEDA).
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EXECUTIVE SUMMARY

Improved water management is of utmost importance for Bangladesh, as nearly 80 million people live and farm on the floodplains. Water management abounds on these floodplains and people have taken measures to cope with water since time immemorial. Due to government interventions, more than 37% of the Net Cultivable Area (NCA) is protected by Flood Control and Drainage (FCD) systems. The crucial importance of FCD systems for the livelihoods of many millions of people makes it necessary to understand water management practices in FCD systems and to develop appropriate institutions and management strategies for them.

Many studies of the water sector in Bangladesh conclude that the intended benefits from FCD systems have not materialised. This is attributed in part to institutional weaknesses. One of the key approaches for tackling these institutional weaknesses is increasing people's participation in water resources management. Although the Government of Bangladesh is committed to the participatory development and management of FCD systems, the existing participatory procedures are strongly irrigation and farmer biased, in spite of the fact that 90% of the Water Management Systems (WM-Systems) in Bangladesh are FCD systems. Many people believe there is little need for water management in FCD systems and that management strategies developed for irrigation systems are also appropriate for FCD systems. However, experiences indicate that the existing participatory procedures do not adequately address the water management issues prevailing in FCD systems.

To design sound strategies and appropriate institutional arrangements for participatory water management in Bangladesh, an understanding of water management in FCD systems is necessary. *The objectives of this report are to present actual water management practices in FCD systems and to analyse the specific nature of water management in FCD systems.* Moreover, it indicates the implications of water management practices in FCD systems for participatory water management.

Water management in FCD systems was researched by focusing on the water management options available in FCD systems and the critical moments in water management. Who takes decisions concerning water management and how these decisions are taken was also a central concern. Lastly, who benefits or dis-benefits from the water management systems and/or from the current water management practices and how was uncovered. To identify these water management issues, a Rapid Water Management Appraisal (RWMA) methodology was developed and applied in 27 FCD systems and two irrigation systems, in November and December 1996. In addition, in-depth studies focusing on local initiatives in water management were conducted in four FCD systems from May to September 1997 and a separate study on the gender dimensions of water management in FCD systems was conducted in March 1997.

The main conclusion to be drawn from these studies is that water management in FCD systems is complex and fundamentally different from water management in large-scale irrigation systems. FCD systems are characterised by a great diversity of stakeholders and by an infrastructure not designed for optimal system performance. The stakeholders each have different, often conflicting, water management demands and thus the infrastructure has to cater for many, at times mutually exclusive, demands. Moreover, the management strategies used in FCD systems are not designed to deal with the specific nature of water management in FCD systems.

The complex nature of water management in FCD systems makes it necessary to rethink participatory water management in the context of FCD systems and to reform the institutional structures in place to manage them. The numerous initiatives of people in the management of

water resources indicate that there is a tremendous amount of water management going on in the field. It is clear that people in rural Bangladesh have an extraordinary capacity to manage water resources and the related water management infrastructure. This does not imply that water management in FCD systems is optimal. Rather, there are many struggles over water control, which are frequently decided in favour of a minority of the stakeholders.

Balancing the water requirements of different water management stakeholders in an equitable manner is a difficult task, which requires the active intervention of a water management agency. There is a large scope and a real need for participatory water management in FCD systems. Forums are required for stakeholders to discuss their different water management objectives and requirements and to take joint decisions with the water management agency on water management planning. To move towards sustainable water management in Bangladesh, fundamental institutional change and the development of innovative participatory water management strategies, which take into account the complexities of water management in FCD systems, is imperative. In the absence of appropriate management strategies and a pro-active water management agency, water management in FCD systems will remain sub-optimal.

1 INTRODUCTION

The image of extreme floods during the monsoon is one that is strongly associated with Bangladesh. In the past, it was thought that floods were a "problem" that could be "solved" through the construction of large embankments. An important outcome of the Flood Action Plan (FAP) studies has been the realisation that full flood control is not an appropriate intervention in the floodplains in many cases. Rather, it is now widely recognised that the integration of infrastructural and institutional measures for flood mitigation and water management in the floodplains should be the cornerstone of integrated water resources management in Bangladesh.

For Bangladesh, the need for improved water management is particularly acute, due to the growing demand for (protection from) water and increasing conflict between alternative uses of water. Boyce (1987) convincingly proves that water control (of which flood control is only one aspect) is instrumental for rural development in Bangladesh. Many studies of the water sector in Bangladesh vindicate this conclusion and argue that improved water management is critical to achieving the intended benefits from existing Flood Control and Drainage (FCD) systems and to ensuring their sustainability (MPO, 1985; FAP13, 1992; FPCO, 1994; GoB/MoWR, 1995a; Faruqee and Choudhry, 1996).

Numerous evaluations have concluded that these benefits are not materialising, partly due to institutional weaknesses. True participation of people in all stages of water resources development is widely believed to be a key requirement for tackling these institutional weaknesses. An important milestone in this regard was the approval of the *"Guidelines for People's Participation in Water Development Projects"* (GPP) by the Ministry of Water Resources (MoWR) in June 1995. Through this approval the Government of Bangladesh (GoB) explicitly expressed its commitment to participatory water management. However, the existing participatory approaches fell short of the expectations, largely because they are strongly irrigation and farmer biased.

A striking aspect of water management in Bangladesh is that FCD systems are the most common type of Water Management System (WM-System), instead of large-scale irrigation systems. In 1992, of the total Net Cultivable Area (NCA) in Bangladesh of 9.15 million ha, 440,000 ha (4.8%) were under large-scale irrigation, while some 3.37 million ha (37%) were protected by FCD works (Khan, 1993; Thompson and Sultana, 1996). In Bangladesh, the public sector, and specifically the Bangladesh Water Development Board (BWDB), has mainly been responsible for providing flood control and drainage facilities.

The performance of FCD systems has often remained below expectations. Moreover, they have several major negative impacts, such as the loss of fisheries, navigation and soil fertility and the exacerbation of drainage problems (Lindquist, 1988; BARC, 1989; Ali, 1990; Gisselquist, 1991; Zaman, 1993; Hossain, 1994; Huq and Ahmed, 1995; IFAPRM, 1995; Thompson and Sultana, 1996). International development agencies as well as the GoB have expressed increasing dissatisfaction with the performance of FCD systems and with the agencies responsible for their management (MPO, 1991; IOV, 1993, GoB/MoWR, 1995a; Faruqee and Choudhry, 1996). However, viable strategies for improving the performance of FCD systems are still to be developed and implemented.

A major obstacle to improving water management in FCD systems is the lack of understanding of the functions and local utilisation of FCD systems. Many professionals believe there is very little scope or need for water management in FCD systems. It is a common perception that water management is the same as water distribution, and that it is therefore only required in irrigation systems. To formulate informed policies and appropriate institutional arrangements for participatory water management in Bangladesh, it is necessary to comprehend the nature of water management in FCD systems. This report contributes to such an understanding by portraying and analysing water management practices in FCD systems and by outlining the principles on which participatory water management should be based.

Grasping the nature of water management in FCD systems is efficiently done by analysing water management issues in the field, such as:

- who makes water management decisions and how these decisions are taken;
- which water management options are available in FCD systems; and
- who benefits and dis-benefits from FCD systems and the current water management practices in them and how.

For irrigation systems the world over these issues have been researched and analysed extensively. Surprisingly, very little research has been conducted on water management in FCD systems. To identify the nature of water management in FCD systems in Bangladesh, a Rapid Water Management Appraisal (RWMA) methodology was developed and applied in 27 FCD systems and two irrigation system, in November and December 1996. In addition, in-depth studies focusing on local initiatives in water management were conducted in four FCD systems and a separate study on the gender dimensions of water management was conducted in one FCD system. This report presents the outcomes of these studies. *The nature of water management in FCD systems in Bangladesh is the key issue addressed by this report.* The objectives of this report are:

- to present actual water management practices in FCD systems;
- to analyse the specific nature of water management in FCD systems; and
- to indicate the implications this has for participatory water management.

In Chapter 2, the development and objectives of WM-Systems are outlined. Chapter 3 deals with the RWMA methodology. The outcomes of the RWMA and other studies are presented in Chapter 4, by detailing how FCD systems are managed. A classification of WM-Systems in Bangladesh from a water management perspective is given in Chapter 5. In Chapter 6, the implications of existing water management practices in FCD systems for participatory water management are set out and a delineation of water management responsibilities is presented. Lastly, conclusions are drawn in Chapter 7.

2 WATER MANAGEMENT SYSTEMS IN BANGLADESH

2.1 The Development of Water Management Systems in Bangladesh

Floods during the monsoon and water scarcity during the dry season are the major water management challenges in Bangladesh. The floods strongly affect cropping patterns and crop yields on the floodplains, as well as fisheries and transportation. In coastal areas, salinity and cyclones are additional factors influencing farming systems. To tackle these issues, national water planning in Bangladesh started in the 1950s. The disastrous floods of 1954 and 1955 drew world attention to the flood problems in then East Pakistan. In 1957, the Krug Mission reviewed the situation and concluded that flood control was instrumental to increasing agricultural production. Based on the recommendations of the Krug Mission the East Pakistan Water and Power Development Authority (EPWAPDA) was created in 1959 and assigned with the responsibilities for water resources development. (MPO, 1986)

In 1964, EPWAPDA completed a Master Plan for water resources development. This Plan proposed the construction of 58 large-scale WM-Systems covering 5.8 million ha, involving embankments, pumping stations and canal irrigation. Many of these systems were implemented between the mid-1960s and late-1980s, although without the provision for pumped drainage. The basic premise of the Master Plan was that full flood control was the key to increasing agricultural production, i.e. the exclusion of river flood water from farm lands through embankments and the removal of excess rainwater within the protected areas by sluicing or pumping. (EPWAPDA, 1964)

The emphasis donors placed on large-scale works for full flood control became less following the World Bank's *Land and Water Sector Study* of 1972. This study emphasised the need for quick results from water development efforts. The development of minor irrigation through Low-Lift Pumps (LLPs), Deep Tubewells (DTWs) and Shallow Tubewells (STWs), supported by low cost, medium-sized FCD systems in shallow flooded areas, was advocated. However, the basic tenant of water resources development in Bangladesh, namely that full flood control and improved drainage are prerequisites for agricultural development, remained unquestioned.

The then government refused to accept the World Bank study, as it was primarily interested in river training works, large flood control works and major barrages in the main rivers. Nonetheless, water development in Bangladesh since 1973 gradually evolved along the lines set out in the study. The area protected by FCD systems constructed by the government grew steadily, reaching 2.7 million ha in 1985 and 3.37 million ha in 1992 (MPO, 1986; Khan, 1993). Through the 1970s and 1980s minor irrigation spread rapidly from 1.2 million ha in 1973 to nearly 3 million ha in 1992, with some 350,000 STWs, 52,000 LLPs, 26,000 DTWs and 135,000 manually operated pumps in operation (FPCO, 1994; FAO, 1994). Due to pump irrigation, crop output rates have risen sharply, especially of *boro,* resulting in near self-sufficiency in rice production in Bangladesh.

After the severe floods of 1987 and 1988, national and international attention again focused on the need to address the flood issue. In 1989, GoB requested the World Bank to coordinate the various efforts for arriving at a flood plan. The result was FAP, a five year study program consisting of 26 components, which aimed at developing a flood plan that would provide a durable solution to the recurrent flood problem. During its five years, FAP evolved from its original focus on full flood control and structural measures to a more comprehensive approach towards water management. Most significantly, the idea that floods are a "problem" that can be "solved" was abandoned. Instead, based on the outcomes of FAP, GoB concludes that:

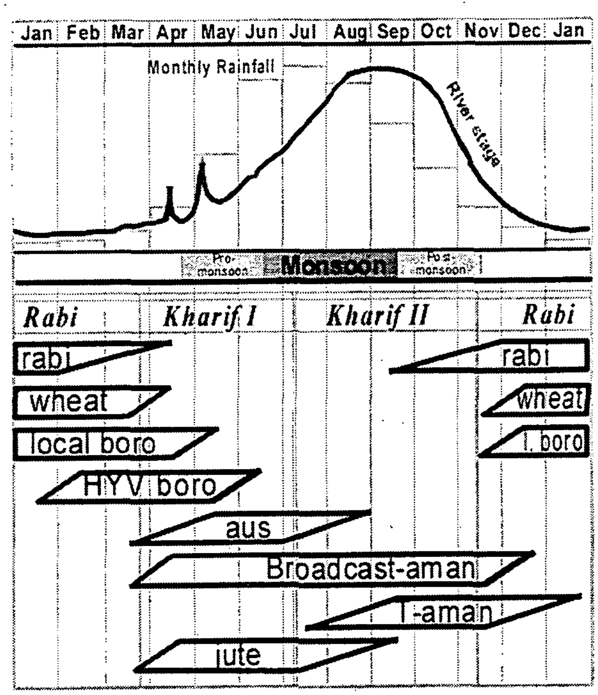
> *"(...) a reformulation of the national water planning goals and objectives has now become necessary to guide future planning efforts and to produce an integrated national water plan." (GoB/MoWR, 1995a:5)*

In this report, FCD systems are understood to be all the areas in the floodplains of the rivers in Bangladesh and in the coastal plains utilised by humans and containing some or all of the following infrastructure: *khals, beels,* cross dams, canals, embankments and regulators. *Beels* are field depressions that contain water during most or all of the year. These are often connected to rivers through a network of natural channels (*khals*). Although irrigation is often practised in FCD systems they do not qualify as irrigation systems as the infrastructure in FCD systems does not provide the same level of control over the flow of water from source to field as in irrigation systems.

There are two cropping periods in Bangladesh, namely: *kharif* and *rabi* (see Figure 1) and three rice growing seasons (*aus, aman, boro*). *Rabi* coincides with the dry season and *kharif* with the wet season. During *rabi* the primary crop is HYV *boro*. During *kharif-I*, *aus* and summer vegetables are grown and during *kharif-II*, *aman* is grown. FCD systems constructed by the government were primarily designed to establish favourable conditions for the adoption of High-Yielding Varieties (HYVs) of rice by reducing the annual depth, timing and duration of flooding. Their design objectives were to:

- Protect standing *aus* and *boro* against early river floods;
- Reduce salt intrusion (in the coastal belt); and
- Expand the area under HYV *aman* by excluding flood waters from the systems.

Figure 1 Hydrological and Agricultural Cycles in Bangladesh



According to GoB and development agencies the primary objective of WM-Systems is to increase agricultural production, through the provision of one, or a combination, of the following: flood control, drainage, reduction of salt intrusion and irrigation. In Bangladesh, a distinction is made between FCD, FCDI (Flood Control, Drainage and Irrigation), and I (Irrigation) systems. The basis for this distinction is somewhat unclear and can lead to misconceptions. The term "FCD" suggests that a certain type of water control infrastructure is only used for flood control and drainage. However, in practice FCD systems are also operated with the opposite objective, for example controlled flooding and retention of water. Moreover, irrigation is often practised in

FCD systems through LLPs, tubewells or traditional irrigation devices. **Hence, from a water management perspective, there is no difference between FCD and FCDI systems.** There is, however, a real difference between large-scale gravity irrigation systems and FCD systems. In this report we will continue to use the term **FCD systems**, but in its broader meaning. We will not use the term WM-Systems when referring to FCD systems, because this is a generic term that covers all physical systems constructed by people to control water, including both FCD systems and irrigation systems, but also drinking water systems or sewerage systems.

Water management in FCD systems is not as straightforward as the agriculture objectives outlined above suggest. Actually, the numerous water management options in FCD systems make water management in FCD systems extremely complex (see Box 1). In comparison, water management in irrigation systems is relatively straightforward. Although it is difficult to realise success in irrigation systems, they have all the ingredients for success. In FCD systems, on the other hand, it is much more difficult to realise success and all the ingredients for failure are present (see Table 1).

Besides the inherent differences between irrigation systems and FCD systems, water management in FCD systems is complicated by the fact that hardly any attention has been given to it. Internationally, much has been written on water management in irrigation systems, resulting in the development of appropriate management strategies for irrigation systems. For FCD systems this has not been the case.

Table 1 Differences between Irrigation Systems and FCD Systems

	Irrigation Systems	FCD Systems
Infrastructure	All infrastructure elements (irrigation canals, drainage canals, structures) are each designed for one specific purpose.	FCD infrastructure has to cater for many demands. Moreover, the demands placed on the infrastructure gradually change, increase and diversify.
Design	Completely man-made and designed for optimal performance.	Only partly man-made and not designed for optimal performance.
Users	Farmers with a homogeneous demand: the right amount of water at the right moment.	Many different users with heterogeneous demands that are often contradictory and mutually exclusive.
Operation	Possible to plan in advance.	Very difficult to plan in advance.
Main Management Challenge	How to equitably distribute water in periods of water scarcity.	How to reach and implement a compromise for conflicting demands, including the exclusion of particular uses of water or infrastructure.

Box 1 Beel Singri: A Typical FCD System

Beel Singri is an FCD system located near Chapai-Nawabganj. It consists of a 2 km embankment with 3 regulators and benefits 4,100 ha. Besides the BWDB infrastructure, the main road from Chapai-Nawabganj to Gomostapur, constructed by the Roads and Highways Department (R&HD), serves as the main embankment protecting the system from floods from the Mohananda River. Two other government agencies have also constructed water management infrastructure in the area. The Local Government Engineering Department (LGED) constructed two water control structures while the Barind Multipurpose Development Authority (BMDA) supplied the area with 24 DTWs and 10 LLPs. Moreover, inside the system, there are dozens of privately owned LLPs for pumping water from the dense network of *khals* and *beels*.

Beel Singri, the name of the system, erroneously suggests that this system relates to only one *beel*. This is not so, as it consists of 10 *beels*, interconnected with each other or the river through several *khals* with a total length of 26.5 km. The *beels* and *khals* are essential resources for the inhabitants of the system. The surface water stored in them serves domestic as well as agricultural purposes. Especially during the dry season, the water in the *beels* and *khals* becomes important, as groundwater is not easily accessible.

The embankment and regulators have led to improved water control and protection from flooding. Although the majority of the inhabitants of Beel Singri have benefited from the FCD system, they have little control over its management. Instead, rural elite, and in particular one family, control the regulators. In Beel Singri there are three main regulators, whose operation is a contentious issue. This is closely linked with the management of the *beels* in the FCD system. Particularly in December and January, there is profound disagreement between different stakeholders on the amount of water that should be retained in the *beels* and *khals* for irrigation and domestic use. Farmers owning medium and high land want to retain as much water as possible, while low land farmers prefer to drain all water so that they can cultivate *boro* paddy inside the *beels*.

This conflict reflects the interests of different socio-economic groups; high land and medium land farmers are generally small farmers with no access to costly groundwater irrigation facilities. Low land farmers consist of a few rich and influential families, who have acquired control over land that used to be common property (the *beels*). Their economic status also gives them access to DTWs, which are essential for cultivating a *boro* crop in the *beel* area. Due to the power of these farmers, they operate the regulators according to their own requirements. Consequently, the majority of the farmers are deprived of surface water for irrigation and domestic use during the dry season.

BWDB does not have a water management plan for this system, and its staff is not involved in water management decision-making processes. One single farmer, who owns the largest portion of low land in the system, controls the actual operation of the regulators. Thus, although the low land farmers are a minority, the system has so far been operated to satisfy their requirements.

Source: SRP 1994; 1995.

Until recently, water management was an engineering biased discipline that strongly concentrated on large-scale irrigation systems. The lack of engineering solutions for the conflicts of interest in FCD systems resulted in these problems being ignored or not even being recognised. Instead, water management strategies developed for large-scale irrigation systems were simply copied and applied in FCD systems. It needs to be recognised that water management in FCD systems is quite different from water management in large-scale irrigation systems and that innovative management strategies need to be developed for improving water management in FCD systems.

Good water management in FCD systems is important, as FCD systems are by far the most common type of WM-Systems in Bangladesh. Moreover, the management of FCD systems is intrinsically linked with the management of the floodplains, as nearly all the floodplains are covered by FCD systems in various stages of development. **The lack of knowledge on water management in FCD systems and their crucial importance makes it necessary to analyse water management practices in FCD systems.** Such an analysis, which places people at the centre of water management, is fundamental for formulating informed policies for the water sector.

2.2 WATER MANAGEMENT PRINCIPLES

To study water management in FCD systems it is necessary to focus on **water management practices**, i.e. how people cope with water management challenges and struggle and negotiate over water. Before going into the nature of water management in FCD systems, it is necessary to define the concepts used in this report, as terms such as water management and Operation and Maintenance (O&M) are often used without being clearly defined. Three fundamental insights underlie the analysis of water management in FCD systems in this report.

- **Water control** is the central element of water management;
- **Water management** is both social and technical in nature; and,
- Water management systems are **socio-technical systems**, i.e. they are systems in which physical and social processes take place related to water management.

Water management encompasses more than just the O&M of water management infrastructure. In essence, **water management is a process through which humans try to influence water quantities and quality in a certain area**. In contrast, Operation and Maintenance are simply **activities** that are executed as part of that process. The defining element of water management is **water control**, which is the capacity to determine how much water goes where, when. Water control consists of two dimensions, namely control in the technical sense and control in a social/political sense. The following definition of water management reflects these two dimensions:

> ***Water management** is the intervention of humans in the manner in which surface and/or ground water is captured, conveyed, utilised and drained in a certain area; it is a process of social interaction between stakeholders, each employing different methods, resources and strategies, around the issue of water control.*

The above definition is a generic one that says nothing about the specific purpose of water management in a certain area. Human intervention in the hydrological cycle can serve many purposes, such as agriculture production, fisheries, navigation, sanitation, drinking water, flood control and drainage. Thus, when studying water management in a particular FCD system, it is crucial to focus on all the water management objectives people pursue in that system. Three elements play a determining role in the performance of a FCD system, namely:

- clear objectives;
- water management infrastructure capable of delivering the service implied in the objectives; and,
- assigned responsibilities, tasks and rights (institutional arrangements) for attaining these objectives.

To achieve sound and sustainable water management these three elements need to be well defined and properly matched. If they are, we can speak of **functional FCD systems**. The insights detailed above are combined in the concept of Improved Water Management.

- **Improved water management (IWM)** is the control of water in a water management system to obtain the objectives of that system, through the adequate **operation** and **maintenance** of water management infrastructure on the basis of transparent and systematic procedures for planning, budgeting, implementation and monitoring.

In this context, **operation** is defined as:

- The manipulation of water management infrastructure to control hydraulic conditions (water levels and discharges) in a WM-System (e.g. opening gates, installing cross dams).

Maintenance is defined as:

- Actions taken to prevent or repair the deterioration of water management infrastructure and to keep the physical components of a WM-System in such a state that they can serve their intended function.

It is not always clear who benefits from FCD systems, as opposed to irrigation systems. Thus, the term "beneficiaries" is not used in this report, as it suggests that everybody benefits from a FCD system. As this is often not the case, the term **water management stakeholder** is used instead. Water management stakeholders are **individuals (both men and women) whose livelihood is directly affected by a WM-System, be it positively or negatively**. A stakeholder approach to water management is important because it ensures the appreciation of all the different "stakes" in water management.

Besides water management stakeholders, there are other actors who have a responsibility or interest in water management, although they do not directly depend on FCD systems for their livelihoods. These are service providers, or key institutional actors, defined as **organisations that have a responsibility or task in water management or represent an interest of one or more categories of stakeholders**. This group of actors includes various government agencies, local government bodies, consultants, donors and Non-Governmental Organisations (NGOs).

3 THE RESEARCH METHODOLOGY

3.1 The Rapid Water Management Appraisal Methodology

A whole range of water management issues in FCD systems deserves attention. To clarify these issues it is necessary to study water management practices in FCD systems. Who takes decisions concerning water management; how these decisions are taken and who (dis)-benefits from current water management practices needs to be clarified. To uncover these water management issues, field research was conducted in 27 FCD systems and two irrigation systems, located throughout Bangladesh (see Table 2 and Figure 2). The irrigation systems were included to check the assumption that water management in FCD systems is different to water management in irrigation systems. The following research questions formed the basis of the field research:

- Which water management practices and issues/conflicts exist in FCD systems?
- Which solutions or coping mechanisms have water management stakeholders devised to resolve or lessen these problems/conflicts/issues?
- Which different forms of organisation (informal groups, committees, etc.) exist in FCD systems and how do they operate?
- What is the perception of the inhabitants of FCD systems concerning the water management system in general and its management?
- What is the opinion of BWDB staff concerning water management in FCD systems?

To answer these questions a Rapid Water Management Appraisal (RWMA) methodology was developed and tested in one Polder. The refined methodology was subsequently applied in 29 WM-Systems, in November and December 1996, by four research teams. The RWMA methodology is an adaptation of Rapid Rural Appraisal (RRA) techniques. Its aim is to collect information on water management in FCD systems in an efficient manner. Fieldwork in a FCD system typically took five days to complete by a team of two to four researchers. The RWMA methodology consists of the following four phases:

- Preparation in the office; for collecting secondary data and maps.
- Field visits, consisting of a system walkthrough and semi-structured interviews with as many different categories of water management stakeholders as possible;
- Interviews with BWDB staff, and
- Writing the RWMA report according to a standard reporting format.

For each phase a number of tools were developed for conducting field work, namely;

- The Water Management Issues (WMI) table, indicating the operation and maintenance situation of all water management infrastructure in a WM-System.
- A map indicating the Water Management Areas (WMAs).
- An Occupation-Location Matrix (OC-LOC matrix), showing which occupations were interviewed in which WMA.
- A questionnaire, in which the research questions were made operational.
- A standard reporting format.

The phases and the tools of the RWMA serve to find an answer to the five research questions. The map with the WMAs on it forms the basis of the fieldwork. A WMA is defined as an area under the direct influence of a structure. During fieldwork each WMA is visited. The information that needs to be collected in each WMA is set out in the questionnaire and the WMI table. This table systematically lists all water management infrastructure in a WM-System and details the design characteristics and the actual operation and maintenance of each structure. The OC-LOC matrix is used as a tool to ensure full coverage of all water management stakeholders. This matrix shows how many people (occupation) are interviewed in each WMA (location). The RWMA methodology assumes that people with different occupations reflect different interests in water management and that individuals with the same occupation can still have different interests depending on their location.

Figure 2 Location of WM-Systems in which the RWMA was Conducted

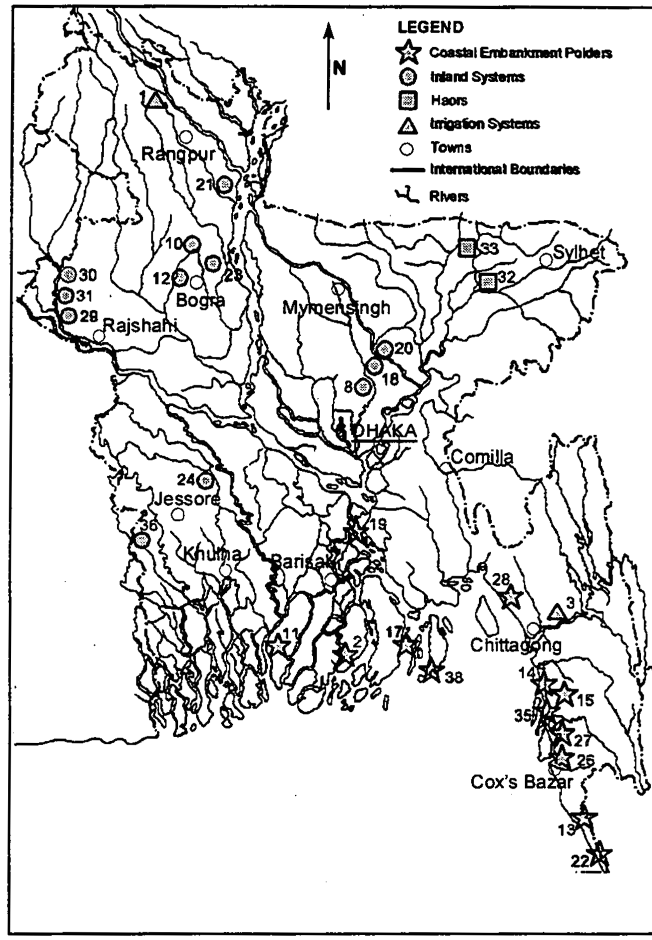


Table 2 Water Management Systems Covered by the RWMA

Name and Type of Water Management System			
Irrigation Systems	**Inland Systems**	**Haors**	**Coastal Embankment Polders**
Buri Teesta Irrigation Scheme [1]	Dardaria Khal [8]	Chaptir Haor [32]	Polder 55/1 [2]
Karnaphuli Irrigation Project (Ichamati Unit) [3]	Gangnai River [10]	Shanir Haor [33]	Polder 39/1 (B&D) [11]
	Protappur Irrigation Project [12]		Polder 67 [13]
	Dewankhali Khal [18]		Polder 64/1A [14]
	Khanchikata Khal [20]		Polder 64/1B [15]
	Kumarnai Bundh [21]		Polder 58/3 (Char Faizuddin) [17]
	Ichamati Gazaria [23]		Hizla Embankment [19]
	Padma Haor Khal [24]		Polder 68 [22]
	Chorai Shomespur [29]		Polder 66/2 [26]
	Bhitabari Damos [30]		Polder 66/3 [27]
	Beel Singri [31]		Polder 61/1 [28]
	Makla Beel [36]		Polder 64/1C [35]
			Polder 73/2 [38]

The numbers in brackets refer to the number assigned to a WM-System on the map (see Figure 2).

The RWMA methodology proved to be very useful for collecting information on water management practices quickly. Although the methodology was appropriate for this exercise there are several limitations associated with it.

- An in-depth analysis of issues encountered in the field is not possible;
- Systems above 2,000 ha and hydrologically complex systems require more time to cover in full, although a RWMA will give a good first impression.
- Special care needs to be taken to ensure that the gender dimension of water management is also covered.

3.2 Investigating Women in Water Management

During the development of the RWMA methodology serious thought was given to the gender dimension of water management and how to unearth that during the RWMA (see Box 2 for reasons why the gender dimension of water management is important). Due to cultural and class reasons, rural women in Bangladesh are more vulnerable than men are to flooding and in many ways women have more to win or lose from changes in the water regime (see Hanchett *et al*, 1997). Although the differentiated impact of water regimes on women and men was recognised during the development of the RWMA methodology it was decided not to consider women as a separate category of water management stakeholders.

During the RWMA it was expected that men as well as women would be interviewed. However, it transpired during fieldwork that only men were being interviewed and that the focus of the discussions was on the productive uses of water. To verify how women are involved in water management and which uses of water are important to them a RWMA specifically focusing on women was executed in Dardaria Khal in March 1997 by a team of female researchers. The outcomes of this study are integrated in the following chapters. Three basic questions were posed for the female-focused RWMA:

- Are women a separate category of water management stakeholders?
- Is the information women provide on the uses of water and water management the same, different or additional to the information men provide?
- How best can a gender differentiated approach be followed during fieldwork?

From the fieldwork it became apparent that the answer to the first question is a qualified no. Women are not a homogeneous category of water management stakeholders, but rather belong to different categories, depending on the productive activities their households are involved in. The female society reflects the same stratification of the society as a whole, and women's views on water management issues are profoundly affected by their socio-economic status. Water is very important for most women because many of them are responsible for the provision of water to the homestead. During periods of water scarcity, however, these uses of water are subordinated to the water needs of agriculture.

The answer to the second question is that interviewing women provides more detailed information on water management in FCD systems, and especially on the domestic uses of water and the flood protection function of FCD systems. It also provides additional information on the productive uses of water.

To follow a gender-differentiated approach during fieldwork both the women and men of a household should be interviewed. This will contribute to obtaining an overall picture of how water management affects the well-being of the household. Ideally, half the RWMA interviewees should be women. Also, the RWMA questionnaire should address each possible water use, including the availability of drinking water and water for household purposes. To make quick contact with women, female researchers with a basic understanding of water management are necessary.

Box 2 The Importance of Gender in Water Management

The term **gender** refers to the relations between women and men. These are revealed in a range of practices and ideas, including the division of labour, roles and resources between men and women. Unlike sex, which is biologically determined, gender relations differ within and between cultures. Gender roles are dynamic; they change over time. Changes can be attributed to factors such as economic hardship, environmental crises, family instability, increasing education levels and development activities.

In Chapter 2, water management is defined as the intervention of humans in the manner in which surface and or groundwater is captured, conveyed, utilised, and drained. Differences exist in the ways in which women and men control water. **A gender analysis is important because it brings to light all the water management stakes in FCD Systems**. Gender differences affecting water management include:

- **Differences in responsibility**; women are almost universally responsible for managing domestic water supplies. This has a crucial influence on the health of household members, indirectly affecting productive activities. Domestic water uses may conflict with productive needs, creating tension for women.
- **Difference in uses of water**; women manage water resources for productive uses alongside men. These productive uses vary from community to community. For example, women may be responsible for subsistence agricultural production while men may be primarily engaged in commercial agricultural production, creating differences in their respective needs.
- **Differences in access and control of water resources**; although women may have access to certain resources, it can not be assumed that they retain control over how a resource is used or allocated.
- **Differences in priorities in the development and management of FCD systems**. Women may place a higher priority on flood protection than men or women may want domestic water supply or irrigation structures close to their households to more effectively divide their time between productive and domestic responsibilities whereas men may be more mobile.
- **Differences in ability to participate through bargaining power and decision-making**. Women tend to play a less public role in community decision-making. While it can be taken for granted that men will participate in public decision making, women may be reluctant to speak or risk conflict.

4 WATER MANAGEMENT PRACTICES IN FLOOD CONTROL AND DRAINAGE SYSTEMS

4.1 Introduction

This chapter focuses on water management practices in FCD systems. It portrays the large capacity of people in rural Bangladesh to manage water resources and the related infrastructure and outlines the specific nature of water management in FCD systems. Many people think that there is very little need or scope for water management in FCD systems. The RWMA field research shows, however, that quite the contrary is true and that water management abounds in FCD systems. There is a much wider variety of water control infrastructure in most FCD systems -- such as cross dams, private drainage pipes, shrimp inlets and pumps -- than the common perception would suggest. Secondly, large and small water bodies, such as *haors*, *beels* and *khals*, are used for different purposes, such as fishing, water retention for irrigation, drainage and domestic use, and these uses differ throughout the year. Consequently, there are more water management options in FCD systems than simply keeping water out during floods and draining the system when river side water levels are lower than country side water levels.

Most importantly, however, the field surveys show that much local initiative is taken to control water and that the management of water resources is a dominant feature of life in rural Bangladesh. The construction of infrastructure such as cross dams and the cutting of embankments are vivid examples of how people cope with water management challenges. A wide diversity of water management practices were found in the field, in which stakeholders with diverging objectives compete and struggle over water control. The outcomes of these struggles determine to a large extent who (dis)benefits from FCD systems.

This chapter describes and analyses how people cope with water management challenges and how they use the infrastructure and the natural resources of a FCD system to achieve their own water management objectives. Section 4.2 gives a stylised account of the development of FCD systems, by indicating the phases through which they can pass. In Section 4.3, the salient characteristics of water control in FCD systems are discussed and categories of water management stakeholders are identified. These two sections set the stage for the description of water management practices in Section 4.4, which gives detailed examples of the uses, management and functions of embankments, regulators and *khals* as well as of *beels* and *haors*. Lastly, conclusions are drawn in Section 4.5.

4.2 The Development of Flood Control and Drainage Systems

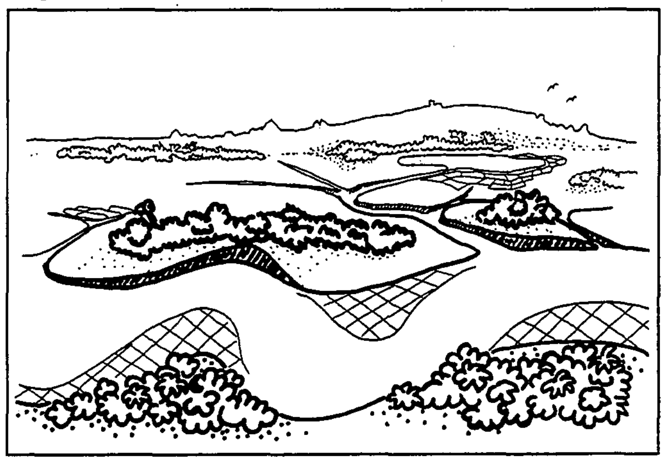
4.2.1 Phase 1: Unprotected Floodplains

To comprehend the complex nature of water management in FCD systems, it is important to understand their development. The following describes this process. It must be kept in mind, however, that this process is never a smooth one and that it is not necessarily followed in all FCD systems. Moreover, this following description does not indicate the struggles and negotiations that underlie the development of specific FCD systems. Also, it is important to note that the term "phase" and "development" are used in a neutral manner. The authors strongly wish to avoid suggesting that all FCD systems should pass through all the development phases, or that phase 4 is better than phase 1. Thus, the process described below is not a normative model but an empirical description of the development of FCD systems as encountered by the authors in the field.

The starting point for the development of FCD systems is the wetlands of Bangladesh. These wetlands encompass the vast floodplains of the Ganges, Meghna and Brahmaputra rivers, covering some 6,3 million ha (Khan *et al*, 1994), which is nearly 50% of the area of Bangladesh. The floodplain area is a complex and diverse sub-system of the main rivers that enable the temporary storage of excess water during floods. They tend to increase enormously the fishery productivity of the river system. Two types of floodplains can be distinguished in Bangladesh, namely the internal floodplains and the deltaic floodplains.

Before any government intervention, flood control and drainage practices exist on the unprotected floodplains and water management abounds (see Figure 3). People take initiatives to control water through the construction of small embankments, cross dams and drainage canals. These well-established local water management practices, which are often crucial for survival on the floodplains, should be seen as the starting point in the development of FCD systems.

Figure 3 Unprotected Floodplains



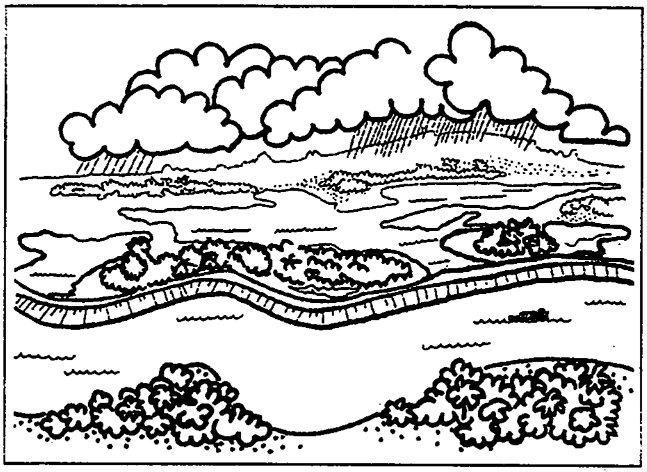
Nonetheless, the internal floodplains are subject to seasonal flooding during the monsoon. These floods are fairly predictable and the cropping patterns are adapted to them, although they result in low cropping intensities and crop yields. More damaging are the much less predictable flash floods (mainly in the Chittagong and Sylhet regions) during the pre-monsoon period. The situation in the deltaic floodplains is quite different, as these areas not only suffer from river floods but also from flooding during spring tides and from salinity intrusion during the dry season. Consequently, yields are rather low.

4.2.2 Phase 2: Flood Protection

In order to increase crop security on the floodplains, initial government interventions are invariably related to controlling floods from the river (flash floods as well as inundation due to high river stages) or from the sea (tidal flooding). The intervention opted for is the construction of embankments, which isolates the area from the source of flooding (see Figure 4). However, although an embankment solves one problem, it creates another, as it does not flood proof the area. Rather, it obstructs the drainage of accumulated rainwater from within the protected area. In some cases run-off from high lands bordering the area also accumulates behind the embankment.

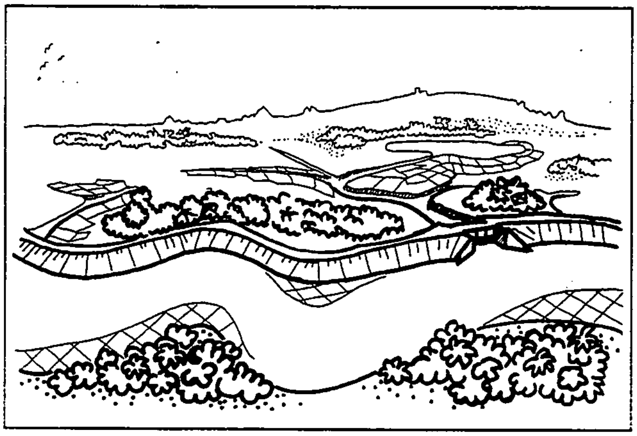
To partly solve this drainage problem, the next intervention (usually implemented at the same time as the construction of the embankment) is to create drainage openings in the embankment. As such drainage openings form a discontinuity in the flood embankment, they would also allow floodwater to enter the area. The engineering solution to this problem is the construction of regulators in the embankment equipped with flap gates on the river side (see Figure 5). These flap gates automatically close when the water level in the river rises above the water level in the interior and open when river water levels drop below the water level in the protected area. Regulators are constructed in embankments where the main *khals* enter the river or the sea.

Figure 4 Flood Protection



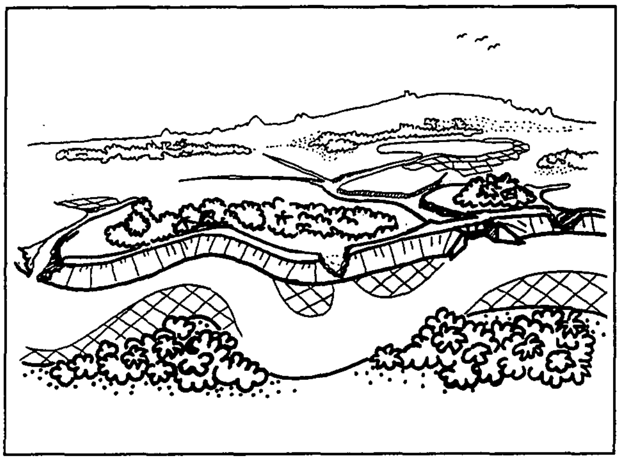
The construction of embankments and main regulators is the second phase in the development of FCD systems. These interventions provide a degree of protection against external floods and make it possible to drain parts of the protected area. Consequently, the risk of crop damage or even failure due to early floods is reduced and the delay in the flooding of the area during monsoon provides greater security for harvesting the standing crop (typically *aus*). However, the system is definitely not flood free, because the first round of interventions also create new problems, in particular drainage problems during the post-monsoon.

Figure 5 Main Regulators for Drainage



Prior to the construction of an embankment, the area would drain off almost as fast as river water levels fell (in October and November), as water could drain from the area along the whole periphery. After completion of the flood control intervention, drainage is confined to the main drainage arteries equipped with regulators. Smaller *khals* are often closed, resulting in a much slower draining of the area. Moreover, in many locations water gets trapped in low pockets behind the embankments.

Figure 6 Embankment Cuts

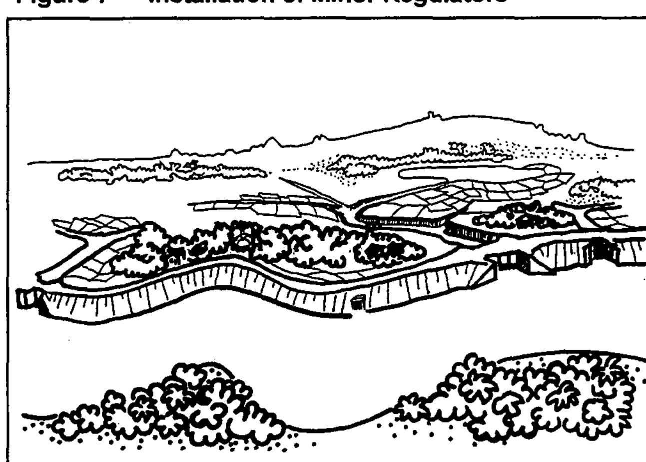


From Figure 1 it can be noted that the amount of rainfall starts increasing from the month of March onwards, reaching its peak in July. Though rivers may experience flash floods in March and April due to localised storms in their catchment areas, river levels usually start rising significantly from mid-July onwards, reaching their peak in September. Thus, until early July it is usually possible to drain accumulated rainwater and run-off from the FCD system through the main regulators, except for in the *haor* area, which is completely submerged by water in May/June. In other areas, drainage becomes impossible in August due to continuous high river stages. Rainwater and run-off then accumulate behind the embankment and floods the interior of the FCD system. Only when the water levels in the rivers start falling, from November onwards, it becomes possible to relieve the area from floodwater. Hence, a protected area remains flooded in the post-monsoon for a much longer time. To evacuate the water trapped in low pockets, people often resort to cutting the embankments (see Figure 6). When such cuts are not repaired in time, they serve as an entry point for early floods in the next season, thereby negating the whole initial intervention.

4.2.3 Phase 3: Reduction of Drainage Congestion

The third phase in the development of FCD systems is the alleviation of the drainage impediments created by phase 2. Some time after the construction of the peripheral embankment and the main regulator(s), a second round of engineering interventions can be observed. During this phase, smaller regulators (also equipped with flap gates) are constructed in the embankment opening up the smaller *khals*. Surface Drainage Outlets (SDOs) are constructed to evacuate accumulated water from low pockets behind the embankments. Often some re-excavation work to improve the conveyance capacity of the drainage channels (*khals*) is carried out as well (see Figure 7). An alternative for solving drainage problems is the installation of large pumps. Pumped drainage, however, is not an economically viable option at this stage. Hence, after phase 3, the environment for agricultural production has been optimised as far as flood control and drainage is concerned.

Figure 7 Installation of Minor Regulators



4.2.4 Phase 4: Optimising Water Control

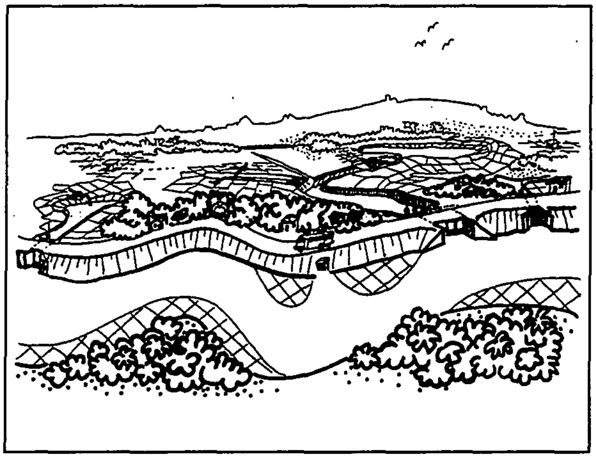
The interventions described above usually take care of the most pressing drainage and flooding problems. This, however, is not the end of the development of FCD systems. As a result of the improved control over water, farmers see new possibilities. With lower flood risks and hence more secure harvests, investments are made in crop production by using higher yielding (but usually more sensitive) varieties, and by expanding the cropping pattern. Also, an additional crop per year becomes possible and cropping patterns are slightly shifted on the calendar to accommodate this new trend. Consequently, crops are grown beyond the original cropping periods into the dry period. This leads to a higher demand for water during the dry season.

To meet this increasing demand for water, means are devised to retain water within the system at the end of the rainy season. Since the regulators had been equipped with flap gates in order to drain the system automatically whenever river water levels allow, water users attempt to block the regulators when the water level in the system has dropped to the desired level. Quite often such actions cause damage to the structure. Also, when a storm occurs, the excess water cannot readily drain off, causing damage to the standing crop. Another round of engineering interventions is required to update the water management infrastructure in line with the changing demands.

During the fourth phase, FCD systems are remodelled to enable retention of water. The regulators, until then equipped only with flap gates, are modified by adding vertical lift gates on the country side of the structures. As water needs to be stored in the system for future use, the volume to be stored is also of importance. *Khals* are deepened and widened to increase the storage capacity within the system. In sloping terrain, water control structures such as weirs (without moving parts) or regulators (adjustable) are built, to retain water in different parts of the system. If designed correctly these structures do not impede drainage. With the possibility to retain water in the system, the need for devices to lift the water from the channels onto the land develops. Many traditional lifting devises are used, such as the *urgi* (swing basket) and the *done* (swing boat), but this is also the moment when the low-lift pump (LLP) makes its entry (see Figure 8).

Parallel to this, but quite independently, another development occurs, namely the installation and use of shallow and deep tubewells (STW and DTW) for irrigation during the *boro* season. In most of Bangladesh, the *boro* season is free from any flood risk and as such ideal for agricultural production. However, the virtual absence of rain during this period requires irrigation facilities to grow a crop. After a FCD system has developed to the level described above, STWs and DTWs also start to be utilised for supplementary irrigation during the post-monsoon. At this point, FCD systems are a fairly complete and complex water management system. The enhancement of water availability becomes the next important issue.

Figure 8 Optimised Water Control



The possibility to retain water in the system rapidly leads to the demand to allow water to enter the system, as soon as the retained water is depleted. Without pumping this is only possible when water levels in the river are higher than the water levels inside the system. Due to this limitation, it is difficult to allow much water to enter the system during the post-monsoon as water levels in the river drop rapidly during that period. However, there is quite some scope in the tidal areas, as long as the water is not saline, to allow water to enter the system twice daily, during high tide. To this end, stakeholders either cut the embankment or irrigation inlets are installed.

To facilitate the entry of water, users often forcibly open the flap gates of the regulators. This practice often causes damage to the structure and a more permanent solution is required. The engineering intervention is to provide hoists for the flap gates or to replace these flap gates with vertical lift gates. Since regulators were initially designed to facilitate the outflow of water only, further modifications are required, in particular with regard to protective works on the country side of the structure. Besides modifying the existing infrastructure to facilitate entry of water, special structures with the sole purpose to let water in, such as Flushing Sluices, Irrigation Inlets and Salt/Shrimp Inlets, are sometimes constructed in the peripheral embankment. Usually these serve a small area.

Although water now enters the system with the objective to facilitate irrigation, FCD systems in this phase are not irrigation systems. This is so because the system itself only provides for the storage of water to be used for irrigation after being lifted out of the conveyance system by means of LLPs or other devices. On the other hand, a narrow conception of the term FCD system gives an inaccurate reflection of the actual situation, as FCD systems serve many more purposes besides flood control and drainage. Nonetheless, the term FCD systems is used throughout this report as it is an established term in Bangladesh and it makes clear the distinction between large-scale irrigation systems and FCD systems. The use of the term FCD systems should not pose a problem, if the reader bears in mind that many more water management objectives are pursued in FCD systems than only flood control and drainage.

4.3 Water Control and Stakeholders in Flood Control and Drainage Systems

The description of the development of FCD systems shows that they have to fulfil an increasing number of functions as they pass from one phase to the next. The solution of one problem often creates one or several other problems. Moreover, as the infrastructure becomes more articulated, the demands put on it increase and are often conflicting. The outcomes of the RWMA confirm that water management in FCD systems is complex, and that there is a wide range of **water management options** and **critical moments** in water management in FCD systems. At the same time, there are also many different water management stakeholders. This becomes apparent if we review the characteristics of water management in FCD systems.

The design of FCD systems primarily aims at establishing conditions for the adoption of HYV rice by reducing the annual depth, timing and duration of flooding. The expected increase in agricultural production, and to some extent the protection of homesteads against floods, has always been the primary economical justification for their construction. From an agricultural perspective the **objectives of FCD systems** are to:

- Protect standing *aus* and *boro* against early river floods (flash floods);
- Reduce salt intrusion (in the coastal belt);
- Expand the area under HYV *aman* by excluding flood waters from the system during the monsoon; and
- Retain water in the system during the post-monsoon period.

Although FCD systems serve to boost agricultural production, agriculture is not the only activity in FCD systems that depends on water. The objectives mentioned above often conflict with **water management demands from other stakeholders**, such as:

- Fisheries: fish production demands flooding of the floodplain during specific periods;
- Transport: water transport is an important means of communication;
- Domestic: surface water is important for domestic purposes, such as drinking water and sanitation;
- Salt production: demands the entry of salt water into the system;
- Shrimp production: also demands the entry of salt water into the system; and
- Livestock: surface water is important for the watering and washing of livestock.

Not only are there conflicting interests between different sectors in FCD systems, also within the agricultural sector there are **diverging water management demands**:

- Low land farmers demand early drainage at the end of the monsoon;
- High land farmers demand water retention in the low lying areas of the system;
- Low land farmers demand the retention of rain water and overland flow on the high lands during the monsoon, as the release of this water floods their land; and
- High land farmers demand drainage of excess rainwater and overland flow from their lands.

Moreover, certain stakeholders have their own specific requirements. Pump owners who sell water, for example, want to secure their share of surface water and construct cross dams in *khals* to do so. Shrimp farmers need high water levels of salt water inside a system, while salt producers demand low water levels. Often this does not conflict, because shrimp are cultivated in the monsoon and salt is produced in the dry season. Increasingly, however, shrimp cultivation is also taking place in the dry season, leading to conflicts with salt producers. Lastly, a special category of stakeholders, namely those living outside a FCD system but affected by it (usually referred to as Project Affected People (PAP)), place another type of demand on FCD systems. Often "outside" stakeholders cut embankments to get relief from flooding or they demand that their land is also included in the system.

This multitude of water management demands within one FCD system lead to many different **water management options** and **critical moments** in water management. They also lead to the following conflicts between stakeholders, because the demands are often characterised by mutual exclusivity. These demands have a strong time aspect, which defines the critical moments in water management:

- **fisheries vs. agriculture**: fishermen require high water levels right from the start of the monsoon, while farmers require low water levels to harvest their *aus* crop and to grow an *aman* crop;
- **high land vs. low land in beels**: high land farmers want to retain water in the *beel* during the dry season for LLP irrigation while farmers with land in the *beel* want to drain the *beel* so that they can cultivate;

- **high land vs. low land in general**: a common feature of FCD systems is that draining the high land leads to drowning the low land. In the wet season, high land farmers drain their land thereby flooding the low land. During the dry season, they demand water retention in low-lying areas. Low land farmers aim at drainage during the wet season and want water retention on high lands;
- **drainage vs. water retention**: at some point in time the choice for water retention needs to be made. This generally entails the construction of a cross dam or the closing of a gate. Intervening too early may cause flood damage by the last storms of the season, too late will reduce the volume of water retained;
- **flood protection vs. drainage**: the construction of embankments leads to higher flood levels outside the FCD system. "Outside" stakeholders often try to cut the embankment to pass floods through the system, while "inside" stakeholders try to protect the embankment to avoid flooding;
- **navigation vs. agriculture**: access to water ways is blocked by structures, navigation always requires high water levels, while agriculture requires varying water levels;
- **salt and shrimp vs. paddy**: the need for saline water for salt production and shrimp farming hampers agriculture. In several cases precautions are taken to limit this conflict (partition dykes) but in many cases the operation of the infrastructure leads to conflicts among different interest groups;
- **agriculture vs. domestic**: the use of surface water for agricultural production during the dry season makes water scarce, to the detriment of domestic water use;
- **drainage vs. road transport**: embankments are cut to alleviate drainage problems. This severely impedes transport on the embankments;
- **security vs. social**: flood and river erosion result in people encroaching on the embankments and building houses and gardens on them. This weakens the embankment, increasing the risk of flooding.

It can be concluded that the most important characteristic of water management in FCD systems is that there are many different water management stakeholders, each with different, often conflicting water management demands. During the RWMA, it was attempted to identify as many different types of water management stakeholders as possible. An important question in this regard was the extent to which a stakeholder's occupation or location determined his level of interest in water control. A list of stakeholders is given in.

Table 3: Water Management Stakeholders

Type of Stakeholder	Demand in Dry Season	Demand in Wet Season
Low land farmers in beels	Drainage of *beel*	Flood protection
High land farmers in beels	Water retention in *beel*	Flood protection
Low land farmers	Drainage	Flood protection, water retention on high land
High land farmers	Water retention	Drainage
Professional fishermen	Almost full drainage	Free entry of water into the system
Leaseholders of water bodies	Almost full drainage	Maximised fish production through flooding
Shrimp farmers		High levels of saline water entry into the system.
Salt producers	Low levels of saline water entry into the system	
Pump owners (LLPs)	Water retention	
Boatmen	High water levels throughout the year	
Households	Water retention	
Agricultural labourers	A well managed WM-System leading to improved employment opportunities in agriculture.	
Transporters/traders	Well maintained embankments.	

4.4 The Management of Flood Control and Drainage Systems

4.4.1 The Use and Management of Embankments

Embankments are the most defining element, or the "common denominator", of FCD systems. They are the first government intervention in the development of FCD systems and primarily serve to protect an area from river floods or tidal action. The embankments of FCD systems in Bangladesh are designed with a free board of three feet above the flood level or tide level with a return period of 20 years (see Photo 1). This protects the land from normal floods and tides. However, they do not and are not designed to provide protection against more extreme floods or cyclone surges.

The protection from normal floods is crucially important for agriculture, as it improves cropping conditions and secures harvests. On the other hand, embankments are also very important for the protection of the lives and property of the inhabitants of a FCD system. The flood protection services provided by embankments are highly valued by the inhabitants of FCD systems, farmers and non-farmers alike.

Photo 1 A flood protection embankment

Embankments have been constructed and managed in Bangladesh for a long time. When the British arrived in Bengal in 1757, they found a widespread system of embankments covering the land. These were built under the Moguls, who imposed a stiff land tax to finance them. The British abolished this tax and the embankments fell into disrepair. (Willcocks, 1930; Pearce, 1991) Since then, however, widespread incidences of local initiatives with regard to the construction of embankments can still be found.

Appreciation of Embankments

Most farmers in the 27 FCD systems covered by the RWMA reported that their livelihoods have improved due to the construction of embankments (see Table 4). *Aus* crops are now better protected against early floods and as a result more farmers cultivate HYVs. In most of the coastal polders, embankments have made it possible to also grow crops during *kharif-II* (mainly *aman*), while this was impossible before. Besides farmers, nearly all the other respondents indicated that they are pleased with the embankments, as it protects their lives and property from floods. Only in Kumarnai Bundh and Kanchikata Khal the inhabitants were not so pleased with the embankments, because their area is not yet completely protected by embankments. Therefore, the ingress of river floods still occurs.

In nearly all the systems studied, and especially in coastal polders, the flood protection function of the embankment for agriculture, human life and property is regarded as extremely important and is appreciated by the inhabitants (see Table 4). In fact, there is a strong demand for higher, stronger and better maintained embankments. This finding is supported by the survey of Water Users' Organisations (WUOs), conducted by SRP in seven diverse FCD systems, which revealed that 90% of the respondents consider the FCD system in their area as useful and their properties to be positively affected by it (SRP, 1997).

Table 4: The Appreciation, Uses and Effects of Embankments

Name of FCD System	Appreciation flood protection function		Usage of Embankments for			Negative Effects of Embankments on		Public Cuts
	For Lives and Property	For Agriculture	Roads	Housing	Gardens	Fisheries	Navigation	
Polder 55/1	High	High	High	High	Low	Medium	Medium	Low
Polder 58/3	High	High	High	High	Low	Low	None	None
Polder 61/1	High	High	Medium	Low	Medium	Low	None	None
Polder 64/1A	High	High	High	Medium	Low	Low	None	Low
Polder 64/1B	High	High	High	Low	Low	Low	None	Medium
Polder 64/1C	High	High	Low	Low	Low	Low	None	Low
Polder 66/2	High	High	Medium	Low	Low	Low	None	High
Polder 66/3	High	High	Medium	High	High	Low	None	High
Polder 67	High	High	Medium	Low	Low	Low	None	High
Polder 68	High	High	Medium	Low	None	Low	None	None
Polder 73/2	High	High	High	Medium	Medium	Low	None	Low
Bhitabari Damos	High	High	High	Medium	Low	High	None	None
Beel Singri	High	High	High	Medium	Low	High	None	None
Chorai Shomespur	High	High	High	Medium	Low	High	None	None
Makla Beel *	-	-	-	-	-	-	-	-
Padma Haor Khal *	-	-	-	-	-	-	-	-
Gangnai River *	-	-	-	-	-	-	-	-
Protappur Irri. Scheme	High	High	High	Low	Low	None	None	None
Ichamati Gazaria *	-	-	-	-	-	-	-	-
Kumarnai Bundh	Medium	Medium	High	High	Low	Medium	None	Low
Kanchikata Khal	Medium	Medium	High	Low	Low	Medium	None	None
Dewankhali Khal	High	High	High	High	Medium	High	Low	None
Dardaria Khal	High	High	High	Medium	High	High	High	None
Hizla Em-bankment	High	High	High	Medium	Low	None	Low	Medium
Shanir Haor	High	High	Low	High	Low	Low	None	High
Chaptir Haor	High	High	Low	High	Low	Low	None	High
Polder 39/1	High	High	High	Medium	Low	Low	Medium	Medium

* These systems have no embankment.

In all cases, however, respondents mentioned a large loss in open water capture fisheries due to the construction of the embankment. This is inevitable, as embankments and regulators restrict the free migration of fish and fish fingerlings between rivers, the floodplain and *beels* (see Section 4.4.4). The loss of navigation was not so marked in most systems, and was only severe in Dardaria Khal, Polder 55/1 and 39/1B&D. The construction of Polder 39/1B&D as a single unit, for example, was postponed due to public opposition against the closure of *khals*. The inhabitants of the area feared that their river-based communication system would be severely hampered by an embankment. Consequently, Polder 39/1B and 39/1D were initially constructed as separate units.

Multifunctionality of Embankments

An important and often overlooked characteristic of embankments is that they are used for many different purposes, i.e. that they are multifunctional. During extreme floods, for example, they fulfil a very important function as a safe haven for livestock and people. Houses are also often built on or along embankments, especially by landless. Although the most important function of embankments is flood protection they are also crucially important as transportation routes. In all the FCD systems studied it transpired that the construction of embankments vastly improved transportation possibilities. Embankments that are contiguous and have a road deck are intensely used for the transportation of people and goods. This has clear knock-on effects for economic development, such as improved marketing, increased trade and better incomes for people in the trade sector.

In Polder 58/3, for example, the construction of the embankment resulted in people moving into the polder area permanently and vastly improved communications and market facilities. The importance of the transport function of embankments is apparent, amongst others, from the fact that local initiatives are undertaken to maintain the road surface of the embankment (see Box 3). Unfortunately, the conventional design of embankments in Bangladesh has not considered their multifunctionality, although proposals for sound alternative designs have been put forward (see FAP 13, 1992).

Box 3 The Importance of the Transport Function of Embankments in Hizla Embankment

Hizla Embankment, an FCD system located in southern Bangladesh, is protected on its western side by an internal embankment along the left bank of Kawria Khal. The farmers who have fields along Kawria Khal use LLPs to irrigate their *boro* rice with tidal water from the *khal*. To correctly install the pipes leading from the pumps to the fields, farmers cut the embankment. However, farmers cover the cuts with planks and bamboo, in effect building their own temporary small culvert, because this embankment is also used as a road. At the end of the dry season they fill the cuts and repair the embankment so that during the wet season the area is protected from floods.

Management of Embankments

In many of the FCD systems studied farmers indicated that floods caused by local drainage problems damage their crops. This type of flooding results from local rainfall and the concomitant run-off being trapped behind the embankment. It is an inherent characteristic of FCD systems that embankments impede the free flow of water and thus exacerbate local drainage problems. This impediment of drainage can lead to the cutting of the embankment by stakeholders or the construction of private drainage pipes (see Box 4) in the embankment.

Embankment cuts, also referred to as "public cuts", are a well-known water management practice in FCD systems. Their occurrence is often cited as the ultimate proof that BWDB constructs "bad" FCD systems and that "the people" are against embankments. This simplistic view reflects a profound misunderstanding of the purpose of embankment cuts and of the nature of water management in Bangladesh in general. Far from being a rejection or destruction of the embankment, the RWMA revealed that public cuts in most FCD systems are a flexible, cost-effective and appropriate operational method used by stakeholders to manage water (see **Box 14**). Embankments are usually cut in a well-planned and systematic manner. In most cases, the cuts are filled again by the inhabitants before the river floods, to be cut once again after the floods pass and drainage congestion becomes severe.

Box 4 The Construction of a Private Drainage Pipe in Kumarnai Bundh

In Kumarnai Bundh, a FCD system located close to Gaibandha, a group of farmers from Mirerdoba, a village near the embankment, took an initiative to solve drainage congestion in their area in 1991. About two hundred farmers raised a fund amounting to Tk. 8000 from the landowners of the affected area. They purchased nine concrete pipe segments of 2 feet diameter each and placed them together under the embankment for local drainage. A connecting canal of 300 m was excavated from the *beel* to the pipe in the embankment to release water. In 1996, farmers raised Tk. 2000 for repairing the pipe outlet and the linkage canal.

The incidence of public cuts in the systems studied during the RWMA was highest in the *haor* systems. Here, embankment cuts are a traditional drainage practice, facilitating fishing and navigation. They are necessary for draining the area so that a *boro* crop can be grown. The *haor* systems are a special case, treated separately in Section 4.4.5.

In the Chittagong area, embankments are often cut for allowing the entry of saline water for salt and shrimp production. This, in turn, severely disrupts communication and is harmful to paddy farmers. In many cases, the shrimp producers place locally constructed shrimp inlets in these cuts and the embankments are restored (see Box 8). Nonetheless, this often weakens the embankment and disrupts communication.

For drainage purposes, farmers in the polders around Chittagong generally place private drainage pipes in the embankment. Under normal conditions, these pipes are sufficient to release the area from drainage congestion. However, after heavy rainfall, it is necessary to cut the embankment at these locations, as the pipes do not drain quickly enough. The cuts are made several times during the monsoon and immediately closed again after drainage is complete. In the polders located in the south-west of Bangladesh, farmers frequently cut the embankment for tidal irrigation. These cuts are usually minor and are restored by the farmers themselves before the flood season.

Embankment cuts to allow the drainage of water trapped inside a FCD system is generally a good water management strategy. However, people residing outside a FCD system sometimes cut embankments. This is highly detrimental for the inhabitants of the FCD system in question. "Outsiders" cut the embankment because embankments frequently cause higher water levels during floods outside a FCD system. They expect that the increased storage created by cutting the embankments will result in lower flood levels in the river.

Specific incidences of this sort of activity were not found during the RWMA, except for in Kumarnai Bundh. The inhabitants of Kumarnai Bundh think that the construction of Sonali Bundh on the south side of Ghagot River has led to higher river water levels and increased drainage congestion in their area (north of Ghagot river). In the past they often attempted to cut the Sonali Bundh. However, the construction of a new regulator in Kumarnai Bundh seems to have decreased the drainage congestion, which has led to less conflicts between inhabitants of Kumarnai Bundh and Sonali Bundh.

Besides the operation of embankments by means of cuts, an important management task relating to embankments is maintenance. Both for effective flood protection and smooth transportation, embankments need to be well maintained. The maintenance state of the embankments in the 27 FCD systems studied was average to poor. The poor condition of many embankments is not only due to a lack of routine maintenance, but is also a result of the conventional design of embankments, institutional arrangements in place and the multiple use of embankments. Because they are a public good that provides benefits to a wide range of people, nobody feels directly responsible for them. Nonetheless, several noteworthy local initiatives relating to the maintenance of embankments were found during fieldwork, and mainly concerned raising the height of embankments during floods.

During times of crises, when the threat of flooding is real and there is no time to apply to external agencies for assistance, stakeholders frequently work together to strengthen and raise weak spots in an embankment. Those stakeholders living closest to the vulnerable portion and others who would be most severely affected by an eventual flood contribute to these initiatives with their voluntary labour, regardless of the fact that other people will also benefit from their work. The highest number of initiatives belonging to this category was found in the *haor* area (see Box 5).

Similar initiatives to the one in Chaptir Haor were found in Beel Singri and Polder 64/1B. In Beel Singri, high river levels threaten to flood the entire system almost every year and damage the *aus* and *aman* crops. To combat this threat, stakeholders strengthen the embankment by raising it at key locations and by protecting its slopes. About 475 labour days were spent in 1996 on works that successfully protected an area of about 1,400 ha in Beel Singri. In Polder 64/1B, stakeholders sprang into action in 1995, after a portion of the embankment was severely damaged, by closing the breach and repairing 300 m of the embankment. About 100 people worked for ten days. This initiative protects 150 ha of land and benefits about 2000 people. For the last two years, the stakeholders regularly maintain the concerned embankment section, as it continues to be a vulnerable spot.

Box 5 Raising of the Compartmental Bundh in Chaptir Haor

In Chaptir Haor the threat of an early flash flood is always present. In 1996, a breach in the embankment at the southern end of the system threatened to destroy the crop of the whole *haor*. Immediately after the breach occurred, thousands of people gathered to raise two compartmental bundhs inside the *haor*, working for three days and nights. These interior embankments would effectively cut off the southern end of the system, thereby protecting a substantial part of the *haor*.

A committee was immediately formed to manage the crisis, consisting of representatives of the 26 villages in the *haor*. Within a few days this committee succeeded in mobilising over Tk 60,000. This money was used to purchase bamboo, bamboo mats, lamp kerosene, and particularly to employ fifteen watchmen. These watchmen patrolled the compartmental bundh continuously to make sure that a potential breach would be identified immediately. Due to this initiative a disaster that could have caused a severe food shortage was successfully prevented. Only a small fraction of the crop was destroyed.

The people in Chaptir Haor are conscious that their livelihood will depend on maintaining these two compartmental bundhs in the future. Thus, the ad hoc committee that was formed immediately after the breach in the main embankment has developed into a permanent organisation with the mandate to ensure regular maintenance of the compartmental bundhs.

Source: Duyne, 1998

Concluding Remarks
In general, embankments are well appreciated by the inhabitants of FCD systems interviewed during the RWMA. The suggestion that they are "failures" (Hossain, 1994) was not borne out by this study. Rather, they are crucially important for the livelihoods of millions of people in rural Bangladesh. The flood protection function was fulfilled by most of the embankments in the systems studied. This is often taken for granted by many inhabitants, to such an extent that only the secondary uses of embankments and some negative effects are an issue.

Nonetheless, the conventional design of embankments in Bangladesh could be reviewed and modified. The findings of the RWMA support the conclusions of FAP 13 (1992) concerning embankments, namely that their multifunctionality needs to be taken into account. The considerable use of embankments for housing, communication and agriculture, though productive, is damaging to the embankment's flood protection function. The design and implementation of multiple-use embankments with provisions for housing, roads, fish ponds, markets and agriculture would improve the maintenance state of embankments and be highly beneficial to the inhabitants of FCD systems.

4.4.2 The Use and Management of Regulators and Sluices

Embankments, if well maintained, provide protection against flooding from outside, but they also cause flooding through the accumulation of rainwater inside a FCD system. One method to overcome drainage congestion is to cut the embankment at strategic locations. After the FCD system has been drained, however, the embankment needs to be restored in order to fulfil its flood protection function. Except for in the *haor* areas, this is not always a practical solution as the moments that drainage is required and the moments that the FCD system needs to be protected against floods are not exactly predictable and may alternate several times a year.

Moreover, cutting embankments is a very labour intensive and time-consuming job, which requires good social organisation.

The engineering solution to this problem is the construction of regulators in the embankment. To fulfil both the function of flood protection as an extension of the embankment, but at the same time to allow for easy drainage these regulators are initially equipped with flap gates at the river side. They are also equipped with fall boards, so that the regulator can easily be closed on both sides for access to the flap gates in case repairs or replacements are needed. Fall boards are also used for water retention purposes. A regulator is defined as a structure built to control the flow of water across an embankment at the head of a *khal* or a structure built in a river or *khal* to control water. Water is controlled by flap gates, vertical lift gates, fall boards or a combination of these.

From a water management point of view two types of regulators can be distinguished, namely Main Regulators and Minor Regulators. Main Regulators are typically situated at the head of the main drainage arteries in a FCD system and are usually constructed at the same time as the flood embankment. Main Regulators are large (more than four vents), serve a major part of the FCD system (more than 2000 ha) and affect many types of stakeholders. Minor Regulators, on the other hand, are small (one or two vents), serve minor parts of a FCD system (less than 2000 ha) and affect only a few types of stakeholders. Minor Regulators are usually constructed to solve more localised drainage problems. A binding characteristic of both Main and Minor Regulators is that they are situated on a *khal*. If this is not the case, then the structure in an embankment is called a surface drainage outlet or a surface sluice.

In FCD systems that do not feature a main *khal*, but instead are drained through a large number of parallel *khals* perpendicular to the river or coastline, Minor Regulators are the primary infrastructure. This is the case where high land borders a FCD system, which drain off through the FCD system, such as in the polders in the Chittagong area. Such a FCD system often has many Minor Regulators and no Main Regulator.

The Functions of Regulators

Initially, both Main and Minor regulators serve to drain excess water from a FCD system during post-monsoon and to protect against floods from rivers or the sea during monsoon. However, once these functions are fulfilled adequately, water users demand better water control and water retention becomes important. In first instance, provisional measures are taken to facilitate water retention but soon the regulators are modified so that water may be retained at the desired level. This is done by installing vertical lift gates at the country side of the regulators. Consequently, the structure does not operate automatically any more and decisions on operating the vertical lift gates need to be taken and carried out.

Moreover, the demand for letting water in grows stronger when flood security increases and drainage problems are reduced. Small sluices, called flushing sluices, are constructed in the embankments for this particular purpose. Note that in Bangladesh the term flushing is used to indicate the entry of water into a FCD system. This may be confusing as the term is used internationally to indicate the drainage of water from a FCD system. Also, the regulators may be further modified to fulfil this additional function by providing the flap gates with hoists to open them or to replace the flap gates by vertical lift gates. Whatever option is chosen, the structures become more complicated to operate.

In developed FCD systems, regulators fulfil a multitude of functions and they become the focal point of water management in FCD systems (flushing sluices and surface drainage outlets, on the other hand, remain mono-functional). Although FCD systems were initially constructed for increasing agricultural production, other sectors, such as fisheries, water transport, salt production and shrimp farming, increasingly demand to be served by the infrastructure. The water management demands of these sectors are often contradictory and even within one sector the demands are not similar everywhere in the system. The conflicting demands typically converge on the operation of the regulator (see Table 5).

Table 5 The Operation of Regulators

Operation	Potential Benefits	Possible Conflicts of Interest
Opening of the gates in the pre-monsoon for drainage.	Allows accumulated rain water to drain out of the system, preventing damage to early *aus* as well as late *boro* on low land.	High land farmers want to store water for irrigation or land preparation.
	Allows the entry of saline water for salt and shrimp production or for fish culture.	Saline water is detrimental to paddy production.
Closure of the gates during the monsoon to prevent flooding	Prevents monsoon river flood damage to *aus* and *aman* crops.	Prevents fish from entering into the system.
from the river.		May cause flooding in the system due to accumulated rain water.
Opening of the gates for flushing during the monsoon.	Allows the entry of water with fish fingerlings.	Extended flooding damages *aman* on low land.
	Supplies extra water for *aman* on higher land.	
Closing of the gates in the post-monsoon for water retention.	Retains water for the flowering of the *aman* crop and for irrigation of the *boro* crop.	Reduces fish catch in *khals* and *beels*.
	Retains water for domestic purposes.	Makes *boro* cultivation in *beels* difficult.
Opening of the gates in the post monsoon for drainage.	Increases fish catch in *khals* and *beels*.	High land farmers want water retention for irrigation purposes.
	Drains *beels* for *boro* cultivation.	Reduces the amount of water retained for domestic purposes.

Regulators, for example, create a choice between draining *beels* and *khals* for *boro* cultivation on low land or for retaining water for irrigation on high land. This water management option often creates conflicts, especially if the regulator drains a large area (see Box 1 and **Box 13**). Regulators also create a choice between fisheries and agriculture (see Section 4.4.4 for the negative impacts of FCD systems on fisheries). Nonetheless, regulators can be operated in such a way that fish fingerlings can enter the *khals* and *beels* of a FCD system. This, however, often creates conflicts with water requirements for agriculture. For example, in the Chapai-Nawabganj Beels, farmers mentioned that fishermen open the gates of regulators at night during the monsoon. This causes the flooding of certain low land areas.

The Management of Minor Regulators

Minor regulators often fulfil all of the functions mentioned above. However, the area served by one such regulator is relatively small and most of the people affected by that regulator know each other and have a common interest. Even when there are different categories of stakeholders depending on a minor regulator it was found that a consensus was usually reached among the stakeholders on how to operate the structure. Often informal committees or other non-formal systems of decision-making determine the operation of minor regulators (see Box 6) and conflicts are resolved within the group of stakeholders. In Polder 64/1B an interesting case of conflict resolution was found, with a youth club in charge of operating a minor regulator. They also construct a cross dam in front of the regulator each year for water retention during the dry season. The farmers of the locality indicated that they had charged the youth club with the operation of the regulator, to avoid social conflicts among themselves.

Box 6 Control over Minor Regulators in Polder 64/1C

In Polder 64/1C there are eight minor regulators, designed with a flap gate on the river side and fall boards on the country side of the structure. Due to poor maintenance, most of the flap gates do not function properly. A person employed by the large landlords and salt producers operates four of the regulators. The landlords and their sharecroppers build cross dams on the country side of the regulators every year because the flap gates are not working properly. They have also constructed a water distribution system with a partition dyke and a channel network for salt and shrimp production. An operator is engaged by the large landlord to distribute the saline water and operate the regulator. The operator is paid five maunds of salt per acre salt cultivated per season. One regulator is controlled by a group of influential people, who collect money from the other water users for operating the regulator. The remaining three are operated on an ad hoc basis by farmers who have fields near the regulators.

In the polders in the Chittagong region, salt and shrimp producers control many of the minor regulators. This creates problems for the paddy farmers, as saline water is let into the system. However, no instances were found in which these problems were insurmountable. In many cases the salt and shrimp producers build partition dykes and separate distribution systems to protect the paddy fields against saline water intrusion, although they force the paddy farmers to pay for this. In many instances they also collect toll from the paddy farmers and other salt and shrimp producers for the operation of the minor regulator.

Another conflict that can be found throughout the country that is typical for minor regulators is between fishermen and farmers. Frequently, fishermen build nets at the country side of the regulators to catch fish. During the monsoon, they let water into the system, causing the submergence of paddy land. At times, these conflicts can be quite severe. In Polder 64/1B, for example, landowners negatively affected by the operation of a minor regulator for fishing purposes had to resort to cutting the embankment to relieve their fields from drainage congestion.

The Management of Main Regulators

In systems with one or several main regulators the impact of the regulators extends over a much larger area, and it may even affect the whole FCD system. Also, the *khal* on which the main regulator is situated is usually the main drainage artery of the system and is often connected to several *beels* and other *khals*. Consequently, the management of main regulators is much more complicated, as one regulator serves many different categories of water management stakeholders, leading to conflicts of interest (see Box 7).

It was found during the RWMA, however, that many stakeholders in the interior are not aware that and how they are affected by the operation of the regulator. A minority of the stakeholders knows who decides on the operation of the regulator and there is little understanding of how the operation of the regulator affects the different stakeholders. Negative effects of a particular mode of operation is often countered by local measures (e.g. if the gates are opened for draining, those who wish to retain water construct cross dams in their area). In systems with main regulators the distances are great and there is little social control. Most of the time a group of powerful stakeholders operate the structure according to their own needs and for their own benefit.

The BWDB should play an important role in the maintenance of Main Regulators, as the size of the structure and its components (gates) is beyond the local capacity to handle. Malfunctioning of a Main Regulator has a major impact on a FCD system. In that sense the BWDB, by timely attending to the maintenance requirements of Main Regulators, has a major impact on the development of FCD systems. Gates left in disrepair for prolonged periods render most of the other investments useless and returns a FCD system to the pre-intervention stage.

Flushing Sluices, Drainage Pipes and Culverts
Besides major and minor regulators, one can find flushing sluices, surface drainage outlets and culverts in most FCD systems. These structures usually have only one particular function and affect only a very limited area. For these reasons they seldom cause conflicts, as the stakeholders usually have the same interest with regard to the operation of the structure. An important category of water management infrastructure, entirely financed and constructed by stakeholders, are private drainage pipes. These pipes serve to drain small pockets of drainage congestion behind an embankment. They cost between Tk 3,000 to 40,000 and are purchased on the local market.

Box 7 The Operation of the Main Regulator in Dardaria Khal

Dardaria Khal, a FCD system located 60 km north of Dhaka, consists of an 18 km long embankment along Banar River, which protects a gross area of 6200 ha, and a long, branched *khal*. The north and north-east side of the system is high land. In the south and south-west of the system there are many small *beels* and one large one: Maduli Beel. These *beels* are filled with water for at least six months a year. In the embankment there are 8 drainage sluices, which drain small pockets of drainage congestion. More than 90% of the system is drained through the 6-vent main regulator at Ekuria, at the head end of Dardaria Khal. This regulator serves the needs of many different categories of stakeholders, and at times its operation is a contentious issue.

The operation of the regulator is officially the responsibility of the BWDB *kalashi*. The operational decisions he takes are strongly influenced by the UP Chairman of Karihata and by other influential people. In April and May the regulator is usually left open, to drain out water from the first rains. At times, however, businessmen bribe the operator to open the regulator so that boats carrying their jackfruits can travel on the *khals*. During the monsoon, the regulator is closed to keep river floods out. This causes flooding inside the system, however, as the *beels* fill up with rainwater runoff and flood the lands surrounding them. When river levels permit, the regulator is opened during the monsoon to drain out accumulated rainwater. At the end of the monsoon, when river levels drop drastically, the gates of the regulator are opened completely to quickly drain the system.

In the post-monsoon the operation of the regulator becomes more contentious. LLP owners (in total 30) along Katakali Khal, a branch *khal* of Dardaria Khal, build several cross dams for water retention sometime in October or November. They sell this water to farmers for *boro* cultivation, and most of them switch to STWs when the *khal* dries up. Before they build the cross dams, they request the UP Chairman and the *kalashi* to close the regulator, so that more water is retained in the *khals*. This prolongs the drainage congestion of the lands near the *beels* in the eastern part of the system. The LLP owners indicated that they were not aware of this.

Besides the LLP owners, farmers that live at the head end of Dardaria Khal influence the operation of the regulator during the dry season. These farmers also use LLPs to irrigate their *boro* crop. Sometime in January the main *khal* starts to dry up and the farmers face water scarcity. To increase the amount of water in the *khal* they make use of the influence of the tide. Especially the effect of spring tide can be noticed in the Banar River during the dry season. The farmers explained that during spring tide the water level in the river is high enough to let water into the *khal*. At that time the LLP owners and farmers of this area request the *kalashi* to open one of the gates of Ekuria Regulator to let the river water into the *khal*. Especially towards the end of the dry season, when the *khal* is nearly empty, this is a very economic way of refilling the *khal*.

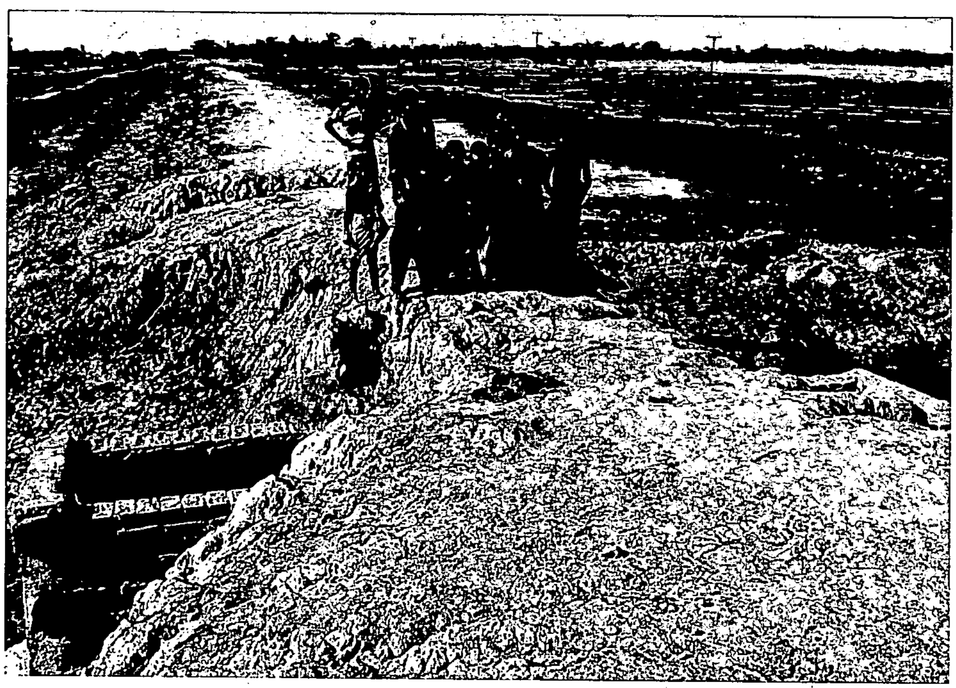
Salt and Shrimp Inlets

A special category of water management infrastructure is the shrimp and salt inlets in the coastal polders (see Photo 2). These are usually constructed by salt and shrimp producers themselves, or sometimes by the government, and can range from simple cuts in the embankment to elaborate wooden and concrete structures (see Box 8). These inlets are used for salt production in the dry season, from November to May. It the monsoon they are used for shrimp cultivation, from July to October. Shrimp and salt inlets do create conflicts, as they allow the entry of saline water into FCD systems.

Box 8 Shrimp and Salt Inlets in Polder 64/1C

In Polder 64/1C more than 60 shrimp and salt inlets have been constructed at different locations along the embankment. These inlets are constructed by cutting the embankment and placing drainage pipes near to the base of the embankment. These pipes are used during the dry season for salt production inside the system, by allowing the entry and drainage of water. During the monsoon they are used to drain water from the shrimp fields. After the placement of the drainage pipe, the cut in the embankment is partly refilled. The top one to two feet of the cuts are left open on purpose and are equipped with wooden fall boards. These openings in the embankment serve to allow the entry of the top layers of saline water during the monsoon for fish culture and shrimp production. These layers carry a high concentration of fish fingerlings. Although these structures are quite well built and highly beneficial to the shrimp and salt producers, they weaken the embankment and hamper its transport function.

Photo 2 A private shrimp inlet in an embankment



4.4.3 *The Use and Management of Khals*

In Bangladesh, the term *khal* is used to refer to a natural drainage channel or creek. They are very common throughout the country and are present before a FCD system is built. During the construction of a FCD system their alignment may be somewhat modified and they are often re-excavated. *Khals* play a major role in water management in FCD systems as they are usually the main water bodies in FCD systems. They are the arteries of the system and, together with *beels* and regulators, form the water conveyance system of FCD systems. *Khals* serve three important water management functions: drainage, water storage (retention) and water inflow. Besides this, *khals* are used for fisheries, agriculture, navigation and domestic use. These different functions and uses of *khals* make their management complex, due to the involvement of different types of stakeholders with conflicting demands.

There are several types of *khals*. In the polders located in the Chittagong region, the *khals* are generally small and perpendicular to the coast. They drain water from the hills to the sea and are not interconnected. (see **Figure 11**) The polders located in the Khulna region often have an intricate network of interconnected khals in their interior with one or two major khals. Hence, the actions of stakeholders in one particular *khal* have consequences for the other *khals* (see **Figure 13**). In Polder 55/1, for example, there are eight main *khals* with many branches, most of which are interconnected. Some of these branches have been converted into fishponds by leaseholders through the construction of cross dams in the *khal*. Moreover, many cross dams are built in the *khals* for water retention and to serve as roads. This practice causes severe drainage congestion throughout the system, although not necessarily at the location of the cross dams.

Table 6 The Function of Khals during Different Seasons

Season Use	Monsoon (June-September)	Post-Monsoon (October-December)	Dry Season (January-May)
Drainage	***** (28)	*** (28)	* (28)
Navigation	**** (6)	*** (6)	-
Fishing	**** (7)	**** (7)	** (7)
Water Retention for Irrigation	-	**** (25)	***** (25)
Water Retention for Fishing	-	*** (6)	**** (6)
Tidal Irrigation	-	**** (7)	** (7)
Saline Water Conveyance for Salt and Shrimp Production	**** (7)	**** (7)	**** (7)
Domestic Purposes	** (20)	*** (20)	***** (20)
Livestock Watering and Washing	** (6)	*** (6)	**** (6)
Seedbeds for Boro	-	**** (2)	-
Boro Cultivation	-	** (1)	***** (1)
Housing	-	** (1)	** (1)

Note: ***** = very important, * = not at all important, the number between brackets indicates the number of FCD systems in which this use of *khals* was found (n=28).

In inland FCD systems (see Figure 9) one often finds one major *khal* with several branches. These branched *khals* can drain an area of up to 10,000 ha and therefore interventions in the *khal* or its branches can create conflicts. The upstream stakeholders who intervene in the *khals* usually do not consider the effects of their interventions for the downstream users. The interventions of stakeholders in interconnected and branched *khals* make their management more complex than the management of single *khals*.

The primary water management function of a *khal* strongly depends on the season (see Table 6). During the monsoon, *khals* are mainly used for drainage. At this time they are also important for fishing in most FCD systems and for navigation in some systems, such as Polder 39/1B&D, Polder 55/1 and Dardaria Khal. In coastal FCD systems, *khals* are also used to convey saline water for shrimp and salt production.

The Management of *Khals*

The drainage function of *khals* is very important during the monsoon because of high rainfall. The water levels in *khals* quickly increase during and after May, which means that the regulators at the outfall of the *khals* need to be opened to drain the surplus water. However, due to rising water levels in the rivers this is not always possible, as opening the gates would lead to the ingress of more water. Nonetheless, in many inland FCD systems, powerful leaseholders of *beels* open the regulator gates during the monsoon to allow the entry of water and fish fingerlings. At this time, the *khals* serve as a conveyance route for the fish heading towards the *beels*. Also, many nets are placed in the *khals* themselves to catch fish. In polders, *khals* are also extensively used for fishing purposes (see Box 9).

Box 9 Conflict over the Use of *Khals* for Fishing in Polder 58/3

In Polder 58/3 there is a severe conflict between farmers and a fish cultivator regarding the use of a *khal* and the operation of its regulator. This conflict is due to the leasing of the Harir Khal by the UP Chairman to the fish cultivator. The fish cultivator opens the flap gates of the regulator to allow saline water with small fish into the *khal* in March and April. He then closes the regulator by placing fall boards and constructs cross dams of low height in the *khal* for retaining water during the monsoon and post-monsoon. This allows the small fish to grow large.

This practice causes tremendous drainage problems for the farmers of the area as their field and homesteads are often flooded after heavy rains. When this happens they rush to the fish cultivator and press him to open the regulator and to cut the cross dams so that the excess water can drain out. The fish cultivator often refuses to do so. The farmers then request the UP Chairman to resolve the problem. If the flooding is severe they cut the cross dams themselves and remove the fall boards. This, of course, leads to serious conflicts with the fish cultivator.

During the post-monsoon, *khals* are used for both water retention (through the construction of cross dams and by closing the regulators) and drainage. Cross dams are built in *khals* for water retention for several purposes, namely irrigation and domestic use, fish capture and fish culture. Cross dams can also serve as roads. The construction of cross dams was very widespread in all the systems studied and is the main water management intervention in *khals*. The building of these structures can cause drainage congestion in the upstream areas in the post-monsoon and water shortage in the downstream areas in the dry season.

In Polder 73/2 the construction of a cross dam in a *khal* by a UP Chairman created severe drainage congestion. This negatively affected the farmers of the area, but they did not take any action against the UP Chairman. Also in Polder 73/2 fishermen construct cross dams during the monsoon and post-monsoon for catching fish, which creates conflicts with farmers. In Protappur Irrigation Scheme farmers-cum-fishermen build cross dams for fishing purposes in the *khals*. During critical moments upstream farmers unite and cut the cross dams, but soon after the farmers-cum-fishermen reconstruct them. Sometimes the farmers enlist the UP Chairman to solve the problem, but no permanent solution has yet been found.

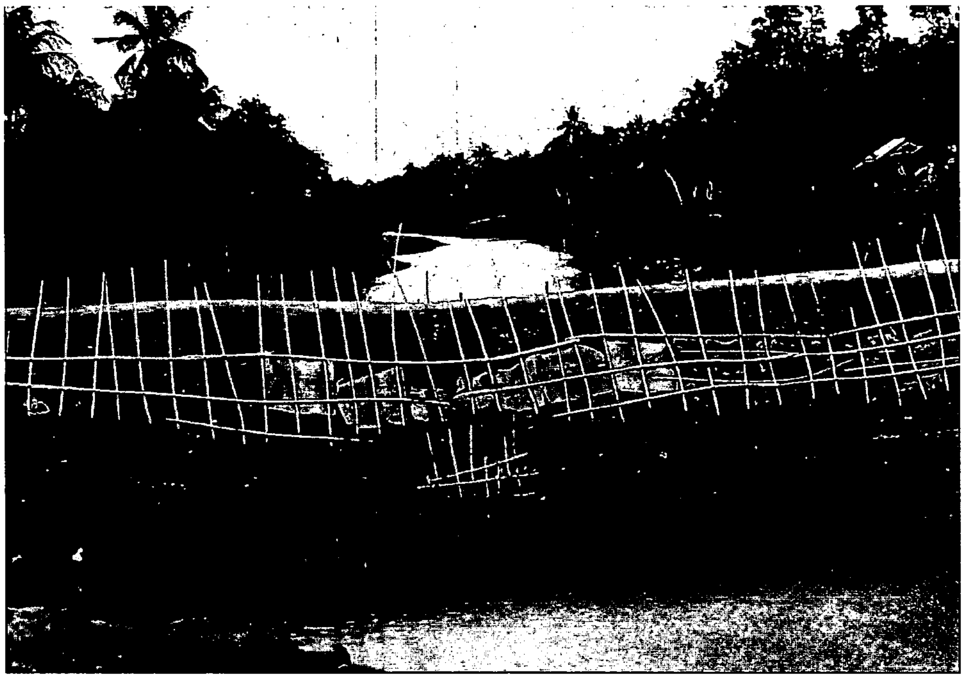
In many of the FCD systems studied, it transpired that farmers gave access to irrigation water a high priority. Many farmers mentioned that the lack of access to irrigation water during the post-monsoon and the dry season is the most serious constraint they face. This is because farmers are satisfied with the present status of flood control and drainage and have grown accustomed to it. In many FCD systems irrigation takes place through the lifting of water from *khals* and *beels* with LLPs or with traditional irrigation devices (such as the *urgi* (swing basket) or the *doon* (swing boat)). In Padma Haor Khal, for example, the farmers raise funds among themselves to build cross dams in the two *khals* of the system. The stored water is used to irrigate *rabi* crops and also to provide supplementary irrigation to *aman* during drought periods.

In the dry season water retention in *khals* becomes very important in many systems, both for domestic purposes and for irrigation. For example, in the upper tract of Beel Singri cross dams

Photo 3 Irrigation from a khal using an urgi

are built in several *khals*. The cross dam at the outfall of Sindurmuchi Khal is a very important one, and is in extensive use for irrigation and domestic water supply. Quite a large area is brought under *rabi* crops by using water stored behind the cross dam. The inhabitants of the area build this cross dam during the post-monsoon. In Mahadara Khal the UP chairman and the inhabitants of the area constructed a masonry cross dam at the outfall of the *khal*. The water retained behind this structure is mainly used for domestic purposes. Towards the end of the dry season, most of the water in the *khals* dries up. This creates a severe water crisis, especially for drinking water and other domestic purposes.

Photo 4 A cross dam in a khal for fishing purposes



In the polders located in the Chittagong region, the construction of cross dams in *khals* during the dry season is very common. These polders generally consist of three strips running parallel to the shoreline, namely a shrimp and salt production strip of up to 100 m wide along the shore, a paddy production strip and a high land strip. The *khals* that flow through these polders originate from the hills and are perpendicular to the shoreline. They nearly always carry water during the dry season and are therefore a good source of irrigation water. Cross dams are built in the *khals* and the water retained behind them is used for gravity irrigation of *aman* and *boro* crops and for fishing purposes (see Photo 4). Often there are conflicts between the farmers who build the cross dam and farmers downstream from the cross dam concerning the sharing of water.

In some *khals*, the beds are used for the preparation of seedbeds for *boro* during the early dry months, and in some cases also for *boro* cultivation. This practice can cause serious problems during the re-excavation of *khals*, as the people cultivating *boro* usually strongly resist the destruction of their crop. The regular excavation of *khals* to increase or restore their water storage and drainage capacity is a very important operational tool. In nearly every single system studied, inhabitants mentioned the re-excavation of khals as one of their top priorities. Poor maintenance of *khals* along with the fact that most of the cross dams and fishing nets built by different interest groups are not removed after they have served their purpose, reduces the drainage capacity of many *khals*. Although many stakeholders want the re-excavation of *khals*, this is not always easy. Officially, most *khals* are *khas* land (government property) but people have often occupied them illegally for growing *boro* or *rabi* crops. Hence, they strongly object to the re-excavation of *khals* (see Box 10).

Box 10 Khal Re-excavation in Gangnai River Improvement System

In the Gangnai River Improvement system, a FCD system located close to Bogra, the land of a large group of farmers living in Medinipur suffered from waterlogging due to drainage congestion. To resolve this problem, a group of forty farmers decided, in 1996, to re-excavate a *khal* that had silted up. This would vastly improve the drainage of their area. The farmers organised several meetings to plan the works and all of them agreed to contribute land and labour for the re-excavation. After agreement was reached they re-excavated a major portion of the *khal*. However, they were not able to do a small portion of the *khal* because the owner of that land did not want to donate it for re-excavation, although he had agreed to do so previously. The group of farmers had a big quarrel with this landowner and some farmers were injured. However, they could not convince the landowner to contribute his land and re-excavation remained incomplete.

Concluding Remarks

Khals are very important in FCD systems, and are the central part of the water conveyance system in FCD systems. The main water management interventions in *khals* are their re-excavation and the construction of cross dams in them. During the monsoon, the main conflict of interests is between drainage and fisheries. During the post-monsoon, drainage versus water retention becomes an issue. In the dry season water scarcity becomes paramount. The access to and the use of *khals* is a function of the power structure in a FCD system. In many cases leaseholders and pump owners impede the drainage function of *khals* and strongly determine how a *khal* is managed. On the other hand, and especially in branched and interconnected *khals*, stakeholders are not aware of the effects of their uses of the *khal* for other stakeholders.

4.4.4 The Use and Management of Beels

Beels are (semi-)permanent lakes lying in depressions in the land. During the monsoon they fill up and become larger and during the dry season they drain out and become smaller or dry up completely. They are only located in inland FCD systems and not in coastal polders. *Beels* are very important water bodies in FCD systems and serve several functions, such as fishing, water storage reservoir (for irrigation and domestic use), flood-recession agriculture and transport. The management of *beels* is strongly linked with the management of *khals* and regulators, as these determine the in- and outflow of water in the *beels*. The main issue in the management of *beels* is which water level should be maintained. This often leads to conflicts between *beel* leaseholders and farmers, fishermen and farmers and between high land and low land farmers.

The main conflict relating to *beels* is between the leaseholders of *beels* and farmers. These conflicts can be quite severe (see Box 11). During the monsoon, the leaseholders and fishermen want to flood the beels and the surrounding floodplain while farmers want to keep their crops flood free. Flood-proofed agriculture and open water capture fisheries are in principle conflicting systems as far as water requirements are concerned. Serving the requirements of both is like serving two master: any compromise which is made is clearly sub-optimal.

Box 11 Two Killed as Peasants' March Attacked

MEHERPUR, July 20: Two youths were killed in rival attack on farmers marching to the town in a protest procession today, reports UNB. Locals said the clash erupted when owners of east and west *beels* (marshes) of village Kola in sadar thana attacked about 200 paddy-field owners at Kola madrasha at 11 am while they were going to the town in procession to submit memorandum to the DC for saving their croplands by opening the embankment erected by the adjacent *beel* owners. One of the processionists died on the spot while another succumbed to this injuries at Maherpur sadar hospital. Both were chopped with *ramdao*. The bodies were sent to the sadar hospital morgue. A case was filed with sadar police. However, none was arrested in this connection.

Source: The Independent, 21 July 1997

In almost all the 27 FCD systems studied respondents indicated that fish yields have decreased dramatically since the construction of the systems. This is because regulators and embankments disconnect the river-*beel* ecosystem (see Box 12). Consequently, it is much more difficult for fish to migrate between the rivers and the *beels*. Over-exploitation has also led to a reduction in fish catches. For the whole of Bangladesh it has been estimated that open water captured fisheries (both from rivers and *beels*) declined by 10% (with 45,000 MT, from 455,000 MT to 410,000 MT) between 1983-1989 (CPP, 1993), mainly as the result of the construction of FCD systems.

In most of the FCD systems studied, not only have fish stock and yields declined, but also access to this traditionally common property resource has profoundly changed. In the past, fishermen were free to fish in the *beels* and on the floodplains. At present, the right to fish in *beels* is frequently obtained through the auctioning of leases by the Deputy Commissioner (DC), although under the new Fish Legislation this practice is forbidden. Lease periods vary from one to 3 years. The leaseholders are usually rural elite or businessmen who allow fishermen to fish in "their" water. A percentage of the catch is for the leaseholder (usually 50%, although quite varied payment systems were found). This change in the access regime also has profound effects on water management conflicts centring on the *beel*, as leaseholders are influential members of society. Hence, they often determine the operation of regulators and the resulting water levels in *beels* (see Box 13).

Box 12 Fish and Flood Control and Drainage Systems

Based on their reproductive behaviour, fish in Bangladesh can be divided in two groups, namely **river fish** (also called white fish) and **beel fish** (or black fish). The breeding and growth of both types is strongly related to the sequence of flooding. The floodplains, which are inundated for four to five months a year, are nutrient and food rich and an ideal habitat for fish. River fish spawn upstream in the major rivers at the start of the rainy season. The eggs and hatchling subsequently flow downstream, and finally enter the floodplain where they find the nutrients for growth. River fish migrate back to the river during the post-monsoon, when the water recedes from the floodplain.

Beel fish, on the other hand, live in the *beels*. They reproduce in the pre-monsoon when the water level in the *beels* rises. Nursing takes place in the inundated floodplain. When the flood waters start receding, beel fish migrate back to the *beels* or get trapped in low-lying patches of water.

FCD systems have a negative impact on capture fisheries. The reduction of the area of floodplain inundated in FCD systems, due to embankments and drainage, strongly affects both type of fish. It reduces their nursing areas, which causes the natural fish stocks to decline. FCD systems also modify the timing and amplitude of flooding, which reduces fish productivity and species diversity. The regulators restrict or even inhibit the free movement of mature fish and fry from the rivers to *beels* and visa versa. Lastly, the tendency to completely reclaim the low lands in *beels* during the dry season for *boro* cultivation and dry season surface water withdrawal for irrigation practically extinguishes all kinds of fish in the *beels*.

Source: Ali, 1990; CPP, 1993

A very common conflict in FCD systems with *beels* is between high land and low land farmers. In the monsoon, the draining of high land causes the drowning of the low land. During the dry season it is the low land farmers who want to drain out the *beel* and the high land farmers who want to retain water. The availability of water in *beels* greatly determines the prospect for agriculture during the dry season, as *beel* water is extensively used for irrigating the *boro* crop and also for *rabi* crops. In Chorai Shomespur, for example, conflicts between high land and low land farmers of Chorai *beel* often arise. During the dry season the high and medium high land farmers want to conserve water in the *beel* for irrigation of their *boro* crop with LLPs. Low land farmers, however, who have land at the bottom of the beel, want to cultivate *boro* on their land.

Photo 5 During monsoon, beels are important for fishing

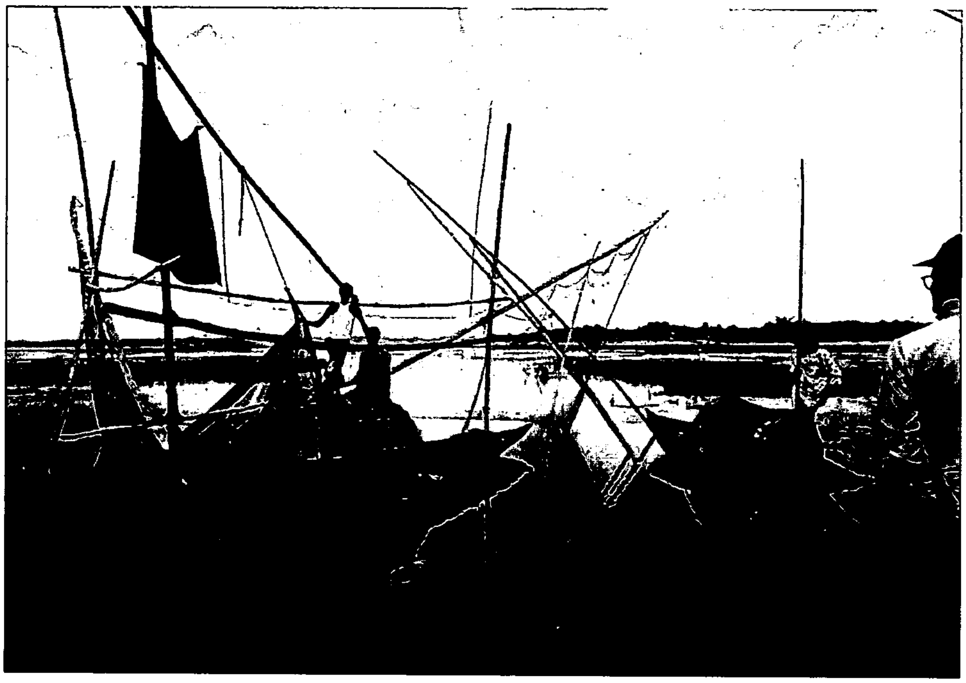


Photo 6 During the dry season the same beel is used for agriculture

The low land farmers in Chorai *beel* are large farmers (more than 15 acres) and own DTWs and STWs, so draining the *beel* is not such a problem to them. Also, the *beel* must be drained for their land to fall dry and be available for cultivation. Once the *beel* falls dry they can switch to their STWs or DTWs. An added advantage of a dry *beel* is that the high land farmers can no longer use their LLPs and thus have to buy water from the low land farmers. In the past, this issue resulted in severe conflicts between the high land and the low land farmers. Last year they discussed the issue among themselves and the problem was solved by delaying the transplantation of *boro* seedlings in the bottom of the *beel*.

Box 13 The Management of *Beels* in Chorai Shomespur

In Chorai Shomespur, a FCD system near Chapai-Nawabganj, there are two large *beels*. In the past, these *beels* were leased out by the district administration to influential people each year. These people allowed fishermen to fish in the *beels* as labourers. These fishermen have to sell their catch to the leaseholder. The leasing practice caused severe conflicts with paddy farmers concerning the amount of water that should be allowed into the *beels* from the river. Fishermen and leaseholders want more water to enter the *beels* in June and July, when the water level in the river becomes higher than in the *beel,* whereas paddy farmers want to prevent the entry of water.

Until recently, the operation of the two main regulators in Chorai Shomespur was completely controlled by the leaseholders. As a result, they allowed the entry of water during the monsoon, even if this caused serious damage to the *aus* and *aman* crops. In 1996 the leasing of the *beels* was stopped, so this conflict has been reduced.

The drainage of the system is also subject to conflict. During the post-monsoon, in September and October, the leasers of the *beels* want to drain the area as a means of harvesting the fish. Most farmers, on the other hand, want to store water in the *beel* for domestic and irrigation purposes during the dry season.

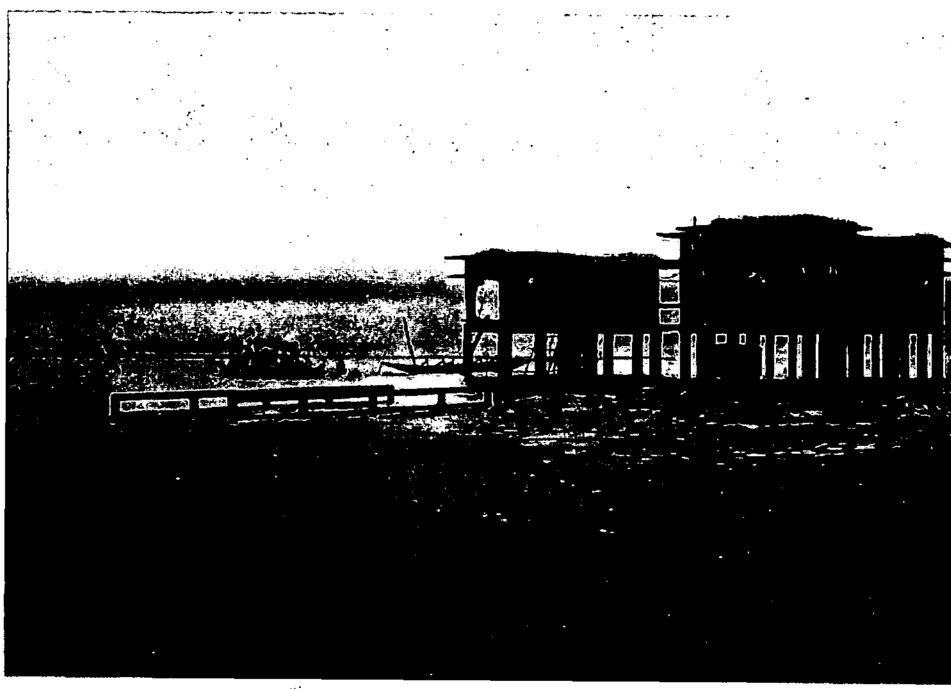
4.4.5 Management of Haors

Haors are a special type of water body located in the Sylhet Depression, in the northeast of Bangladesh. This area is a low-lying, bowl-shaped basin covering 6000 km^2. Most of this land is only between 5 to 8 m above sea level and is flooded to a depth of 5 m or more during the monsoon (see Photo 7). Several meandering rivers traverse the Depression, including the Surma, Kalni, Kushiyara and Baulai. In between the natural levees of the rivers, large, seasonally-flooded, saucer-shaped depressions called *haors* are located. In the lowest pockets of these *haors* permanent lakes, called *beels*, are located.

During the last two centuries much of the forest which used to cover the *haor* area has been consumed and in its place *boro* is now cultivated. At present as many as five million people depend on the *haors* for their livelihood. They live in villages, usually located on the higher land (natural levees) along the rivers. The fields inside the *haors* are planted during the dry season with *boro* and some *rabi* crops. During the monsoon, crop production is not possible as the *haors* are flooded from May to November. In December, when the monsoon flood waters recede from the *haors*, farmers prepare their land and transplant *boro* seedlings.

The main water management challenge in *haors* is to protect the *boro* crop against early flash floods in March and April. Water then enters the *haors* through *khals* and rivers or, where there is an embankment, through breaches and cuts in the embankment. The low entry points to a *haor* must therefore be closed before river levels start rising and preferably a submersible embankment should surround the whole *haor*. These embankments are high enough to keep out the early flash floods but not high enough to provide full flood protection during the monsoon.

Photo 7 A haor during the monsoon



The tradition of constructing and managing embankments in the *haor* area is very strong and dates back more than a century (see Box 14). Public investment in the water sector in the *haor* area began in the 1970s, with the construction of more and higher embankments, sometimes equipped with regulators, by BWDB. At the same time, there has been a rapid growth in irrigation of the *boro* crop through farmer-owned LLPs. Although the increase in rice production has been substantial as a result of the construction of submersible embankments, this benefit has been somewhat offset by adverse impacts on fisheries, wetland habitat and navigation.

Box 14 The Management of Embankments in Haors

In Shanir Haor, the construction of a submersible embankment, including an 8 vent regulator with steel gates, was initiated and financed by the *zamindar* of Gauripur in 1915. Inhabitants of the *haor* constructed the embankment as paid labourers. The *zamindar* subsequently raised land taxes from 1.5 to 1.7 taka per *ker*. After the abolition of the *zamindari* system in 1948, the inhabitants of Shanir Haor, under the leadership of large landowners, managed and maintained the embankment and protected their *boro* crop against floods. *Chada* (public contributions in kind, cash or labour) were raised from the farmers to finance the works. This self taxing system stopped in 1965, when union chairmen started receiving food from the central government to carry out earthwork. In 1976, BWDB reconstructed the embankment and replaced the 1915-regulator with a 6 vent regulator equipped with fall boards. Again, people were engaged in earthwork as paid labourers.

In the *haors*, farmers know that they lose their only crop if there is an early flash flood. Thus, they all want a strong embankment that can withstand the flash floods until harvesting is finished. In Shanir Haor there is a permanent organisation, the Shanir Haor Development Committee, which has members from each of the 47 villages around the *haor*. This locally constituted committee has defined its own mandate, and is responsible for monitoring river water levels and the condition of the embankment until harvesting is finished. Three guards are appointed in March and April (the critical period of flash floods) to patrol the embankment and to monitor river water levels. If need be, the public is mobilised to re-enforce weak spots in the embankment or to fill public cuts.

The committee also coordinates the placing of public cuts in the embankment, which are made in November and December. These cuts are made deliberately to gradually drain the *haor* to permit the transplanting of rice seedlings. They are systematic and form an integral part of the management of embankments in *haors*. Each year in December, a deep cut is made in the embankment at Ahammokhali to drain the lowest agricultural land inside the *haor*. At other places cuts are also made (in total around 20). The cuts must be closed at all costs when the river starts rising (in March) or else the entire *haor* becomes flooded. The cut at Ahammokhali is closed every year with traditional methods, consisting of bamboo poles, rope, bamboo mats and earth. BWDB Food For Work (FFW) pays for the earthwork and the public provides the other materials. Most other cuts and breaches are also filled through FFW. Once FFW officially stops, the Shanir Haor Development Committee *de facto* takes over the responsibility from BWDB to protect the *haor* against flooding. Any remaining breaches or cuts in the embankment are repaired, on the basis of voluntary labour. It can be concluded that in the context of *haors*, **embankment cutting is an efficient and effective embankment management method and an integral part of the water management practices evolved by the inhabitants.**

Sources: FAP 6, 1993.

In *haors* with a submersible embankment the most important component of water management is embankment management. The inhabitants of *haors* take many initiatives to protect their *boro* crop from flash floods, among others by ensuring that open *khals*, cuts and breaches in the embankment are closed every year in February and March. Later, once the *haor* is flooded, in May or June, the embankment is cut by fishermen and boatmen, to allow fish fingerlings in and to make transport possible. In November, farmers deepen the cuts and other cuts are strategically placed to allow the efficient draining of the *haor* so that the rice seedlings can be transplanted.

Photo 8 An embankment cut that has been closed

Due to the short growing season of the *boro* crop, there are some very critical moments in water management in the *haors.* The submersible embankment both protects against early flash floods at the end of the growing season but it also impedes quick drainage at the beginning of the growing season. A delay in drainage leads to a delay in planting which leads to a delay in harvesting. As a result, the harvest becomes more endangered by early flash floods. Thus, in the context of *haors*, the cutting of embankments is not a bad thing or a criminal offence as it is critical for draining a *haor* quickly. Actually, it is the most efficient and cost-effective embankment management method under the circumstances (see Box 14).

Besides the cutting of embankments, the operation of regulators plays a part in the management in *haors.* To protect the *boro* crop, the intrusion of flood water needs to be delayed up to half May. In those *haor* FCD systems that have regulators (most do not) this entails closing them in March (either closing vertical lift gates or placing wooden fall boards) prior to when flash floods occur. Ideally, the fall boards should be removed or the lift gates carefully opened sometime in May, when the *boro* crop has been harvested. By opening the regulators in May, water levels inside the *haors* should have sufficient time to rise so that the difference in water levels inside and outside the embankment is small when the submersible embankment overtops during the monsoon floods.

In practice, regulators are not operated in this manner. They are closed in March and opened in November, when river water levels recede to such an extent that drainage of the *haor* becomes possible. The operation of regulators in *haors* does not create conflicts and is fairly straightforward, as all concerned stakeholders agree on the need to protect the *haor* against flash floods and to drain it as soon as possible.

Although *haors* need to be drained as fast as possible in the post-monsoon, contour bundhs between 1 to 1.5 m high and 1 to 3 m wide, locally called *jangal*, are often reconstructed in the protected area to restrict post-monsoon drainage on high land. In Bangladesh, contour bundhs are a water management technology unique to the *haor* area. In Chaptir Haor, 92 contour bundhs with a total length of more than 50 km were found. Through this technology farmers can retain sufficient moisture to make irrigation during the early stage of paddy cultivation unnecessary. Contour bundhs also play an important role in the transport of crops from the fields to the threshing grounds and to the homesteads. Every year the people of Chaptir Haor invest considerable human and material resources to repair and maintain them. (see Duyne, 1998 for a fuller description)

In the *haors* mainly local *boro* varieties are grown in the low land areas and large parts of the medium high land areas are cultivated with HYV *boro*. It is often assumed that the traditional *boro* varieties do not require irrigation. However, both crops need irrigation water. To foresee in this need the *haor* is not completely drained in the post-monsoon. Instead, a significant amount of water is retained in the *khals*, *beels* and *dhobas* (natural ponds) for irrigation purposes. Around these water bodies farmers have built small irrigation systems. Locally, irrigation canals are called *palla*. These canals have a depth of 1-1.5 m, a width of 1-3 m and a length varying between 250 m to 1 km. About 400 *pallas* of various sizes and length were found in Chaptir Haor, irrigating an area of about 2,500 ha (one third of the total area of Chaptir Haor). In some cases *palla* also serve to link *beels* with *dhobas* and *khals*. Along the *pallas* individual farmers dig little pits from where the water is lifted to their field channels with traditional lifting devices, such as the swing boat (*done*). (Duyne, 1998)

While individual farmers do the construction and maintenance of field channels, the *palla* are maintained collectively. Every year the farmers of Chaptir Haor spend hundreds of labour days to re-excavate the palla. All farmers owning land inside the command area of a specific *palla* participate in these yearly maintenance works. There is an informal rule that each farming household should send one person to participate in the re-excavation works for whatever number of days required. The date and volume of work to be done is decided in the context of meetings that are called by elderly and well-respected farmers. (Duyne, 1998)

Another important dimension of water management in *haors* is the use of water for domestic purposes. In general, the inhabitants of *haors* depend on tubewells for drinking water throughout the year. During monsoon the people extensively use surface water of the *haor* for bathing, washing and cooking. In the dry season, however, water for households purposes becomes scarce because the *khals* dry up from January onwards. Therefore, in the dry season people have to depend on hand tubewells for all domestic water needs. The number of tubewells is insufficient, however. A section of the better off households has installed their own tubewells. The people who do not have tubewells have to go to the rivers during the dry season for bathing and washing and to fetch water for drinking and cooking.

In *haors*, the *beels* are very important for open water capture fisheries as a significant section of the community are professional fishermen. Also, elite of the society have a fisheries interest, as they lease the *khals* and *beels in a haor*. Professional fishermen have to make a contract with the leaseholders for catching fish in the *beels* and *khals*. The condition for fishing in the leased *beels* is that the fishermen may keep 12.5% to 50% of the catch and that the remainder goes to the leaseholder. The percentage depends on the amount of fish caught. The catch rate varies throughout the year and is the highest at the end of the monsoon. If there is a good catch, the fishermen have to give a larger percentage to the leaseholders.

There are few conflicts between farmers and fishermen, as the needs of both are similar as far as post-monsoon drainage is concerned. The farmers want to drain the *haor* as fast as possible in December, so that they can plant their boro crop, while leaseholders also want to drain out the *khals* and *beels* at this time for fishing. In Chaptir Haor as well as in Shanir Haor, post-monsoon drainage meetings are held between the leaseholders of *beels* and *khals* and the farmers to decide when and where cuts are to be made in the embankment. During these meetings it is also decided how much water should be retained for irrigation of *boro* and how much should be drained for fishing and planting and agreement is reached on when and how to close the cuts after drainage is completed. In some cases leaseholders have to pay compensation to farmers when the embankment is cut for fishing purposes only. Interestingly, fishermen do not participate in these meetings. Most of them feel that their opinion will not be taken into account as they catch the fish in the *beels* and rivers on a contract basis.

The *haor* agricultural system and the water management it requires is unique in Bangladesh. Water management practices are well established and the current mode of embankment management is the most logical and cost-effective one. The scope for further structural measures is limited, as flood protection during the monsoon is economically unfeasible and the current management of the embankment more or less optimal. Nonetheless, the *haor* agricultural system is coming under increasing pressure, mainly due to a rapidly increasing population density and reduced drainage effectiveness.

4.4.6 The Use of and Control over Water Management Infrastructure

The hydrological conditions and the multitude of water management objectives in FCD systems make water control extremely important. Water control is characterised by two factors, namely the actual use of water management infrastructure on the one hand and control over the infrastructure in the social sense on the other hand. Due to the many water management objectives in a system, infrastructure is used in many, often unforeseen, ways. Also, additional infrastructure is often constructed to fit the system to the requirements of the water users. In the above, a systematic review was given of how the elements of FCD systems are used and managed. The following salient uses of infrastructure, and the water management objectives that come with it, were identified.

In coastal polders, tidal irrigation is often practised, although the regulators are not designed for this purpose. Three types of tidal irrigation can be recognised. The first method is very general and inefficient: water flows freely in and out of a *khal* and enters the fields by gravity or through LLPs. To make this possible, the flap gate on the regulator needs to be forcibly opened. The second method tries to trap the water by means of a flap gate (on the country side) or a cross dam with a wooden lift gate. Again, the flap gate on the river/sea side has to be forcibly opened. An important critical moment is when salinity levels in the *khal* become too high for irrigation. At this time the river/seaside flap gate are usually returned to its automatic operation state. A third method is the constructing of irrigation inlets through the embankment. In a few polders this has been done, with good results.

Cross dams constructed in *khals* for road communication and water retention for LLP, and sometimes gravity, irrigation are important infrastructure created through local initiatives. However, they impede the drainage function of the *khal*, which defines the critical moment: too early placement increases flood damage risk, too late lets precious water escape.

Cutting of embankments is another important water management strategy. In *haors*, and to a lesser extent in other FCD schemes, the cutting of embankments is a very efficient and cost-effective form of water management. In *haors*, the embankments serve to protect against flash floods. An important critical moment is the final date of *boro* planting. Therefore the embankments need to be cut as soon as possible in the post-monsoon to allow the early drainage of the *haor*.

In other FCD schemes cutting of embankments is more contentious. The most common function is to take away drainage problems resulting from the construction of the embankment. Another function, typical for coastal FCD schemes, is to allow the entry of saline water for shrimp and salt culture. This is dangerous because the cuts are made so deep that salt water can also enter at low tide, creating unacceptable flood risks. Lastly, cutting of embankments located on the opposite bank of a river is quite common. The people who do this think that the water levels in the river will be lowered by flooding their neighbour, thereby reducing the flood threat to themselves.

Control over water management infrastructure largely determines who are the winners and losers of a certain intervention. Often a group of people monopolise the operation of a structure to pursue their own interests. The following forms of social control of water management infrastructure were found in the field:

- **people living in the vicinity of a regulator have control over it.** Minor regulators are often controlled by stakeholders (mainly farmers) living near to them. The proximity of the structure and the fellow water users exerts a large social control over the "operators", resulting in few water management conflicts.
- **Salt and shrimp producers** monopolise the operation of minor regulators and additional infrastructure built by them in salt and shrimp areas. They are often well organised and even collect funds for the O&M of the infrastructure (also from paddy farmers). Although conflicts are usually contained, there is often serious resentment among the farmers regarding the operation by the salt/shrimp producers.
- around irrigation infrastructure, be it cross dams or more permanent infrastructure, **committees** have often been formed. Often UP Chairmen are involved, in a problem solving mediating capacity. These committees are sometimes long lasting institutions, which play an important role in local water management.
- some **village leaders**, including UP Chairmen, pursue different objectives which do not always improve the water management in the area. In a number of cases *khals* and *beels* were leased out for fisheries, causing serious harm to other water management objectives.
- **organisations**: apart from the organisations mentioned above, BWDB is officially the most important organisation in the field of water management. Although BWDB is formally in charge of all water management infrastructure, from planning and design to operation and maintenance, in practice operation is clearly controlled by the water users.

How water management is organised in the field strongly depends on the importance a certain water management objective has for the community. People tend to organise themselves to ensure a safe environment (*haors*), or powerful people with a high interest organise the people (salt and shrimp producers, landlords). At the same time, there is always a struggle going on to gain control over infrastructure and hence control over water.

4.5 Conclusions

The above description of water management practices clearly shows that **water management in FCD systems is complex**. It is characterised by many different stakeholders, each with different, often conflicting water management demands. These stakeholders are not passive recipients or victims of water development projects, but active managers of water who have devised ingenious water management strategies, such as the construction of cross dams or cutting of embankments. Nonetheless, the infrastructure of FCD systems has to cater for many, often mutually exclusive, demands. Lastly, the management model used in FCD systems has not been specifically designed to deal with the complexities of water management in FCD systems. Hence, the three elements of a functional WM-System (clear water management objectives, infrastructure capable of realising those objectives and an appropriate management structure with clearly assigned responsibilities) are only partly in place and not properly matched in FCD systems.

It is necessary to rethink water management in the context of FCD systems. The numerous examples of people's initiatives in the management of water resources show that there is a tremendous amount of water management going on in the field. It is clear that BWDB is not involved in water management decision-making, although they are responsible for the operation and maintenance of FCD systems. It was also found that formal project committees, such as sluice committees and water user organisations, were hardly instrumental in the management of FCD systems. "People's participation" takes place through informal organisations and unofficial channels that cut through the official management structure.

The extent to which FCD systems have been re-appropriated by their inhabitants suggests that they largely manage FCD systems in Bangladesh, although officially they are owned and managed by BWDB. Although FCD systems are more or less locally-managed, this does not imply that water management in these systems is optimal. Rather, many struggles over water control take place, which are usually decided in favour of a minority of the stakeholders.

The large role local government representatives, mainly UP Chairmen, and village leaders play in water management in FCD systems, either as mediators or as initiators of new developments, warrants special attention. The role that local governments play in the management of water resources goes back a long way. A good understanding of this history is essential for the formulation of appropriate institutional arrangements for water management in FCD systems. People's participation in water management will necessarily involve people's representatives, especially at the union level, as a basic principle of the delineation of water management responsibilities is the delegation of decision-making power to the lowest level possible.

It is clear that balancing the water requirements of different water management stakeholders in an equitable manner is a difficult task. It is also clear that there is scope for improvements in current water management practices even though FCD systems are already largely "people"-managed. Forums are required for stakeholders to discuss their different water management objectives and requirements and to take decisions on water management scenarios. In general, new and innovative management models for FCD systems need to be developed. In the absence of such forums and appropriate management models, the operation of FCD systems will remain under the control of small powerful groups serving their own interests rather than the interest of the majority. The implications of the water management practices described in this chapter for people's participation and the delineation of water management responsibilities are set out in Chapter 6.

5 CLASSIFYING FLOOD CONTROL AND DRAINAGE SYSTEMS

5.1 Introduction

The types of WM-Systems in Bangladesh vary widely. Each WM-System is unique and possesses its own distinct set of water management challenges. This wide diversity makes it necessary to classify WM-Systems in Bangladesh. In the past, a typical distinction was made between FCD, FCDI, D (Drainage) and I (Irrigation) systems. This classification suggests that there are fundamental differences between these four types of systems. From the foregoing it is clear that this classification is arbitrary and does not reflect the complexity of water management in Bangladesh. Therefore, it is proposed to drop the old classification and to use the term FCD systems to cover all types of agricultural WM-Systems in Bangladesh besides large-scale gravity irrigation systems or small-scale pump irrigation systems.

A new classification of FCD systems from a water management perspective is needed, based on the development phases and water management characteristics of FCD systems. The first necessary distinction is that between FCD systems and "I" systems, but only if "I" is understood to mean large-scale irrigation systems with control over the flow of water from the source to the farm intake. This follows from the main argument of this report, namely that water management in FCD systems is more complex and of a different nature than water management in large-scale irrigation systems.

The question then becomes whether it is necessary to further classify FCD systems. This question is important because of the diversity that exists between FCD systems. Any attempt at improving the management of FCD systems must be based on a clear understanding of the water management issues and challenges a particular type of FCD system faces. A classification of FCD systems from a water management perspective forms the basis for the development of appropriate management strategies.

5.2 A Classification of Flood Control and Drainage Systems in Bangladesh

The classification of WM-Systems in to FCD, FCDI and D systems is a project-based classification. Classifying FCD systems from a water management perspective calls for different criteria and the recognition that a system is fundamentally different from a project. The characteristics of FCD systems and the phases of their development are two powerful criteria that can be used to classify FCD systems.

An important characteristic for classifying FCD systems is the type of flooding they are subjected to. For example, it is possible to classify FCD systems as drainage-only systems, full protection against river floods systems, protection against tidal flooding (coastal polders) systems and protection against flash floods (*haor*) systems. This classification ties in with the four different types of floods in Bangladesh, namely:

- **Rainfall floods** (local flooding): caused by heavy monsoon in FCD systems, which generates runoff volumes in excess of local drainage capacity.

- **River floods** (monsoon floods); characterised by a relatively slow rise of river water levels, a long duration and a large area of inundation.
- **Tidal/coastal flooding**; resulting from tidal surges associated with cyclones and spring tides; and
- **Flash floods**; river floods that rise rapidly and have a short duration. They occur as a result of intensive localised rainfall in the catchment area of the rivers.

The water management issues in these four situations are quite different. However, the type of flooding is only one characteristic. A classification of FCD systems from a water management perspective should also be based on the management intensity levels in FCD systems and their characteristics, such as the type of infrastructure, the water management challenges and the typical conflicts (see Table 7). Applying these characteristics leads to the following classification of FCD systems in Bangladesh, which coincides with the geomorphic areas of Bangladesh (see Figure 14):

Water Management System Type	Symbol on Map	Geomorphic Area
Haor systems	□	Floodplains
Coastal plain polder systems	✡	coastal plain
Deltaic plain polder systems	⊛	deltaic plain
Beel systems	[symbol]	pleistocene terraces/ floodplains
Floodplain systems	O	Floodplains

These five types of FCD systems each face their own set of water management challenges. They are quite distinct form each other and can be readily identified in the field (see Figure 9 through Figure 13 for a typical view of each type). This does not mean, however, that these different types of FCD systems need separate institutional frameworks for their management. What is needed is sensitivity for the diversity in FCD systems and mechanisms for involving all water management stakeholders in their management.

Figure 9 Floodplain System

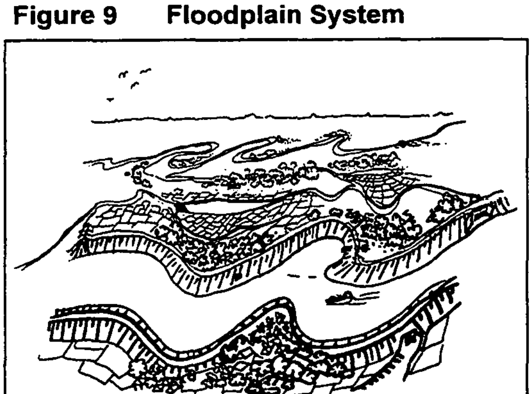
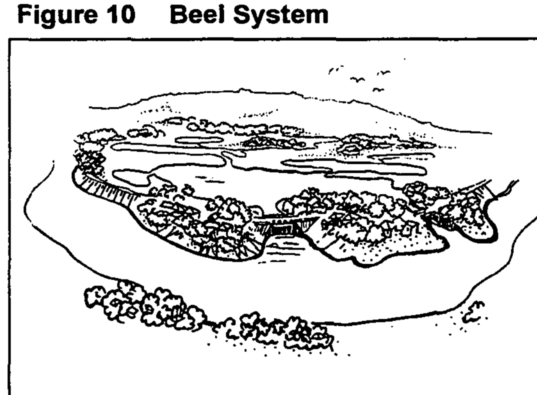


Figure 10 Beel System



The development phase of a FCD system is extremely important for participatory water management. The management of a FCD system becomes increasingly more complex as it passes from phase 1 to 4, as outlined in Section 4.2. Consequently, the need and scope for participatory water management increases. It is very important to note that phase 1 of the development of FCD systems are the unprotected floodplains, including local initiatives to control water. Conceptualising FCD systems to include the unprotected floodplains opens up the larger question of how the floodplains should be managed. In the past, FCD systems were conceived to exist only after the government constructed big embankments and regulators. This report departs from that conception and places the management of the floodplains, in whatever form of development, at the centre of attention. Thus, participatory water management is already very important during phase 1 and it should serve as the starting point for exploring whether a certain area should move on to phase 2 and higher or if it should remain in phase 1. Although phase 4 might seem like the logical end station for the development of the floodplains to many engineers and policymakers, in many cases phase 1 or 2 is more appropriate.
The table of characteristics of FCD systems (see Table 7) can be combined with the development phases of FCD systems, which results in a classification matrix for WM-Systems in Bangladesh. Applying this classification matrix to the WM-Systems covered by the RWMA results in Table 8 (also see Figure 14). This classification matrix is a very powerful tool, because it provides a framework with which all FCD systems in Bangladesh can be classified. Also, it serves as a strong basis for determining which interventions and management intensity levels are necessary in a particular FCD system.

Figure 11 Coastal Plain Polder System

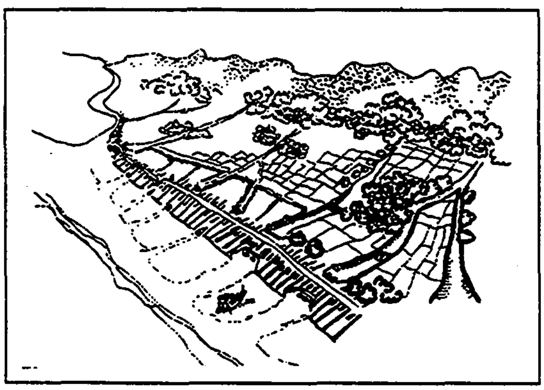


Figure 12 Haor System

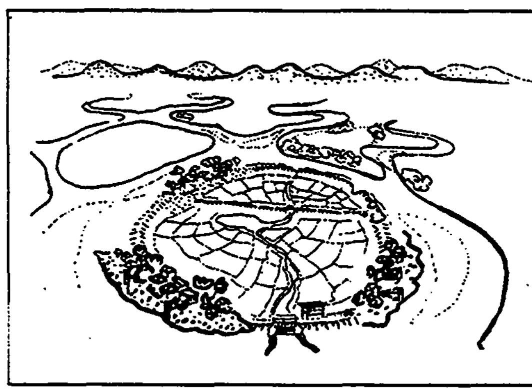


Figure 13 Deltaic Plain Polder System

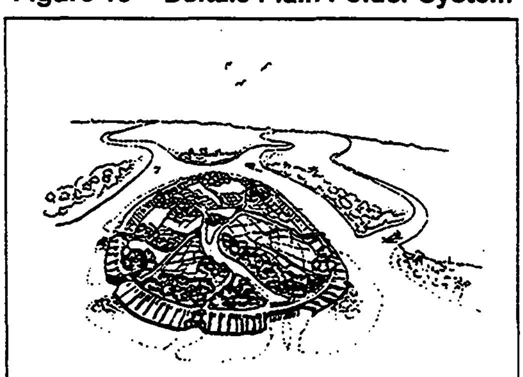


Table 7 Characteristics of Different Types of Water Management Systems in Bangladesh

System / System Elements	Beel System	Floodplain System	Haor System	Coastal Plain Polder System	Deltaic Plain Polder System
Embankment	One main river embankment, and some minor embankments.	One or two main river embankments.	Submersible river embankment around the system.	One main sea-facing embankment, some minor embankments.	Sea-facing and river embankments around the system.
River (exterior)	One, and sometimes, two rivers.	In the middle of a network of rivers (in the floodplains).	Surrounded by rivers.	Sea on one side, *khals* or rivers on one or two other sides	Surrounded completely by rivers and/or the sea.
***Khal* (interior)**	Usually one main *khal* with one outfall.	Many *khals*, parallel to the main rivers, that are old stream beds of the main rivers.	Some, relatively small.	Many, relatively small *khals*, parallel to each other and perpendicular to the shoreline.	Many interconnected *khals*, spider web type.
Beels	Several large *beels* and many small ones.	Few large *beels*, or many small ones.	Some, usually small.	None	None
Structures	One main regulator and some cross dams, few other structures.	Few, would require many structures for optimal management.	Very few. Embankment cutting is the main operational tool.	Many minor regulators, sluices and cross dams.	Many minor regulators, sluices and pipes. One or two main regulators.
Catchment area	High land on two or three sides of the system, results in runoff into the system.	System area and inflow from the floodplains.	System area.	System infrastructure also has to handle runoff from adjacent high lands.	System area.
Main water management constraint	Drainage of internal flooding due to monsoon rains.	River floods.	Flash floods.	Drainage congestion and water retention.	Drainage congestion due to blocking of khals.
Main water management challenge	Operation of the main regulator and management of the *beel*.	Controlling river floods.	Keeping flash floods out until the *boro* is harvested.	Managing salinity levels inside the polder and controlling tidal flooding.	Defining a coherent water conveyance system and controlling tidal flooding.
Typical conflicts	Between *beel* leaseholders and farmers and between high land and low land farmers.	Few conflicts.	Very few conflicts.	Between farmers and salt and shrimp producers. Between upstream and downstream farmers.	Between farmers throughout the system relating to drainage congestion.
Other	Water retention is very important.	Prone to embankment cuts by neighbours. Susceptible to river erosion.	Flooded six months of the year. Homesteads at elevated locations, mostly on river banks.	Salt and shrimp production very important. Prone to cyclone damage.	Salt and shrimp production important in some areas. Navigation very important.

Figure 14 Geomorphic Areas of Bangladesh

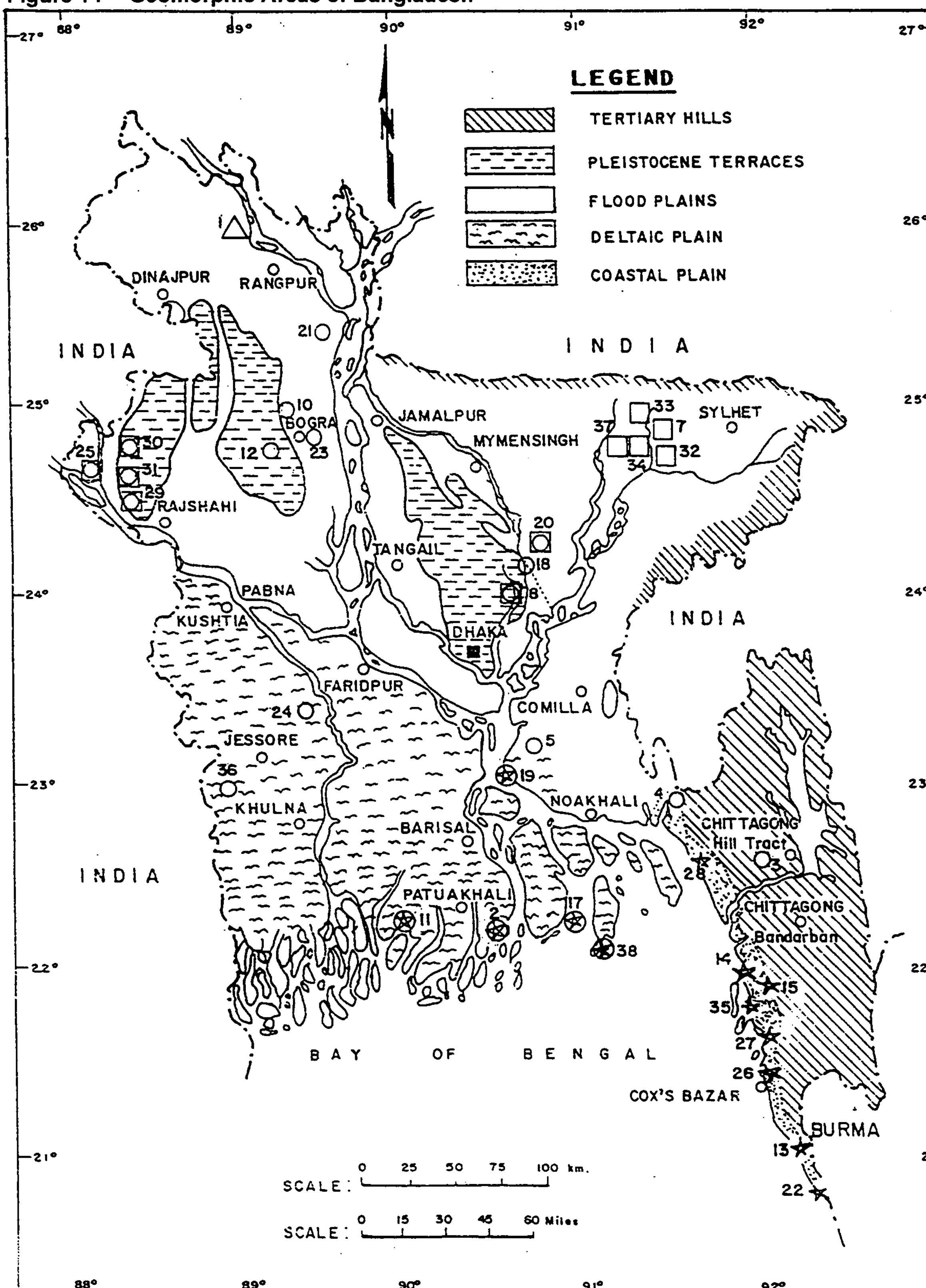


Table 8 A Classification of the Water Management Systems Covered by the RWMA

	Development Phase			
WM-System Type	Phase 1: Unprotected Floodplains	Phase 2: Flood Protection	Phase 3: Reduction of Drainage Congestion	Phase 4: Optimising Water Control
Beel System			Khanchikata Khal [20]	Dardaria Khal [8] Beel Singri [31] Bhitabari Damos [30] Chorai Shomespur [29]
Floodplain System	Gangnai River [10] Ichamati Gazaria [23] Makla Beel [36]	Padma Haor Khal [24]	Kumarnai Bundh [21] Dewankhali Khal [18]	KIP-Ichamati Unit [3] Protappur Irrigation Project [12]
Haor System			Chaptir Haor [32] Shanir Haor [33]	
Coastal Plain Polder System		Polder 66/2 [26]	Polder 61/1 [28] Polder 64/1A [14] Polder 64/1B [15] Polder 64/1C [35] Polder 66/3 [27] Polder 68 [22]	Polder 67 [13]
Deltaic Plain Polder System		Hizla Embankment [19]	Polder 58/3 (Char Faizuddin) [17] Polder 73/2 [38] Polder 39/1 (B&D) [11]	Polder 55/1 [2]
Irrigation System				BTIS [1]

Note: The numbers in brackets refer to the number assigned to a WM-System on the map (see Figure 14).

6 IMPLICATIONS FOR PARTICIPATORY WATER MANAGEMENT

6.1 Introduction

It is widely acknowledged internationally that existing institutional frameworks for the management of water are inappropriate and a major constraint for achieving sustainable and integrated water resources management (Merrey, 1997). This growing recognition has lead to various attempts at reforms in the water sector. Under the influence of neo-liberal policies, many countries are currently implementing **water management transfer** policies. This entails the partial or complete transfer of the management and/or ownership of WM-Systems from government agencies to farmers' organisations or private sector institutions. These policies are widely advocated as a solution to problems of poor water management and inadequate performance. (Geijer, *et al*, 1996)

In Bangladesh, a coherent policy concerning the institutional arrangements required for sustainable water resources management and development is still under debate. In this debate, increasing attention has been given to people's participation. One of the implicit objectives of the first version of the GPP (GoB/MoWR, 1995b) was to transfer some of the responsibilities for O&M to water users. These Guidelines did not, however, indicate the responsibilities of different types of water management stakeholders and organisations and it lacked a clear conception of participatory water management.

The enhancement of effective people's participation in water management is crucial for improving the development and management of FCD systems in Bangladesh. The GoB, BWDB and the donor community accept that this is the core strategy that needs to be followed in reforming the water sector, as is evident from the *Bangladesh Water and Flood Management Strategy*. This policy paper emphasises the need for the creation of an appropriate institutional framework for expanding the participation of stakeholders in the planning, implementation, operation and maintenance of water management infrastructure (GoB/MoWR, 1995a).

This chapter outlines such an institutional framework by focusing on participatory water management and the delineation of water management responsibilities, mainly at the WM-System level. It does so by indicating different types of participation, by defining participatory water management and by formulating principles for the delineation of water management responsibilities. Several options for moving towards participatory water management in FCD systems are presented at the end of this chapter, pulling together all the ideas put forth on participation and delineation and the nature of water management in FCD systems. This chapter provides a point of departure for establishing participatory water management, grounded in a sound understanding of water management in rural Bangladesh, without answering all the questions surrounding participatory water management. We do, however, address the main issues that need to be taken into account when moving towards participatory water management.

6.2 Participatory Water Management

6.2.1 Types of Participation

In recent years, "participation" has been heralded as one of the most vital components of successful development projects. It is widely believed that the participation of people in development projects helps to ensure the sustainability of project outcomes, reduce public expenditure and improve efficiency, equity and standards of service. As a result, the terms "people's participation" and "users participation" have become very popular and many governments, NGOs and donors are placing increased emphasis on participation.

However, the ubiquitous use of the term participation can create confusion, as participation means different things to different people. In many cases, participation has become a hollow phrase deriving from current fashions of political correctness. More often than not, in the context of project interventions by outside agencies, participation is little more than consultation, with no decision-making power left in the hands of the people concerned. Due to the contradictory use of the term participation, it is important to clearly define it. This section indicates who "the people" are whose participation must be ensured, what participation means and why it is important.

Who are "the people"
Discussions on "people's participation" in the context of irrigation and FCD systems usually focus on male farmers. This narrow focus is very dangerous because it only puts the spotlight on one category of people. In development projects in general, and certainly in FCD systems, there is a wide array of **other** stakeholders who strongly influence or are affected by the outcomes of interventions. For this reason, it is important to shift the focus from "people's participation" to **stakeholder participation** -- the participation of all relevant stakeholders in the development process. (Rahnema, 1992; ODA, 1995; World Bank, 1996)

In the context of FCD systems, *water management stakeholders are individuals whose livelihood is directly affected by a FCD system, be it positively or negatively*. Typically, this would include nearly all the inhabitants of a FCD system. The focus on stakeholders is crucial, because it forces one to look at all the "stakes" in a FCD system. It also sensitises one to the fact that different stakeholders have different levels of power, different interests and different resources.

What is Participation
This report endorses the following definition of participation:

> *"Participation is a process through which stakeholders influence and share control over development initiatives and the decisions and resources which affect them." (World Bank, 1996:xi)*

Thus, the key characteristic of participation is the **sharing of power** between stakeholders and development agencies. However, participation can take many forms in the context of water development and management.

Box 15 Types of Participation

1. **Passive Participation:** People participate by being told what is going to happen or has already happened. It is a unilateral announcement by an authority without listening to people's responses. The information being shared belongs only to external professionals.
2. **Participation in Information Giving**: People participate in answering questions posed by researchers using questionnaires or similar methods. People do not have the opportunity to influence proceedings, as the research findings are neither shared nor checked for accuracy with them.
3. **Participation by Consultation**: People participate by being consulted, and external people listen to views. These external professionals define both problems and solutions and may modify these in the light of people's responses. Such a consultative process does not concede any share in decision-making and professionals are under no obligation to take on board people's views.
4. **Participation for Material Incentives**: People participate by providing resources, such as labour, often in return for food or cash. It is very common to see this called participation, although people have no stake in prolonging activities when the incentives end.
5. **Functional Participation**: People participate by forming groups to meet predetermined objectives related to a project. Such involvement does not tend to be at the early stages of project planning, but rather after major decisions have been made. Although these groups often participate in discussions, very little decision-making power or authority is given to them.
6. **Interactive Participation**: People participate in joint analysis and decision-making with external agencies, which leads to action plans and the formation of new local institutions or the strengthening of existing ones. These groups take control over local decisions and they assume a range of responsibilities.
7. **Self-Mobilisation**: People participate by taking initiatives independent of external agencies. They mobilise and organise themselves around commonly felt needs and decide how the resources of their environment should be developed. They develop contacts with external agencies for resources and technical advice, but retain control over how resources are used.

Source: Pretty, *et al*, 1995

A useful distinction of the various types of participation is presented in Box 15. The seven types of participation are listed in order of increasing depth of involvement on the part of stakeholders. They can be regarded as particular forms of participation applicable under certain circumstances, but can also be seen as successive steps towards an increased sharing of power between stakeholders and development agencies. However, the ultimate form of participation - self-mobilisation- is not necessarily the end goal of every endeavour to promote participation. For particular purposes any of the intermediate forms of participation may be preferred. The typology of participation given in Box 15 shows that participation has many manifestations and that it is therefore important to indicate which type of participation one is talking about.

To date, mainly the first four types of participation can be found in the water sector in Bangladesh, although type 7 occurs in the *haors*. During the identification and design of FCD Systems, passive participation and participation in information giving (e.g. during feasibility studies) by inhabitants of an area to be affected by the project are quite common. Off late some projects include consultation rounds with project affected people. Through FFW supported maintenance works people often participate for material incentives. However, participatory processes involving the sharing of power and shared decision-making are still a rarity in Bangladesh.

Although the types of participation listed in Box 15 are all legitimate forms of participation, it is generally accepted that the depth of stakeholder involvement in water development and management needs to be increased. In the context of participatory water management, which entails the participation of water management stakeholders in joint analysis and decision-making with government agencies concerning water management, it is essential to move towards interactive participation. This implies actually handing over responsibilities and decision-making powers to the stakeholders and demands a certain degree of decentralisation.

In this context it is important to distinguish between the interaction between the WM-Agency and the stakeholders on the one hand and between stakeholders among themselves on the other hand. Hence, **interactive participation has two dimensions**. The first dimension requires a formal policy and formal procedures, preferably embedded in law, in which the right, duties and responsibilities of all concerned are clearly spelt out.

The second dimension is much more complex, as rural society in Bangladesh is highly stratified and exhibits large power differentials (see, for example, Wood, 1994; Blair, 1979, 1985; and Ahmad and Jenkins, 1987). Moreover, there is great diversity of stakeholders in FCD systems. While the occupation and location of an individual determines the (kind of) stake each individual has in a FCD system, their position in the existing power structure is ultimately decisive for their actual influence on the water management decisions taken. In many cases this may not be in proportion to their individual interests. Simply enacting a law or issuing guidelines, important as that may be, will not ensure the actual participation of all stakeholders in water management. This requires much more fundamental social change. Nonetheless, any policy or program aimed at achieving participatory water management must take into account the highly stratified nature of rural society and must endeavour to protect the rights of the powerless. The small part, we feel, that participatory water management can play in the creation of a more just society is detailed in Section 6.4.

Why participation is important

The overriding reason for promoting participatory water management, and the institutional arrangements it requires, is to develop sound and sustainable FCD systems. This is necessary because other types of institutional arrangements (such as full government control or private sector management) have not succeeded in this regard. Thus, in essence, participation is a compromise solution between these two extremes. It is hoped that gains in efficiency and the standard of service can be achieved when water management stakeholders participate in the identification, planning, design and management of FCD systems. However, increasing the depth of participation in the water sector can only be realised in the context of:

- supportive national policies;
- a bureaucratic culture that promotes interactions and negotiations between central and local government bodies on the basis of equality;
- project and program designs that are flexible and relatively simple, using existing institutional resources;
- devolved authority to the local level to generate resources, combined with resource commitments by both the stakeholders and the central government;
- parallel efforts to build local capacity to manage these resources; and
- institutional structures that take into account the very stratified nature of rural society in Bangladesh and ensure the rights of the powerless.

If these minimal conditions are met then participatory water management will contribute to attaining the following objectives:

- improving the effectiveness of public investments in the water sector;
- reducing and improving the efficiency of public spending on operation and maintenance in the water sector;
- improving the quality of water management for increased agricultural production and other economic and non-economic activities;
- increasing the security for people and property against flooding; and
- poverty alleviation.

6.2.2 Participatory Water Management

The above discussion on participation serves as a basis for defining participatory water management. In the planning and design phase of a FCD system, participation refers to the right of all water management stakeholders to participate in decision-making processes and to be informed and consulted. Once a FCD system has been constructed participatory water management becomes necessary. Participation in water management refers to the involvement and interactive participation (type 6) of all water management stakeholders in decision-making processes pertaining to the management of a FCD system. In Chapter 2, Improved Water Management (IWM) was defined as:

> *the control of water in a water management system to obtain the objectives of that system, through the adequate* ***operation*** *and* ***maintenance*** *of water management infrastructure on the basis of transparent and systematic procedures for planning, budgeting, implementation and monitoring.*

Combining this definition with the definition of participation, **participatory water management** may be defined as:

> *The control of water in a water management system to obtain the objectives of that system, through adequate operation and maintenance of the water management infrastructure on the basis of transparent and systematic procedures for planning, budgeting, implementation and monitoring and on the basis of decision-making processes in which water management stakeholders are actively involved and have a final say.*

Participatory water management implies the involvement of all water management stakeholders as full partners with government agencies in managing FCD systems. Note that the definition of participatory water management does not indicate the distribution of responsibilities between water management stakeholders and development agencies. Various types of organisational arrangements are possible under participatory water management, in which the role of the state, the private sector and civic society can vary widely. This topic is dealt with in more detail in the following section. The radical difference with state-controlled water resources development and management is that power is shared between stakeholders and development agencies, and that stakeholders can influence and control decision-making processes.

6.3 The Delineation of Water Management Responsibilities

6.3.1 Introduction

For participatory water management to be meaningful and possible, a clear delineation of water management responsibilities between different stakeholders and between stakeholders and the WM-Agency is crucially important. This touches on a fundamental issue, namely the division of responsibilities and decision-making power between the state, the private sector and civic society in the provision of water services. This section sets forth principles for the delineation of water management responsibilities and gives a preliminary outline of the institutional arrangements required to achieve sustainable water management.

A delineation of water management responsibilities needs to take into account several features that characterise water (see Box 16). These characteristics affect the way water is handled by markets and governments and often result in "market failures", i.e. a divergence between the market outcome (without government intervention) and the economically efficient solution. Thus, a strong government presence in the water sector is inevitably required.

Four broad areas of organisational responsibility for water management can be identified: (1) Planning, policy and coordination, (2) Design and construction, (3) Laws and regulation, and (4) Operations management. Governments have put in place a wide array of institutional arrangements to discharge responsibilities in these areas, depending on their political, cultural and administrative norms and practices. Notwithstanding this diversity, the following questions need to be asked concerning these institutional arrangements:

- Does government involvement in each of the four areas mentioned above lead to effective management? If not, what are the priority areas for government involvement?
- Are different organisations responsible for the four areas mentioned above or are line agency functions not separated?
- Are current financing arrangements for capital investments in, and the management of, water services appropriate?

Box 16 Important Characteristics of Water

Water is **a unitary resource**. Rain, surface water and groundwater are all the same resource, although in different manifestations and in different parts of the hydrological cycle. Hence, the uses of water within a river basin or aquifer are interdependent, and actions taken in one part of the basin often have strong impacts elsewhere. These interdependencies can quickly lead to conflicts among users.

Because water activities have many physical interactions within the ecosystem and with other economic activities, they are often characterised by **externalities**. Externalities are the unintended real side effects of one party's actions on another party that is ignored in decisions made by the party causing the effects.

Water's **mobility** makes it difficult to establish enduring and secure water rights that are necessary for efficient market transactions. In addition, the **bulky** nature of water makes it expensive to move significant quantities upstream or outside of river basins.

Most water related **investments** involve large capital investments with long gestation periods. In part, this explains the lack of private investors in the water sector. Also, WM-Systems typically exhibit increasing returns to scale and are therefore prone to natural monopolies. Consequently, without government intervention, there will be under-investment in the water sector and monopoly pricing.

In some uses, water is a **public good**, where one person's use does not decrease nor subtract from its value to others who use the same good (e.g. fishing and navigation). Public goods are not consumed when used, hence they can continue to provide the same benefits to everyone. However, it is difficult to charge for public goods based on individual use.

Sources: World Bank, 1993; 1994.

In the past, many governments assumed central responsibility in all four areas mentioned above. In Bangladesh, for example, the government plans, designs, owns, operates and finances nearly all the water management infrastructure in the country. However, in many countries the roles of the government and the private sector in the provision of infrastructure services are being restructured. In part, this is due to the limited financial and administrative resources of governments. More importantly, however, this restructuring is deemed necessary because the performance of governments in infrastructure provision has been disappointing and is typically plagued by poor maintenance, unresponsiveness to users and bad investments.

At present, the world-wide trend is **decentralisation**: the distribution of responsibilities for decision-making and operations to lower levels of government, financially autonomous public agencies, community organisations, the private sector and NGOs. This entails that central government deals only with the overall policy, regulation, supervision and enabling functions, while local public agencies, local government, private companies, NGOs and user groups can own and manage parts of the water resource system. Thus, the **government remains responsible for establishing the policy, legislative and regulatory frameworks for managing water supply and demand, while the delivery of services is decentralised to the lowest level possible.**

6.3.2 *Principles for the Delineation of Water Management Responsibilities*

The combination of "market failures" and "government failures" in the provision of water management infrastructure and services make it necessary to rethink who should be responsible for what at different levels. Water management can be considered at the national, regional, basin and local levels. At each level, the management of water as an unitary resource requires that there are functional linkages between all the different parties involved. This, in turn, requires a clear delineation of water management responsibilities.

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The delineation of water management responsibilities is **not simply a question of drawing up a list indicating who should operate which structure and who should maintain it**. Rather,

Box 17 Principles for the Delineation of Water Management Responsibilities

- **All water management stakeholders need to participate in, and have an influence on**, the planning, design and management of water management infrastructure.
- Policy/planning, design/construction and regulatory functions need to be separated from operational activities at each level of government, i.e. the **separation of line agency functions** in the water sector is necessary.
- Responsibilities need to be **delegated** to the lowest appropriate level, based on the concept of **subsidiarity**. This entails finding the most appropriate level at which decisions should be taken, while recognising that different types of decisions may need to be taken at different levels.
- Water management infrastructure should be **managed as a service industry** that responds to stakeholders' demands, exhibits transparent decision-making is accountable to the stakeholders.
- Water should be viewed as a scarce resource of a **unitary nature**, to be managed in an integrated manner, to meet economic, social and environmental objectives rather than only as an input for a specific sector (such as agriculture).
- The provision of water and a **water conveyance system** needs to be separated from the provision of **flood protection services**.

the delineation of water management responsibilities touches on the fundamental issue of the distribution of decision-making power between the public sector, the private sector and civic society and the linkages between them. For the water sector in Bangladesh this has far-reaching consequences, as the government has been solely responsible for water development to date (although, as was shown in Chapter 4, people in rural Bangladesh are actively involved in water management and have undertaken many water development efforts on their own). To focus the discussion on the appropriate institutional arrangements for the water sector in Bangladesh it is necessary to reach agreement on principles for the delineation of water management responsibilities. Based on international experiences, six fundamental principles can be identified that need to be followed in assigning responsibilities for the management of water (see Box 17).

These six principles are a necessary foundation for sustainable water management. They should apply whether water management infrastructure and services are provided by the public sector, the private sector or by a public-private partnership. To move towards sustainable water management and to arrive at a delineation of water management responsibilities in FCD systems in Bangladesh, these six principles need to be applied. The starting point is the acknowledgement that FCD systems provide a public service. For public service provision several management models exist: government owned and managed, public utility, private enterprise and user self-management (see Table 9). Which management model is applicable to water management in FCD systems?

Table 9 Management Models for Public Services Provision

Model Characteristics	Government Managed	Public Utility	Private Enterprise	User Self-Management
Payment	No direct payment by users.	Users pay in proportion to their usage (intricate billing system), with effective measures against defaulters.	Users pay actual costs and a profit margin. Effective punitive measures against defaulters.	Users pay partly in proportion to the services and partly as a membership fee.
Budget	Quality of service suffers during budget constraints.	Revenue collected remains in the utility.	Revenu collected remains in the enterprise.	Revenues stay within the group.
Maintenance and Operation	Government fully responsible for maintenance and operation.	Utility owns, maintains and operates the facilities.	Enterprise owns, maintains and operates the facilities.	Users own, maintain and operate the facilities.
Users	Free use for all.	Use of facility only by those who apply and pay.	Use of facility only by those who pay.	Relative small group with high level of social control.
Management Control	Users only have say in management through political representation.	Under state control, public has a say through political representation.	Users have no say in management.	Users have sole decision making power.
Examples	Roads network.	Gas, electricity, water, telephone.	Airlines, security guard.	School, club, cooperative.

World-wide experience shows that public services are best provided by autonomous agencies organised as public utilities and run along commercial lines. This implies that these agencies have focused and explicit performance objectives, well-defined budgets based on revenues from users and matching government funds, and managerial and financial autonomy. Public utilities are mandated by the government and can be held accountable through performance agreements and management contracts.

To date, the government manages FCD systems in Bangladesh. This has not yielded the expected results. However, if one wants to move towards sustainable water management, it is not so clear which of the other three management models is appropriate. In the context of FCD systems there are large practical problems with the Public Utility Model, as well as with the Private Enterprise Model, especially pertaining to the impossibility of excluding users and the difficulties with payment. The User Self-Management in its pure form is also not suitable. Bangladesh has opted for a mixture of these models for the management of FCD systems, which is termed **participatory water management**. What this entails is outlined in the next section.

6.4 Moving Towards Participatory Water Management in Flood Control and Drainage Systems

6.4.1 Introduction

The Minister of Water Resources, Mr. Adbur Razzaq, accurately summed up the main challenge facing the water sector in Bangladesh when he stated:

> *"While the imperative for participation is well understood by all concerned, the mechanisms for getting it on a sustainable basis is not yet clearly defined." (SRP, 1998a)*

This section addresses precisely that issue by pulling together all the strands of this report. Based on the definition of participatory water management and the water management practices described in Chapter 4, the need for participatory water management in FCD systems is underlined. This section then goes on to present a broad outline of the institutional arrangements needed for participatory water management in FCD systems, taking into account, amongst others, the classification of FCD systems, the power structure of rural society and the nature of water management in FCD systems.

We contend that any organisation that wishes to establish participatory water management in FCD systems, be it government, donor or NGO, needs to underwrite the premises presented in Box 18 (in addition to the basic principles for the delineation of water management responsibilities). More importantly, **how** these premises will be translated into practice needs to be indicated. In this section we present our version of how true participatory water management may be realised in FCD systems, by defining the mechanisms for getting participation on a sustainable basis.

Box 18 Basic Premises of Participatory Water Management

- FCD systems are the most common type of WM-System in Bangladesh; hence it is essential to focus on achieving participatory water management in FCD systems.
- The scope for the construction of new FCD systems is very limited and therefor the focus needs to be on the management of existing FCD systems.
- It is not a matter of how the people can participate, but rather how government should participate in the management of FCD systems
- Decentralisation of decision-making powers, transparent procedures and lateral accountability are fundamental for effective participation.
- It is neither effective nor desirable to set up formal and elaborate organisations exclusively for people's participation in water management; the institutional framework for participatory water management needs to build on existing organisational practices.

The crucial question is how.

6.4.2 The Need for Participatory Water Management in Flood Control and Drainage Systems

As became apparent in Chapter 4, FCD systems are not managed in a participatory manner at present, although they are more or less "people"-managed. Decisions regarding both operation and maintenance are not taken based on transparent and systematic procedures and there is no formal accountability to the users. The planning, design and implementation of FCD systems has largely been carried out by BWDB with little involvement of water management stakeholders. At most, participation in information giving (type 2) or participation for material incentives (type 4) has taken place. Similarly, maintenance is controlled by the state. However, the financial and human resources of BWDB are insufficient to manage FCD systems efficiently and effectively. Due to resource constraints at the central government level and other factors, this situation is not likely to change. Therefore, new institutional arrangements are required to improve the management and performance of FCD systems.

Participatory management is an essential prerequisite for improving the performance of FCD systems. Precisely because there is so much water management going on in FCD systems and there are so many local initiatives to control water, participatory water management is needed to coordinate all the different water management objectives. The need for participatory water management in FCD systems becomes starkly clear if the following questions are answered:

- Who are the water management stakeholders in FCD systems?
- What is there to be managed?, and
- What types of institutional arrangements are needed for the management of FCD systems?

Many different categories of water management stakeholders were identified in Chapter 4 (see

Table 3). There are numerous conflicts between these different categories, for example between high land and low land farmers. The occurrence of these conflicts points to a need for collective decision-making for optimising the balance between benefits and damages. This is not assured in the current organisational set-up.

In FCD systems, there is much that needs to be managed. Participatory water management entails the participation of government agencies, as partners of water management stakeholders, in the management of FCD systems. This consists of joint and transparent decision-making in various tasks, such as:

- **Operation planning**: decision-making regarding the operation of the system;
- **Maintenance planning**: decision-making the maintenance of the system;
- **Resource mobilisation**: decision-making on how and which resources are to be used, the sharing of burdens; and
- **Implementation and monitoring**: decision-making on who will implement and monitor the above.

Most importantly, participatory water management is instrumental for identifying and clarifying water management conflicts and attempting to reach a consensus on an optimal water management scenario for all parties. At times, these conflicts might be the result of mutually exclusive water management objectives, resulting in losers no matter which scenario is chosen. Reaching an understanding on the most desirable water management scenario is only possible if those directly involved in the conflicts are part of the decision-making process.

The types of institutional arrangements needed for the management of FCD systems is a difficult issue, because it is inherently political in nature. Moreover, it is a difficult issue because the model of "water users' organisations" as proposed in the first version of the GPP, and as is common in many irrigation systems, has proven to be dysfunctional and ineffective in the context of FCD systems. The efforts under SRP to implement the provisions of the first version of the GPP, from 1994 to 1997, did not lead to a sustainable improvement of water management in FCD systems. Besides institutional constraints, this was mainly due to the inappropriate nature of the participatory framework set out in the GPP (see SRP, 1997 and Soussan and Datta, 1998).

The principle of a "users' organisation" is that people organise themselves to pursue a common goal, which can only be achieved by interacting with each other. Concerning the basis for organisation in FCD systems, and the gains to be had from organising, the following can be remarked:

- Interests with regard to water levels to be maintained are very conflictive between farmers and between farmers and other stakeholders;
- The extent of benefits strongly vary from one place to the other and differ among stakeholders from greatly benefited to greatly dis-benefited;
- FCD systems cater to very diverse interests; and
- FCD systems are partially a collective good. This means that excluding people from benefiting is difficult and that "free rider" behaviour cannot be prevented.

In view of the above, the water users' organisation model as developed for irrigation systems does not mesh with the water management requirements in FCD systems. Thus, although there is a real need and scope for participatory water management in FCD systems, the institutional arrangements that will ensure this still need to be developed.

6.4.3 Institutionalising Local Participation

To answer the need for participatory water management in FCD systems, an institutional framework is needed in which the roles, tasks, responsibilities and rights of all concerned parties are clearly defined. Naturally, this framework should be based on the nature of water management in FCD systems. The material contained in this report can be summarised in several implications for participatory water management (see Box 19). These implications were extensively discussed with senior government officials, key donor officials, directors of NGOs, senior academics, consultants and policy advisors active in the water sector in Bangladesh at a National Conference on Participatory Water Management held on 18 December 1997 in Dhaka (see SRP, 1998a). The participants agreed that these implications should serve as the building blocks for an institutional framework for participatory water management. This section presents an outline of the institutional arrangements needed for participatory water management in FCD systems, based on these implications and the other considerations mentioned in this report.

The gist of these implications is that the institutional arrangements for participatory water management should focus on the management of FCD systems and build on existing organisational practices. To make this more concrete, it is essential to distinguish between the flood protection function and the water conveyance function of FCD systems and between the O&M Cycle and the Project Cycle.

FCD systems consist of two clearly distinguishable components, namely the flood protection component (embankments) and the water conveyance component (*khals* and canals with water control structures). The term Water Management Block (WM-Block) is introduced here to refer to an independent unit of the water conveyance system (usually a *khal* with its associated regulator) in a FCD system. A typical FCD system is built up of a number of WM-Blocks. The stakeholders in a WM-Block can be identified fairly easily, and their (dis-)benefits reasonably well assessed.

The flood protection component encompasses all the WM-Blocks and other protected areas. Stakeholders with contradicting stakes in the water conveyance system may benefit equally from the flood protection system, or people not having any stake at all in the water conveyance system may greatly benefit from the flood protection system. Hence, the management structure for the flood protection function needs to be different from that for the water conveyance function.

Besides the difference between the flood protection function and the water conveyance function, it is important to bear in mind that FCD systems are permanently in a stage of operation and maintenance, also before any government intervention takes place in them. Operation and maintenance in FCD systems consists of recurring activities on an annual or seasonal basis, which we term the O&M Cycle. It is this O&M Cycle, i.e. the management of FCD systems, that should be the foundation of institutional arrangements for participatory water management.

Box 19 Implications for Participatory Water Management

FCD systems not only affect agriculture. All people, regardless of their gender, occupation or socio-economic status are legitimate stakeholders in FCD systems. Moreover, water management is closely linked to all aspects of the rural livelihood system and many formal and informal organisations are already in place that deal with water management.

- **Implication 1**: It is preferable to invest in existing organisations and to make them work better, rather than establishing completely new organisations. Locally Elected Bodies have the legitimacy and can most effectively represent the water management interests of the people in FCD systems. The Thana Development Coordinating Committee (TDCC) should remain the sole body responsible for coordinating all government activities in a FCD system, strongly supported by the WM-Agency.

People in rural Bangladesh have the technical, material and organisational capacity to make substantive contributions to the planning, implementation and management of FCD systems.

- **Implication 2**: Local resources should be mobilised, but full control over them has to remain with the stakeholders; control and decision-making over the allocation of government resources has to be shared between stakeholders and the WM-Agency.

People in rural Bangladesh have proven capabilities to manage FCD infrastructure. Most commonly they rely on relatively simple, temporary, local-level organisational practices. When the interest of several villages are at stake, or in case of conflicts, local informal leaders or the Union Parishads play a key role in their resolution.

- **Implication 3**: The institutional framework for participatory water management needs to build on effective and time-tested organisational practices, implying that formal organisations at the WM-Block level are not necessary.

Water management is a continuous and permanent process undertaken by people. Projects are temporary interventions in this process.

- **Implication 4**: The institutional framework for participatory water management should focus on the management of FCD systems, with the same institutions playing a key role in the various phases of the Project Cycle.

FCD systems need innovative management structures, because they are different from irrigation systems and pose complex water management challenges. Moreover, FCD systems and infrastructure are a public good. This demands an active role of government in their management and precludes fully handing them over to WM stakeholders.

- **Implication 5**: The management structure of a FCD system should reflect the difference between the flood protection function and the water conveyance function of a FCD system. The management of the flood protection function should be the joint responsibility of the WM-Agency and the WM-System Committee. The stakeholders should be responsible for the water conveyance function at the WM-Block level. The WM-Agency should play an advisory role at the WM-Block level by preparing Operation Plans and Maintenance Plans, in consultation with the stakeholders.

Box 20 Implications for Participatory Water Management (cont.)

Effective participation in water management requires transparent procedures, lateral accountability and local control over resources.

- **Implication 6**: In water management planning and project formulation participatory appraisals should be mandatory. Throughout implementation the formal approval of stakeholders has to be obtained for all critical decisions.

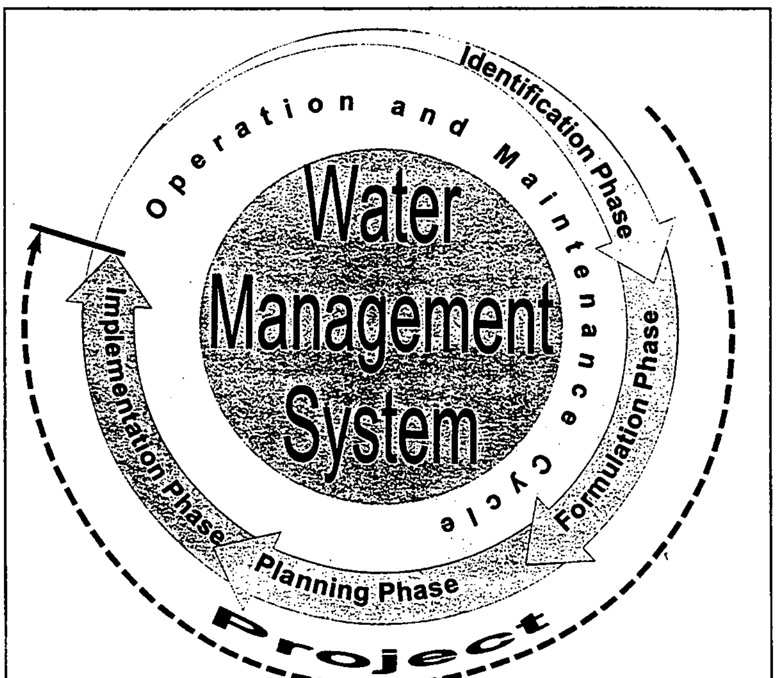
The hierarchical organisation, centralised decision-making and vertical accountability typical for government agencies thwarts effective participation of these agencies in water management.

- **Implication 7**: Full responsibility for the WM-Agency's involvement in the management of a FCD system has to be delegated to its representatives at the system level. Except for overly technical issues, they should be answerable to the WM-System Committee.

Either formally or informally, the O&M Cycle consists of the following sequence of activities concerning O&M: Needs Assessment, Planning, Implementation and Monitoring and Evaluation. Through this process constraints for the preferred mode of operation are identified. At a certain moment such water management constraints cannot be resolved through normal maintenance. This is the start of the Project Cycle. Taken together, the O&M Cycle and the Project Cycle constitute the Water Management Cycle (WM-Cycle) of FCD systems (see Figure 15).

Note that the Project Cycle emanates from the O&M Cycle. The process of identifying water management constraints does not have a clear starting point in time. Usually there is a gradual recognition among stakeholders of an increasing inability of the system infrastructure to satisfy their water management demands. In first instance these constraints are felt by those using or those affected by (the prevailing use of) the system's infrastructure. After being identified as such, these constraints find their way through formal and/or informal channels to the WM-Agency. At a certain point in time a decision needs to be taken to seek solutions for these constraints. A project is then formulated in broad lines and proposed. After the necessary approvals and financial resources have been obtained this is followed by the actual implementation of the project. The resulting rehabilitated or newly constructed infrastructure is added to the inventory of the FCD system for subsequent operation and maintenance and thus becomes part of the O&M Cycle.

Figure 15 The WM-Cycle



In summary, any institutional framework delineating the tasks, roles and responsibilities of the stakeholders and the WM-Agency needs to fully acknowledge and address the nature of water management in FCD systems. In particular, the institutional framework needs to:

- allow for the separate management of the *flood protection function* and the *water conveyance function*;
- have as its foundation the WM Cycle, i.e. the management of FCD systems, of which the O&M Cycle and the Project Cycle are integral parts;
- allow for changing roles to be played by the WM-Agency and the stakeholders while the FCD system evolves to maturity; and
- build on existing organisational practices.

Based on these considerations, the institutional framework for participatory water management presented in Table 10 is put forward. This framework makes maximum use of existing organisations by assigning them additional roles, rights and duties concerning participatory water management. Also, three new organisations are proposed, namely the WM-System Committee, WM-Block Leaders and the WM-Block Meetings. Due to their centrality in participatory water management more attention is given to them below.

The water conveyance component of a FCD system usually consists of many, largely independent, units (WM-Blocks). Concerning the management structure of FCD systems, it is proposed to have a WM-System Committee at system level and WM-Block Leaders at Block level. The WM-System Committee would be responsible for the flood protection function of the FCD system, while the Block Leaders would be responsible for the water conveyance function.

A WM-System Committee is a standing committee composed of the Chairmen of those Union Parishads (UPs) of which a significant portion (10% or more) of the inhabitants are affected by the FCD system or its management. UP Chairman are the democratically elected representatives of the inhabitants of an area and as such, in principle, represent the interests of all the stakeholders. Through the WM-System Committee the stakeholders participate indirectly, through representation, in all policy decisions regarding the FCD system.

As the WM-System Committees has the status of a standing committee of Union Parishads all proceedings, procedures, decision-making, etc. should be in compliance with and subject to the relevant Act(s) of Parliament on Local Government and the Rules, Regulations and Administrative Orders with regard to Parishad committees. This implies, amongst others, that WM-System Committees may (be requested to and) decide to co-opt others onto the WM-Committee as full-time or as ad-hoc members with full, limited or without the right to vote. Also, the members of the WM-System Committee may decide on the procedure for appointment and tenure of the person to chair the committee.

The WM-System Committee plays an important role in system operation, system maintenance and the identification of system constraints. In system operation, the WM-System Committee is the guardian of the interests of all the stakeholders in a FCD system and the representative body for all these stakeholders. The committee mediates and arbitrates in water management conflicts between adjacent WM-Blocks and guards against operation of WM-Blocks in a manner that adversely affects neighbouring WM-Blocks. Most importantly, the WM-System committee safeguards and is the custodian of the flood protection function of a FCD system.

In system maintenance the WM-System Committee is the coordinating and policy making body. In identification of system constraints the WM-System Committee is the representative body of the stakeholders and the coordinating body for receiving and forwarding reports on water management constraints. The interested reader is referred to SRP, 1998b for a full exposition on the rights, roles, tasks and responsibilities of the WM-System Committee.

A WM-Block Leader is a person appointed by the Annual Meeting of the stakeholders in a WM-Block and is charged with implementing the Operation and Maintenance Plans adopted by the Annual Meeting. The Block Leader liaises between the stakeholders, the WM-Agency and the WM-System Committee. More than one person may be appointed as Block Leader. The composition as well as the procedure for the (s)election of the Block Leadership will be decided by the stakeholders concerned in a manner acceptable to those stakeholders. As the tasks of Block Leaders may be quite demanding it is not unreasonable for the Block Leader(ship) to receive a remuneration for their services.

In system operation and system maintenance the Block Leaders are the implementers. They carry out the operational activities in the WM-Block based on the agreed Annual Operation Plan and collect the necessary monitoring data. They also oversee the implementation of the annual Maintenance Plan in the WM-Block. Concerning the identification of system constraints the role of the Block Leaders is manifold. They will usually be the first to be informed about constraints by the stakeholders or they identify constraints themselves. After an initial assessment Block Leaders may either solve the constraint by mediating between stakeholders, or through the introduction of slight modifications in operation schedules with the consent of all affected stakeholders. If this is not possible the Block Leader forwards the issue to the WM-Agency and the WM-System Committee and collects and provides all relevant information required by the WM-System Committee for deciding on the approach to solve the constraint. The interested reader is once again referred to SRP, 1998b for a full exposition on the rights, roles, tasks and responsibilities of the Block Leader.

The third important element in the participatory water management of FCD systems is the WM-Block Meetings. These meetings, besides being a formal gathering of all the stakeholders of a particular WM-Block, are the decision-making forums with respect to water management in a WM-Block. It is through the WM-Block Meeting that the stakeholders can directly participate in decision-making regarding water management. The stakeholders may participate collectively, through delegation or through representation.

A minimum of one WM-Block Meeting is held each year. All WM-Block Meetings are convened by the WM-System Committee to discuss and decide on water management issues concerning the WM-Block. Any concerned party, such as stakeholders, the WM-Agency, other government agencies or NGOs may forward a motivated request to the WM-System Committee for convening a WM-Block Meeting.

Table 10 Institutional Framework for Participatory Water Management

Elements of the WM-Cycle	Key Participants	Primary Role and Responsibilities
System Operation ◆ Operation Planning	WM-Agency	Service provider and advisory body. Preparation of Annual Operation Plan. Monitoring and Evaluation of Operation. Maintaining transparent accounts and documentation on all activities undertaken by the WM-Agency for system operation.
◆ Implementation of Operation Plan	TDCC/DDCC	Coordinate and reinforce the various activities of government agencies in systems operation, ensuring that they do not conflict or adversely affect each other.
◆ Monitoring and Evaluation of System Operation	Union Parishad Chairman	Representative and leader. Ensure that the final Annual Operation plan takes into consideration all stakes in a WM-Block. Ensure that the WM-Block Leader is appointed in a manner that meets the approval of the majority of stakeholders.
	Gram Parishad Chairman	Representative and leader. Make public announcements of upcoming WM-Block Meetings. Arrange a public meeting prior to a WM-Block Meeting to decide on the modality of attending the meeting.
	WM-System Committee	Guardian of the interest of all the stakeholders and representative body. Safeguard the flood protection infrastructure. Convene WM-Block Meetings. Perform annual audits of the financial and technical input by the WM-Agency.
	Stakeholders	Primary beneficiary or adversely affected. Adherence to the agreed operation schedules and safeguarding against unauthorised operation practices. Provide agreed share of resources for communal actions.
	WM-Block Meeting	Decision-making body of stakeholders. Reach agreement on the Annual Operation Plan and its implementation. Identifying all necessary resources for operation activities. Appointing the person(s) charged with the implementation of the Operation Plan.
	WM-Block Leaders	Implementation of the Annual Operation Plan. Collection and recording of monitoring data on system operation.
System Maintenance ● Inventory and Assessment of Maintenance Needs	WM-Agency	Provide technical assistance and maintain crucial infrastructure. Prepare Annual Maintenance Plans in consultation with WM-System Committee, WM-Block Leaders and stakeholders and present to Annual WM-Block Meetings. Incorporate changes in final Maintenance Plan and distribute to WM-System Committee and WM-Block Leaders.

♦ Maintenance Planning and Budgeting • Implementation of Maintenance Works	TDCC/DDCC	Coordinate and reinforce the various activities of government agencies in systems maintenance, ensuring that they do not conflict or adversely affect each other.
	Union Parishad Chairman	Representative and leader. Ensures that the final Annual Maintenance Plan takes into consideration all stakes in a WM-Block.
	Gram Parishad Chairman	Representative and leader. Make public announcements of upcoming WM-Block Meetings and agenda. Ensure fair contributions by individual stakeholders for communal actions.
	WM-System Committee	Coordinating and policy-making body and custodian of the flood protection function. Maintenance of the flood protection infrastructure. Convening WM-Block Meetings. Perform annual audits of the financial and technical input by the WM-Agency.
	Stakeholders	System user and monitor. Carry out maintenance tasks as agreed by the WM-Block Meeting. Report to the Block Leader any unacceptable practices with regard to ongoing maintenance works. Provide agreed share of resources for communal actions.
	WM-Block Meeting	Decision-making body of stakeholders regarding system maintenance. Reach agreement on the Annual Maintenance Plan and its implementation. Identify all necessary resources for maintenance activities.
	WM-Block Leaders	Collect data on the maintenance condition of all WM-Infrastructure in the WM-Block and submit to WM-Agency for preparation of the Maintenance Plan. Report any unforeseen damage or unexpected deterioration of WM-Infrastructure to the WM-Agency, WM-System Committee and others.
Identification of System Constraints ♦ Identification of Water Management Constraints	WM-Agency	Technical advisor and coordinator. Maintain updated records on system constraints and prepare recommendations for the WM-System Committee, indicating whether a project needs to be formulated.
• Reporting and Recording Water Management Constraints	Other Government Agencies	Technical advisor and stakeholder if constraints fall in the realm of their mandate. Report system constraints to the TDCC/DDCC and provide technical assistance to the WM-Agency where needed.
♦ Inventory and Analysis of Water Management Constraints	TDCC/DDCC	Forum for discussion and coordination between various government agencies. Ensure that proposed solutions to constraints do not in turn cause constraints for other agencies.

	Parishads and Parishad Chairmen	Representative of the stakeholders and mediator. Responsible for the adequate treatment of all constraints reported to them by stakeholders of Block Leaders.
	WM-System Committee	Representative body of all stakeholders and coordinating body for receiving and forwarding reports on system constraints. Decide on which steps need to be taken.
	Stakeholders	Discuss and report system constraints, while taking all possible actions within their capacity to alleviate constraints.
	WM-Block Meeting	Decision-making body. Take into account all stakes when deciding on remedial actions and ensure that all reported constraints are resolved in a befitting manner.
	WM-Block Leaders	Identifiers of system constraints. Hold discussions among stakeholders on observed constraints. Report unresolved constraints to WM-Agency and WM-System Committee.
Project Formulation ◆ Preliminary Needs Assessment ◆ Preliminary Design ◆ Preliminary Impact Assessment ◆ Pre-Feasibility Study	WM-Agency	Implementing and coordinating agency. Field a planning team and plan and implement the project formulation process, assuring a high standard in needs assessment, preliminary designs and impact assessments.
	Other government agencies	Contribution of specialised know-how to the project formulation process.
	Planning Team	The pivot in project formulation, responsible for carrying out all the actual work.
	TDCC/DDCC	Local planning organisation. Dissemination of all relevant information on the project to the various government agencies and coordination.
	Parishads and Parishad Chairmen	Important source of information for needs assessment. Ensure that teams conducting needs assessments are brought in contact with all relevant stakeholders.
	Project Committee	Formal body representing the interests of the stakeholders. Convey the opinions and demands of the stakeholders to the Planning Team and the TDCC/DDCC.
	Stakeholders	Main source of information.
	NGOs	Facilitator for participatory processes. Raise awareness among stakeholders on their entitlements
Project Planning ◆ Institutionalisation of Stakeholder Participation ◆ Needs Assessment Study	WM-Agency	Implementing and coordinating agency, responsible for fielding a planning team and ensuring the quality of the needs assessment studies, Rapid Water Management Appraisals, detailed designs and impact assessment studies.
	Other Government Agencies	Contribution of specialised know-how to the project planning process.

♦ Rapid Water Management Appraisal Study	Planning Team	The pivot in project planning, responsible for executing or supervising needs assessment studies, Rapid Water Management Appraisals, detailed designs, impact assessment studies and the preparation of feasibility study reports.
♦ Impact Assessment Studies	TDCC/DDCC	Local planning organisation. Ensure that the project is in line with the overall development objectives of the area and disseminate relevant information to the various government agencies. Coordinate activities by various agencies in connection with the project.
♦ Detailed Design	Parishads and Parishad Chairmen	Important source of information. Ensure that teams conducting needs assessments and appraisals are brought in contact with all relevant stakeholders.
♦ Feasibility Study	Project Committee	Formal body representing the interests of the stakeholders. Organise WM-Block Meetings for approval of project designs at designs and 1Xlity studies.
	Stakeholders	Main source of information.
	WM-Block Meeting	Final decision-making body. Responsible for discussing the designs, financing, implementation and work plan with the WM-Agency and for giving final approval to the project.
	NGOs	Facilitator for participatory processes.
Project Implementation ♦ Generation and Mobilisation of Resources	WM-Agency	In charge of project implementation. Mobilisation of government and other resources. Tendering of works in accordance with laid down rules and regulations. Implementation of the works and preparatory activities. Ensure high quality of work and maintain records on progress, quality and accounts.
♦ Execution of Works	Parishads and Parishad Chairmen	In charge of local resources for project implementation. Organise and manage the works to be carried out by the stakeholders. Arrange rights of passage for contractors during execution of works.
♦ Supervision of the Works	Project Committee	Represent and protect the interests of the stakeholders in project implementation. Obtain and verify relevant data on the execution of works in order to (dis)-approve payments to contractors. Liaise with other government agencies through the TDCC/DDCC.
♦ Monitoring of the Works	Stakeholders	Provide resources and carry out works as agreed. Monitor the works being executed by third parties.
	WM-Block Leaders	Monitor the execution of works and forward reports of violations of contract. Organise the execution of works by stakeholders.

A minimum of one WM-Block Meeting is held each year. All WM-Block Meetings are convened by the WM-System Committee to discuss and decide on water management issues concerning the WM-Block. Any concerned party, such as stakeholders, the WM-Agency, other government agencies or NGOs may forward a motivated request to the WM-System Committee for convening a WM-Block Meeting.

A special WM-Block Meeting is the Annual WM-Block Meeting. The Annual WM-Block Meeting discusses and decides on the Annual Operation Plan and the Annual Maintenance Plan. It also decides on the composition, the tenure and the procedure for the (s)election of the Block Leadership. The initiative to hold the Annual WM-Block Meeting is taken by the WM-Agency, who informs the WM-System Committee that the draft Annual Operation and Maintenance Plans are completed and requests the WM-System Committee to convene the Annual WM-Block Meeting.

Based on a presentation by the WM-Agency of a concept Annual Operation Plan, an overview of maintenance requirements with cost estimates and an overview of the available funds for operation and maintenance, the Annual WM-Block Meeting will take decisions on the following (see SRP, 1998b for full details):

- **The final Annual Operation Plan**: After discussing and amending the concept Annual Operation Plan the Annual WM-Block Meeting will define the Annual Operation Plan for the up-coming year.
- **Allocation of available resources for operation and maintenance**: The Annual WM-Block Meeting will decide how and for which operation activities and maintenance works the funds allocated by the Central and Local Governments will be utilised and how the remaining requirements will be satisfied by using the stakeholders' resources.
- **The maintenance work plan**: Taking into account the constraints of all concerned a realistic work plan will be agreed on by the Annual WM-Block Meeting.
- **Appointment of the Block Leader(ship)**: The Annual WM-Block Meeting will (s)elect, the Block Leader(ship) for the next year.

The outline of the institutional arrangements for participatory water management presented above indicates how stakeholders and the WM-Agency may jointly develop and manage FCD systems. However, the appropriate representation of the stakeholders is only one aspect of participatory water management. Equally important are the institutional implications for the agency charged with facilitating participatory water management. As the participatory processes in water management take place at the WM-System and WM-Block level, the representatives of the agency at those levels need to be given sufficient mandate to effectively participate. Participatory water management will only be successful when decisions are truly made jointly, which implies that:

- a fair proportion of decision-making power needs to be handed to the stakeholders;
- decision-making power within the agency needs to be delegated to the level where the interface of participation takes place (thus to the system level); and
- transparency of operations, access to information and accountability to the system stakeholders needs to be assured.

Thus, there is a strong need for a continued government presence at the FCD system level, in the form of a pro-active WM-Agency. Turning over all responsibilities to the people will not solve the government's problems with the maintenance of water management infrastructure. Although more decentralisation of control and authority over the water sector to the local level is essential, people and local level institutions will continue to need professional, material and technical assistance.

Hence, a new mandate and structure for the BWDB is needed, which will enable it to be a partner for water management stakeholders. It should act as a technical support agency to the stakeholders, while at the same time retaining direct responsibility for the real-time management of water resources and water management infrastructure at the local and regional levels. A withdrawal of the BWDB from the field level would be disastrous for water management in Bangladesh. Rather, what is needed is a partnership between the WM-Agency and the water management stakeholders. Consequently, the BWDB will need to delegate decision-making powers to lower levels in the hierarchy, in particular to the FCD system level. At the same time, the agency's procedures will need to be made transparent and open for scrutiny by the stakeholders and the agency will need to be made accountable to the stakeholders.

6.5 Concluding Remarks

The institutional framework presented above mainly focuses on the first dimension of participation, namely between stakeholders and the WM-Agency. However, by doing so, we are not suggesting homogeneity among stakeholders. Equally important is the second dimension of participation, namely the active participation of all the different categories of stakeholders. This dimension, however, is complex due to the great diversity of stakeholders in FCD systems and the stratified nature of rural society in Bangladesh. The basic question is whether the institutional arrangements detailed above will ensure the participation of all stakeholders, including the relatively powerless, or if it is just another eyewash.

In the debate on participatory water management in Bangladesh many academics, NGOs, consultants, policy-makers and donors have suggested that the best way to ensure the participation of all stakeholders is by organising them into several water management groups or associations, for example a landless group, a women's group, a fishermen's group, a project affected people group and so forth. Besides SRPs dismal results in organising WUOs, the obvious question arises who is going to organise these 80 million water management stakeholders in Bangladesh.

We contend that water management in the rural areas is often considered in isolation, especially by those proposing a plethora of water management groups. It needs to be recognised that water management is closely linked to all aspects of the rural livelihood system and that many formal and informal organisations are already in place that in one way or the other deal with water management. Consequently, it should be acknowledged that water management is subject to the same power structure as the rest of the rural society. It is unrealistic to expect that a different (read democratic) power structure for water management can co-exist alongside another (read entrenched undemocratic) power structure for the rest of the society.

Attempting to establish egalitarian procedures for water management that are in conflict with the existing power structures would be a waste of time and resources. Instead, the existing power structures should be accepted as a boundary condition when introducing participatory procedures. In this situation Voltaire's "*the best is the enemy of the good*" clearly applies: although much remains to be desired, a focus on the first dimension of participation can already engender major improvements in water management. The potential for such improvements is considerable, even if stakeholders do not participate in an egalitarian manner. Thus, we support a pragmatic approach to participatory water management that does not subordinate the realisation of improvements in water management to the democratisation of rural society at large. We contend that it is possible to realise major improvements in water management within the confines of existing power structures, through implementing the institutional arrangements described above.

7 CONCLUSIONS

Improved water management is of utmost importance for Bangladesh, as nearly 80 million people live and farm on the floodplains. Water management abounds on these floodplains and various flood protection and drainage measures have been taken by both stakeholders and the government. In a sense, the floodplains can be thought of as an amalgamation of FCD systems in various stages of development. The crucial importance of FCD systems makes it necessary to understand water management practices in FCD systems and to develop appropriate institutions and management strategies for them.

Water management in FCD systems is complex and fundamentally different from water management in irrigation systems. It is characterised by many different stakeholders, each with different, often conflicting water management demands and by an infrastructure not designed for optimal performance. Moreover, this infrastructure has to cater for many, often mutually exclusive, demands. Lastly, the management strategies currently used in FCD systems have not been designed to deal with the complexities of water management in FCD systems.

The numerous initiatives of people in the management of water resources show that there is a tremendous amount of water management going on in the field. Water users devise management arrangements to put FCD systems to their own use. This does not imply that water management in FCD systems is optimal. On the contrary, many struggles over water control take place, which are usually decided in favour of a minority of the stakeholders. Nonetheless, it is clear that people in rural Bangladesh have an extraordinary capacity to manage water resources and the related water management infrastructure.

Balancing the water requirements of different water management stakeholders in an equitable manner is a difficult task. It is clear that there is scope for improvements in current water management practices in FCD systems. Forums are required for stakeholders to discuss their different water management objectives and requirements and to take decisions on water management scenarios. Also, a pro-active WM-Agency that is fully geared towards water management is sourly needed in FCD systems. To achieve sustainable water management, the development of innovative participatory water management strategies that take into account the complexities of water management in FCD systems is imperative.

This report outlines institutional arrangements for participatory water management that are both innovative and realistic. The question how participatory water management can be achieved in FCD systems has been answered and the way forward is thus clear. However, to move towards sustainable water management and actual poverty reduction difficult choices need to be made. It is unrealistic to expect that the institutional changes needed to implement participatory water management can be realised within the confines of a technical department in a line Ministry. Full political backing and a strong political will are required to see through the implications of participatory water management for government agencies, such as major changes in staff composition, responsibility and accountability. As long as participatory water management remains only an issue for political debate it is unlikely that the promise of improvements in water management will become reality.

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