MANAGEMENT OF CONFLICTS BETWEEN IRRIGATION AND FISHERIES IN A SELECTED WATER RESOURCES PROJECT

by

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It is hereby declared that this thesis or any part of it has not been submitted elsewhere for the award of any degree or diploma.

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ABSTRACT

In many areas of Bangladesh, *beels* or shallow wetlands are dewatered or drained to allow dry season agriculture. Structural interventions including embankments and sluice gates are often introduced for this purpose, with the main objective to increase crop production with higher economic return to the farmers who are relatively strong in the community power structure. However, this arrangement adversely affects fisheries, ecosystem and their livelihood support in the short and long terms. So the water use conflicts between dry season agriculture and fisheries are almost inevitable. The conflicts are more complex where the open access fisheries resources are limited due to intervention of the aquatic ecosystem. Even within a participatory process of decision-making for such interventions, the needs and priorities of the fishing communities are often marginalized, mostly because of their weak position in the community. Based on a socio-technical approach, this thesis provides an understanding of the conflicts between agriculture and fisheries due to structural interventions in a selected water resources development project. Social survey and stakeholder analysis through FGDs and interviews with different groups including farmers, fishermen and women revealed the differences in their realities and identified the conflicts by assessing the impact of project interventions on irrigated agriculture, fisheries, ecosystem and livelihood support. An apparent discontent prevails among the less powerful fishing community as their needs, priorities and alternate livelihood options have not been properly addressed in the project formulation process. Technical analysis revealed conflicting water requirements in the dry season for irrigated agriculture, fisheries and aquatic ecosystem. This study also attempted to identify a feasible platform for conflict resolution. Two stakeholder workshops were arranged to understand the potential areas and opportunities for conflict reduction. Although such workshops or meetings may be very useful to find agreeable mitigation measures where the social power structure is skewed, participation of the local government in this process and policy interventions are essential to reduce the conflicts.

ABBREVIATION

ADB	Asian Development Bank
BWDB	Bangladesh Water Development Board
CEGIS	Centre for Environmental and Geographic Information System
DEM	Digital Elevation Model
DoF	Department of Fisheries
FAP	Flood Action Plan
FCD	Flood Control and Drainage
FCDI	Flood Control Drainage and Irrigation
FGD	Focus Group Discussion
GoB	Government of Bangladesh
HYV	High Yielding Variety
IWFM	Institute of Water and Flood Management
KII	Key Information Interview
LGED	Local Government Engineering Department
PRA	Participatory Rural Appraisal
SSWRDSP	Small Scale Water Resources Development Sector Project
SWIWRMP	South West Integrated Water Resources Management Project
UP	Union Porishad
WARPO	Water Resources Planning Organization
WL	Water Level

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CHAPTER ONE
INTRODUCTION

1.1 Background

Water and fisheries are often open access resources in developing countries. Fisheries make important contributions to food production, food security, nutrition, livelihood support and aquatic biodiversity. On the other hand, irrigated agriculture is inspired from a need to meet the growing demand for food, often exploiting the water necessary for fisheries (Heinz, 2002). In case of water scarcity, conflicts among the use of water for irrigation and fisheries are almost inevitable (Nguyen-Khoa and Smith, 2004). The conflicts are more complex where the open access fisheries resources are limited due to intervention of the aquatic ecosystem to promote irrigation. Even within a participatory process of decision-making for such interventions, the priorities and perspectives of the fishing communities are often marginalized, mostly because of their weak position in the community power structure. In these situations, successful Integrated Water Resources Management (IWRM) depends on consensus building and conflict management (GWP, 2003). Nguyen-Khoa and Smith (2004) present a protocol for participatory impact assessment and management as a mechanism for conflict resolution between irrigation and fisheries. In this protocol, stakeholder workshops serve as a platform for conflict resolution.

Several subprojects of the Southwest Area Integrated Water Resources Management Project (SWAIWRMP) have introduced structural interventions for flood control, drainage and water conservation (ADB, BWDB and WARPO, 2004b). The purpose of these interventions is to allow storage of fresh water for dry season irrigation, drain out water to allow cultivation in beels and prevent saline water intrusion during the later part of the dry season (BWDB and WARPO, 2005). Although these interventions have been beneficial to dry season agriculture, fisheries and the aquatic ecosystem have been adversely affected (LGED, 2007). Similar effects have been reported by Shafi (2003) and Harun (2005). This was also confirmed from a reconnaissance visit to a few subprojects in the area. There is an apparent discontent among the fishing community that their needs, priorities and alternate livelihood options have not been properly considered in the project formulation process. This study conducted a detailed investigation in these issues as part of the academic research program of IWFM under the Crossing Boundaries (CB) Project.

1.2 Rationale of the Study

Competition for scarce resources, e.g. water, may create conflicts in water requirements by different user groups. The water requirement conflicts eventually give rise to social conflicts in a community. These conflicts are expressed and visible in the community if the community power structure is somewhat balanced. However, the water requirement and the social conflicts are often unexpressed if the community power structure is uneven because the less powerful user groups are suppressed and remain silent.

Development interventions have both positive and negative impacts on the environment, ecosystem and livelihood. The success of any development project depends on equitable sharing of direct or indirect benefits and minimizing or mitigating the negative impacts. FCD projects are implemented mainly to promote agriculture, sometimes converting wetland areas into permanent agricultural lands. However these projects may reduce wetland areas and the hydraulic connectivity between the rivers and floodplains.

The structural interventions result in disruption of aquatic ecosystem, adverse effect on fish species and finally sufferings of the fishing community. The resulting loss of livelihood pushes vulnerable groups into poverty, making it particularly difficult for the poorest to cope with. For some landless households, fishing plays the role of livelihood of last resort, even though water and fish become scarcer as competition for these resources increase (Nguyen-Khoa and Smith, 2004). Giving high priority to agriculture sector and ignoring the livelihood of the marginal fishing community results in conflicts between dry season agriculture and fisheries. This conflict may turn into severe problem in the context of Bangladesh as the number of FCD projects are increasing rapidly.

Conflict management is urgent, although it is a very difficult task considering the complexity of the interactions among various factors, water sub-sectors, and stakeholders in the integrated water resource management process (Ti, 2001). The purpose of this study was to identify conflicts in details and finally investigating a feasible platform for conflict resolution.

1.3 Objective of the Study

This study is expected to provide an understanding of conflicts between irrigation and fisheries due to structural interventions in water resources development projects.

The specific objectives of the study are to:

(i) identify conflicts in water use for irrigation and fisheries in a selected subproject of SWAIWRMP;
(ii) determine water requirements for irrigation, fisheries and the aquatic ecosystem;
(iii) assess the impact of project interventions on irrigated agriculture and fisheries; and
(iv) explore the feasibility of developing a platform for conflict resolution/reduction.

1.4 Outline of the Methodology

The study was conducted in the Siapagla FCD subproject in Narail district. Preliminary investigation and literature review showed possible conflicts in water use for irrigated agriculture and fisheries resulting from project interventions. The study identified these conflicts through focus group discussions (FGDs). The major groups were farmers, fishermen and women Seasonal variability in water requirements for irrigation, fisheries and ecosystem was estimated from an analysis of secondary information on various aspects including cropping pattern, crop water requirement, irrigation and fishing practices, and predominant fish and other aquatic species. This analysis revealed conflicting water requirements. Impact of project interventions on irrigated agriculture, fisheries and ecosystem was assessed from FGDs and structured interviews.

The relations among stakeholders and the power structure for community decision-making was identified through stakeholder diagramming based on information collected through the FGDs mentioned above. This helped in understanding the potential areas and opportunities for conflict resolution. Two stakeholder workshops were arranged to identify agreeable mitigation measures and to explore the feasibility of using such workshop in future as a platform for conflict resolution.

1.5 Scope of the Study

The study covers the identification of conflicts between irrigation and fisheries through FGDs, interviews, etc., in a selected sub-project of SWAIWRMP. A hydrologic analysis was performed to determine the conflicting water requirements. This study also attempts to find a feasible platform for conflict resolution.

1.6 Limitations of the Study

The findings of this study are limited to the study area or sub-project. Extrapolation of the results to other areas should be done judiciously. This study identified a platform for conflict resolution between agriculture and fisheries. However, feasibility of effectively using this platform for conflict resolution depends on further detailed investigation and field testing. Theoretical options are also recommended for management of the conflicts. However, feasibility of these options will also require further study.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

Bangladesh has an intricate network of rivers that flow into the Bay of Bengal in the south. These rivers and wetlands are in many ways responsible for the fate of its people Over half of the country is floodplain, which along with the rivers and lakes (locally called beels) provides fisheries resources for many people as their source of income and food. This is particularly important for relatively poor households since they have few options for income generation (World Fish Centre, 2007a).

Despite the importance of these resources, the inland capture fisheries in Bangladesh have been neglected by the policy makers. Development policies have always favoured agriculture (World Fish Centre, 2007a). During the last fifty years, huge development interventions have been undertaken mainly for increasing crop production for the increasing population, improvement of road communication systems, industrialization, urbanization, etc. The major national and regional development interventions that affect the water resources and fisheries include the FCD/FCDI projects, construction of roads and highways across wetlands for easy and quick transportation, abstraction of groundwater for irrigating crop fields, introduction and intensification of the high yielding variety (HYV) of rice and mono cultivation of rice, indiscriminate use of insecticides, pesticides and chemical fertilizers in crop fields and upstream diversion of the Ganges water flow at Farakka – all of which have profound impact on fisheries (Ali, 2006). This bias towards agriculture often had negative impact on capture fisheries Also, water bodies have been drained during the dry season to grow rice, or flood control structures have been built to protect crops which have been acting as barriers to fish migration (World Fish Centre, 2007a). Therefore these interventions have eventually given rise to conflict between the agriculture and fisheries sectors.

This chapter summarizes the review of previous studies conducted on consequences of structural development interventions, water requirement for fisheries, water use conflict and conflict management.

2.2 Project Interventions and Their Impact

IUCN (1993) presents an overview of water development activities in Bangladesh and their impact on wetlands. Since increasing production of food grain is the main objective of the recent development activities, improvements in water resources management have taken place in water level control in the monsoon season and in expanding water supply for irrigation in the dry season. FCD (Flood control and Drainage) structures are constructed to serve these purposes. Gravity drainage controls are supposed to have significant impacts on the entire crop calendar. Gated hydraulic structures are planned to be used to restrict pre-monsoon backflows into low-lying areas preventing damage to the harvest of irrigated winter rice. These are designed to lower maximum flood levels inside the polder by preventing inundation from high river levels and to control outflow when river levels are low, thereby conserving water for supplemental irrigation of late monsoon crops and early winter upland crops. The present trend of water development activities brings changes in agriculture practices in the wetland areas. FCD structures are reducing inundated areas and preventing free flow of water to and from rivers to wetlands. Large scale utilization of surface and ground water for irrigation has greatly reduced the wetland areas. Consequently, the aquatic ecosystem is disrupted, fish species are adversely affected and the fishing community suffers.

The livelihood losses adversely affect the vulnerable groups, especially the fishers who are amongst the poorest people in Bangladesh. Most possess few capital assets; many are landless and have few alternative livelihood options. Their access to lakes, rivers and floodplains is strongly affected by decisions made by the people who control aquatic resources at the local level, particularly the rich and the elites (World Fish Centre, 2007c). Again, the farmers are the dominant group among the rich and elites whicb results in a conflicting situation between fishers and farmers.

2.3 Effect of Project Interventions on Fisheries

The fisheries of the inland freshwater rivers, beels and floodplain are the most vulnerable to the effects of water development activities, e.g. FCD developments. These development activities caused obstruction to fish spawning and migration, the draining of many formerly productive beels, the consequent reduction in floodplain area, production and the enforced concentration of artisanal fishing effort on to the depleted river fish stocks (FAP13, 1992). The effects of FCD subprojects on fisheries are described in the following sections.

2.3.1 Fish habitat

There are two principal seasons in Bangladesh (wet and dry) which define the available fish habitat at any given time. Fish species native to Bangladesh waters have evolved with and adapted to the hydrologic cycle. During the monsoon season (May through October) fish expand their range throughout the floodplain, while in the dry season fish seek refuge in discrete bodies of standing water. During each of the two seasons fish life cycles are quite different and evolve to capitalize on habitat which has been created by hydrologic conditions (EGIS, 1997).

The principal dry season fish habitat is rivers and beels. Canals and pagars are subject to desiccation and apparently do not provide the stability for maintenance habitat that beels and rivers do. These habitats therefore are the primary sources for floodplain fish stocks during the wet season. It is inferred that since few species occur in canals, the canals play a corridor function between beels and rivers during monsoon only (EGIS, 1997).

The dry season represents the most critical season for all species – mortality rate is high and populations are at their lowest levels, habitat is limited, predation is at a peak, and growth is slowed. Competition for food is keen during the dry season and fishing pressure remains high. Reductions in dry season aquatic habitat can lead to increased harvest opportunities in the short term, but have the potential for reducing the parent stocks to below levels that have traditionally existed. Certain minimum flow requirements are necessary in rivers and canals during the dry season to maintain a healthy population, and to ensure that sufficient parent stock is available for repopulation of the floodplain during the wet season (EGIS, 1997).

2.3.2 Fish migration

In recent years, majority of fresh water fish have declined both in abundance and biodiversity; researchers have identified barriers to migration as a major contributing factor (Ghosh, 2007). Fish migration characteristics in Bangladesh are discussed by FAP17 (1994). Few river fish are confined to one habitat throughout the year. The species that reside on the floodplain and beels during the dry season tend to be those with adaptations to withstand limiting conditions (such as desiccation, isolation and deoxygenation) in the dry season pools. The majority of species, however, are migratory. Of these some are restricted to small geographical areas and take only short migrations (20-30 km). Some however, migrate substantial distances, up to several thousand kilometres, between widely different habitats.

Fish migration is most commonly brought about by a behavioural response to currents. However, the nature of this response can change during the lifecycle of the species. The most fundamental change is between active upstream migrations, usually undertaken by adults moving to their spawning grounds, and the passive or combined active/passive downstream migrations of juveniles. Both phases are important to maintain the fish population.

In southern Asia, the fish communities have been divided into the 'black fishes' which are essentially resident on the floodplain and the 'white fishes' which show some distinct migration within the river system, usually associated with spawning. The black fish are those which would normally retreat into beels or other residual water bodies after the floods have receded. They are commonly taken in the kua or fish pits, which trap the last remnants of the floodplain waters (FAP17, 1994). The local fisher community categorized white fishes (carp fish) and black fishes (cat fish) based on their migratory movements.

Seasonal variation in fish migration is divided into four periods: over wintering dry season (mid December-mid March), spawning migration season (mid April –mid June), nursery / grow out migration season (mid June – mid September) and flood recession season (mid September – mid December) (Ghosh, 2007).

The carps show five types of migration as brood migration and then return migration of the fingerlings in the floodplains and then in the beels and rivers. During two harvesting seasons January – March and November- December, the carp species dominate. The fingerlings prefer to disperse in floodplain from last of May up to October and return to river in September to November (Ghosh, 2007).

The catfishes migrate to floodplain from March to May to breed (May – August). These fishes return to standing water from October to early December and reside there from January – early April and November – December. Tables 2.1 and 2.2 show the fish migration of white fish (carps) and black fish (cat fish) species at different stage of their life cycle, respectively.

Table 2.1: Seasonal migration of White fish (carp fish) at different stages of life cycle.

Category: Carp Fish

Period	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Spawning migration												
Fingerling migration												
Dispersal of young over floodplain												
Return of young to beel and river												
Harvesting beel and river												

Table 2.2: Seasonal migration of Black fish (cat fish) at different stages of life cycle.

Category: Cat Fish

Period	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Spawning migration												
Migrate to floodplain												
Dispersal and Growth												
Return of young to standing water												
Dry season residence in standing water												

(Source: Ghosh, 2007)

2.3.3 Suitability of water bodies

The suitability of a water body (khal or beel) for a particular use (e.g. aquatic ecosystem) varies in an intricate manner. Snelder (2006) gives a qualitative suitability pattern of a water body with respect to water flow (see Figure 2.1). This qualitative pattern maybe also applied to fish habitat and migration.

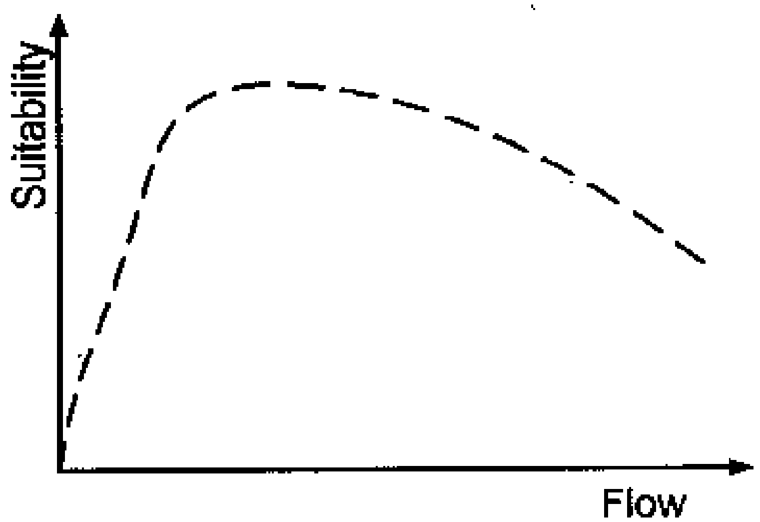


Figure 2.1: A typical suitability pattern for a water body in terms of flow.
(Source: Snelder, 2006)

The suitability, or the 'level of protection', initially rises quickly from zero at a zero flow to a maximum value. From this point onwards, the level of protection may decline or stay uniform with increasing flow.

2.4 Water Use Conflicts

Ricardo Ramirez (1999) provides an understanding of conflicts to support community based natural resource management. In natural resource management, conflict is often inevitable. The growing demand for finite or renewable natural resources to satisfy the needs of different stakeholders is a common source of conflict. As resource becomes scarce, the competing interests cannot be fully met. Faced with such situations, stakeholders will make choices about how best to act to pursue their own interests. Stakeholder negotiation will inevitably involve conflicts of interest and trade offs. Although these conflicts are often taken to be bad or negative, they are logical developments in the absence of proper democratic, legal and administrative mechanisms to handle issues that are at the root of water conflicts (Joy and Pranjape, 2007)

Conflicts in water management bears the complexity of the interactions between various factors, water sub-sectors and stakeholders in the integrated water resources management processes. The root of these conflicts lies in different perceptions of the concerned parties or in different technical perspectives. Conflicts may be classified into four groups: a) Social conflicts, b) Economic conflicts, c) Legal Conflicts, d) Water conflicts in perspective (Ti, 2001).

Sectoral perception of water use result in various forms of water conflicts, which reflect different perceptions from the sectoral needs for water or from different concepts of water use priority in the process of social and economic development. This kind of conflict is termed as social conflicts in water management (Ti, 2001). The failure to integrate water resources management into the social and economic development processes will lead to the aggravations of conflicts in water management.

Nguyen-Khoa and Smith (2004) discuss various forms of conflicts between irrigation and fisheries, their source and possible mitigation measure. Since water and fisheries are often common property or open access resources, particularly in developing countries, and the scarcity of water is increasing, the occurrence of conflicts between interest groups for irrigation and fisheries is inevitable. Table 2.3 summarizes the possible sources of conflict, recognizing that impacts on the productivity of fisheries can arise from both changes in production potential, resulting from change in habitat.

Table 2.3: Summary of sources of conflict in interests between irrigated farming and fishing.

Process	Possible conflict of interests
Physical system	
Storage of water for irrigation	Affects river flow regimes, attenuating floods but increasing available dry season flow, unless abstraction for irrigation is direct from the reservoir. Dam or weir structure can reduce longitudinal habitat connectivity. Can create habitat and fishery, but rapid or extreme volume and area fluctuations threaten stock survival.
Diversion of water for irrigation	Fish losses in pump impellers. In gravity flow systems fish may enter without harm but may become trapped. Complete abstraction of dry season flows may break connectivity of rivers.
Flood protection	Reduced lateral connectivity between river and floodplain habitats, although "fish friendly" operation of regulators can mitigate this. Reduction in flooding may permanently isolate floodplain lakes
Change in land use water delivery	Conversion of natural floodplain habitat to irrigated command. Canals usually comprise straight sections connected by curves where as fish prefer sinuous channels. Lining and discontinuous flow provide very poor habitat. Canals and access roads may reduce lateral connectivity of the floodplain and/or longitudinal connectivity in small tributaries. Culvert or bridges across drainage lines will not necessarily maintain habitat connectivity, depending on current velocities and the height of any steps / cascades.

Process	Possible conflict of interests
Water removal	Drainage of wetlands reduces habitat area, but may increase stream flows during rain. Disposal of drainage flows in to inland water bodies can degrade water quality and habitat. Natural drainage lines often realigned to straight sections connected by curves but drains generally offer better habitats for fish than canals, though pesticides in drainage water can be damaging.
Operation	
Irrigation scheduling	Scheduling to match crop water requirements may affect fish present in canals or rice fields.
Maintenance (waterways)	Removal of vegetation and sediment may degrade habitat and spawning grounds. Use of herbicides may severely impact fish populations.
Maintenance (embankments)	Removal of vegetation from canal and drain embankments can reduce shade and food availability and thus degrade habitats.
Land use	Cropping pattern influences water demand and consequently the water available to support aquatic resources. Farming practices can affect fish populations in drainage channels through to natural water ways. Pesticide and herbicide contamination are the most obvious causes of fish mortality, but land, management practices such as bare soils during the rainy season leading to erosion through surface runoff can also have negative impacts.
Paddy cultivation	Natural fisheries production in paddies is dependent on the up migration of fish at the start of the wet season and much of the catch is achieved during the down

	migration. With migration, lower water levels give less need to store water, and loss of permanent wetlands and connectivity to paddies can reduce fish production unless the rain fed crop cycle is managed traditionally with sufficient dry season aquatic habitat well connected to paddies. Irrigated dry season crops are likely to produce high fish yields because there is no natural up migration and reproduction.

(Source: Nguyen-Khoa and Smith, 2004)

The above range and variety of possible conflicts between fishing and irrigation interests indicate that their probability of occurrence is significant and can lead to suboptimal and equitable outcomes.

In the context of Bangladesh, water resource development activities, namely flood control, drainage and irrigation, closures of natural canals and large/ small rivers got a boost in the 1960s. A huge number of water development schemes were constructed and still under construction as development interventions overlooking the ecology of the beel. Water requirements for aquatic habitat were totally ignored, while planning, designing and implementing the schemes. As a result, aquatic habitats were eradicated, removed, shrunken and / or modified with impunity affecting the open water capture fisheries and livelihood of the fishermen community (Ali, 1997). Flood control drainage and irrigation (FCD/I) projects alter the inundation pattern to create an artificial environment conducive to agricultural production (FAP 6, 1994). Flood control projects have a series of relatively specific impacts on fisheries. The conflicts between irrigation and fisheries begin as the fisheries issue in flood control is usually seen in terms of trade-offs. If the overall benefits to agriculture and other sectors exceed the disbenefits suffered by fishers and those dependent on them, the project is acceptable to the respective authority. This kind of approach ignores many serious issues regarding distribution and what constitutes a benefit for different groups within the population (FAP 17, 1995).

The fishery is one of the worst affected sectors by flood control developments throughout Bangladesh. The negative impacts arise mainly from flood control structures that block the spawning and feeding migrations of many species of fish to and from floodplains, beels, rivers and tidal khals, reducing the breeding stocks and reproduction to a stage of extinction for several fish species. For increasing the agricultural land area inside the FCD project areas, many permanent flooded beels have been completely drained or converted to seasonal beels which dry out during the winter months. The former destroys the fisheries and the later causes the destruction of many resident breeding stocks of fish. River flows have been altered in both depth and duration of flooding and with it the change in the pattern of siltation that causes probable detrimental effects on riverine fish and /or their food organisms. As a result, fishermen's catches and earnings have been badly affected and some full time fishermen have had to seek other work or move out to elsewhere (Ali, 1997).

Chanda beel is an ideal case to see how development interventions can systematically destroy a wetland. It has lost its typical wetland character and almost turned into a vast crop cultivable land due to human interventions. Plenty of fish were available in the past at Chanda beel which were good enough for the livelihood of fishermen. At present, a vast majority of fishermen have left the occupation and adopted agriculture or other occupations for living. But it has positive impact on agriculture. Before 1960, in the dry season only 39% of the total area of the beel was under agricultural practices, which increased to 53% in 1975 and by 2005 it rose to 72%. In the wet season the agricultural land was only about 9% before 1960, which slightly increased to 13% in 1975 and by 2005 it increased to 25%.

2.5 Conflict Management

The following characteristics of open access resources (water and fisheries) aggravate the conflicts and make it complicated to manage (World Fish Centre, 2006):

i. Over exploitations, hence not sustainable,

ii. Difficult to manage,

iii. Favours powerful and rich, hence not equitable, and

iv. No incentive for conservation, therefore not sustainable.

Ti (2001) suggest that conflicting situations can be reduced by planning the freshwater resources development, use, management and protection in an integrated manner, considering both the short and long term needs of the social dimension and the stability and sustainability of the social and economic development processes. It is essential to create conditions for an efficient environment for the economic use of water, including a well defined legal and institutional framework for the utilization and conditions for a fair and equitable sharing of the beneficial use of the water resources.

Franks et al. (2004) studied the situation and conflicts amongst competing uses in Usangu basin, Tanzania and put forth some suggestions to develop a sustainable management plan with the help of local stakeholders. There is no simple solution for allocating and managing water amongst competing uses. It requires a holistic approach. Water resource management depends on the proper understanding amongst the stakeholders about the problems within the basin and linkages between them. Physical, administrative and cultural boundaries should be borne in mind while managing water amongst competing uses. It should be noted that water resources management and use are closely related to management of other resources such as land and therefore a holistic approach to resource management within the catchment is needed. There is also a need to support bottom up participative process and to integrate them within a plan for catchment which covers a large area and supports a large resident population.

Stakeholder Analysis is an effective tool to reduce conflict. Kammi Schemeer (2001) studied the usefulness of this tool in policy formation to avoid conflicting situation. Policy makers and managers can use a stakeholder analysis to identify the key actors and to assess their knowledge, interests, positions, alliances and importance related to the policy. This allows policy makers and managers to interact more effectively with key stakeholders and to increase support for a given policy or program. When this analysis is conducted before a policy or program is implemented, policy makers and managers can detect and act to prevent potential misunderstandings about opposition to the policy or program. When a stakeholder analysis and other key tools are used to guide the implementation, the policy or program is more likely to succeed.

Multi-stakeholder negotiation is neither possible nor desirable for powerless groups. Weak, disenfranchised stakeholders stand to lose much from negotiations where power differences are too acute to enable collaboration. Nevertheless, all stakeholders stand to benefit when the negotiation playing field is transparent, so that the decision to venture into a negotiation is based on reliable information (Ramirez, 1999).

Scientific Committee on Water Research (1998) suggested research in the following issues which may help in management of conflicts:

- Global assessment and analysis of fresh water resources: spatial and temporal variability;
- The value of improved prediction and new data sources for water resources estimation;
- Handling of multiple scale problems;
- Interrelationships between hydrological and biogeochemical cycles and food production;
- Developing better understanding of the structure and dynamics of fresh water systems;
- Sustainable reservoir development and operation;
- Water demand management and equitable distribution:- analysis of socio-economic impacts of policy instruments; and
- Development of tools for linking water resources planning with landscape ecological planning.

Nguyen-Khoa and Smith (2004) present a protocol for participatory impact assessment and management as a mechanism for conflict resolution between irrigation and fisheries. In this protocol, stakeholder workshops serve as a platform for conflict resolution. Key features of this protocol are: (1) genuine participation of the stakeholders; (2) integrated assessment and management of impacts of irrigation on fisheries; (3) management of information and an informed decision making process; and (4) adoption of an iterative and learning process. The success of water resource management options lies in considering the priority needs of the poorest sections of local communities and the improved management of irrigation taking into account the benefit of both farmers and fishermen.

IKLARM (2000) conducted stakeholder workshops on natural resource management at Kathuria Beel (Narail Sadar Thana, Narail District) to collect information from around one thousand households of five villages who were benefited from Kathuria beel. Ten problems were identified at the primary level and finally four major problems were selected by the vote of local people. They discussed the reasons behind those major problems and possible solutions. To identify the most desirable and preferable solution of each problem, multi-criterion analyses on possible solutions were performed. The results of stakeholder workshops are well accepted not only by the local people but also by UNOs, NGOs, Fisheries department, etc. This presents the idea that if sufficient time is given, stakeholder workshops can be an effective method for conflict resolution.

An important project to promote ecologically sound management of floodplain resources (fisheries and other wetland products) for the sustainable supply of food to the poor of Bangladesh is the Management of Aquatic Ecosystems through Community Husbandry (MACH) project (Winrock International and Others, 2002). MACH has involved all community resource users (fishers, farmers, the middle class and elites, women, local government, and others) and considered all the products (fish, plants, water and wetlands products) and factors affecting a wetland. The project has helped establish a total of 42 community-based management organizations, including 16 wetland resource management organizations (RMOs), nine upland stream resource management committees (RMCs), and 17 *dohas* or river RMCs. These groups are utilizing best resource management practices on more than 18,000 ha of rainy season wetlands and more than 50 km of streams. MACH is seeing results in the wetlands and communities where it works. Positive trends are being seen in fish production as well as overall biodiversity at all MACH sites. MACH has also appreciably influenced institutions and national and local wetland policy and widely disseminated lessons learned both within Bangladesh and in other countries (Winrock International and Others, 2002).

CHAPTER THREE

DESCRIPTION OF THE STUDY AREA

3.1 Location

The study area was selected on the basis of existing conflicts in water use among dry season agriculture, fisheries and the aquatic ecosystem due to the subprojects of SWAIWRMP. A completed subproject; Siapagla FCD subproject is selected as study area. After completion of this sub project on 1998, agriculture production increases remarkably but fisheries production decreases up to 28.8 mton (from 1998 to 2001) at Siapagla sub project area along with the deterioration of fishers' status (LGED, 2008),which indicates the existing conflicts in the study area.

Siapagla FCD subproject is located at Narail Sadar Thana, Narail District. It is situated between the Afra Khal to the West and the Chitra River to the Northeast. Natural highlands define the Eastern boundary and a local road defines the Southern boundary. A small low pocket land along the Afra Khal in the Northwestern corner of the basin has been included in the subproject. There are seven villages in this subproject area. They are: Chamrul, Peruli, Araji Mitna, Barmara, Bakshadanga, Chahar Baliadanga, Malidanga. Figure 3.1 indicate the location of Narail Sadar where Siapagla FCD subproject is located-

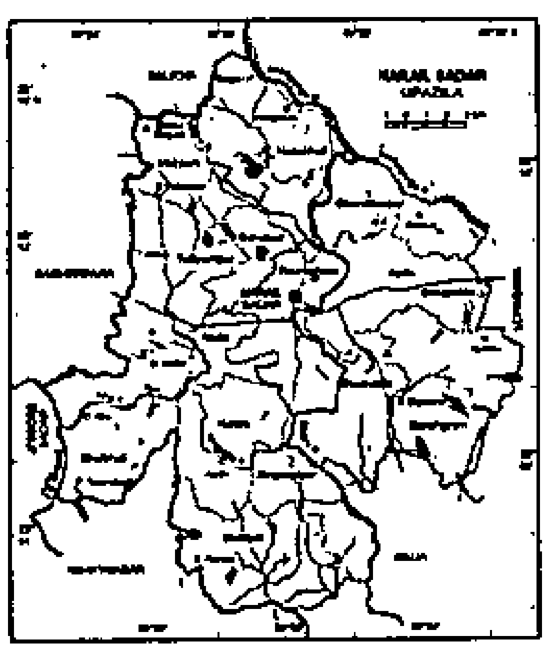


Figure 3.1: Narail Sadar Upazila.
(Source: Banglapeidia, 2006)

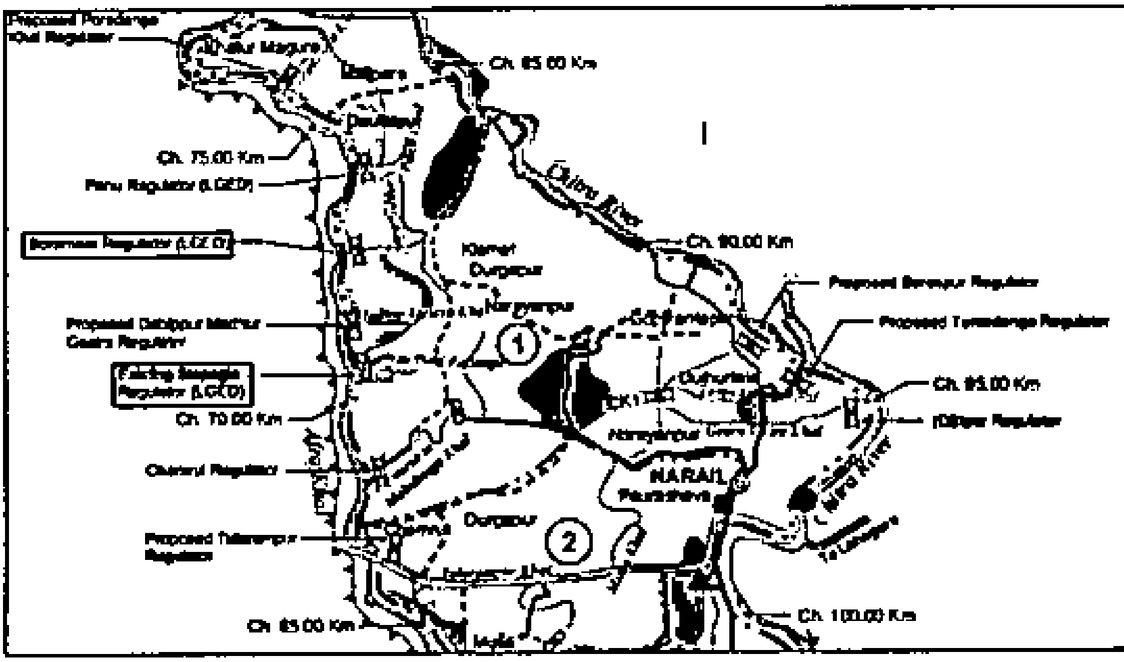


Figure 3.2: Siapagla FCD subproject area consisting Siapagla and Baramara regulator.

(Source: LGED)

Siapagla and Baramara regulators are identified in the figure 3.2 by the green coloured box.

Figure 3.3 shows the detail map of the project area.

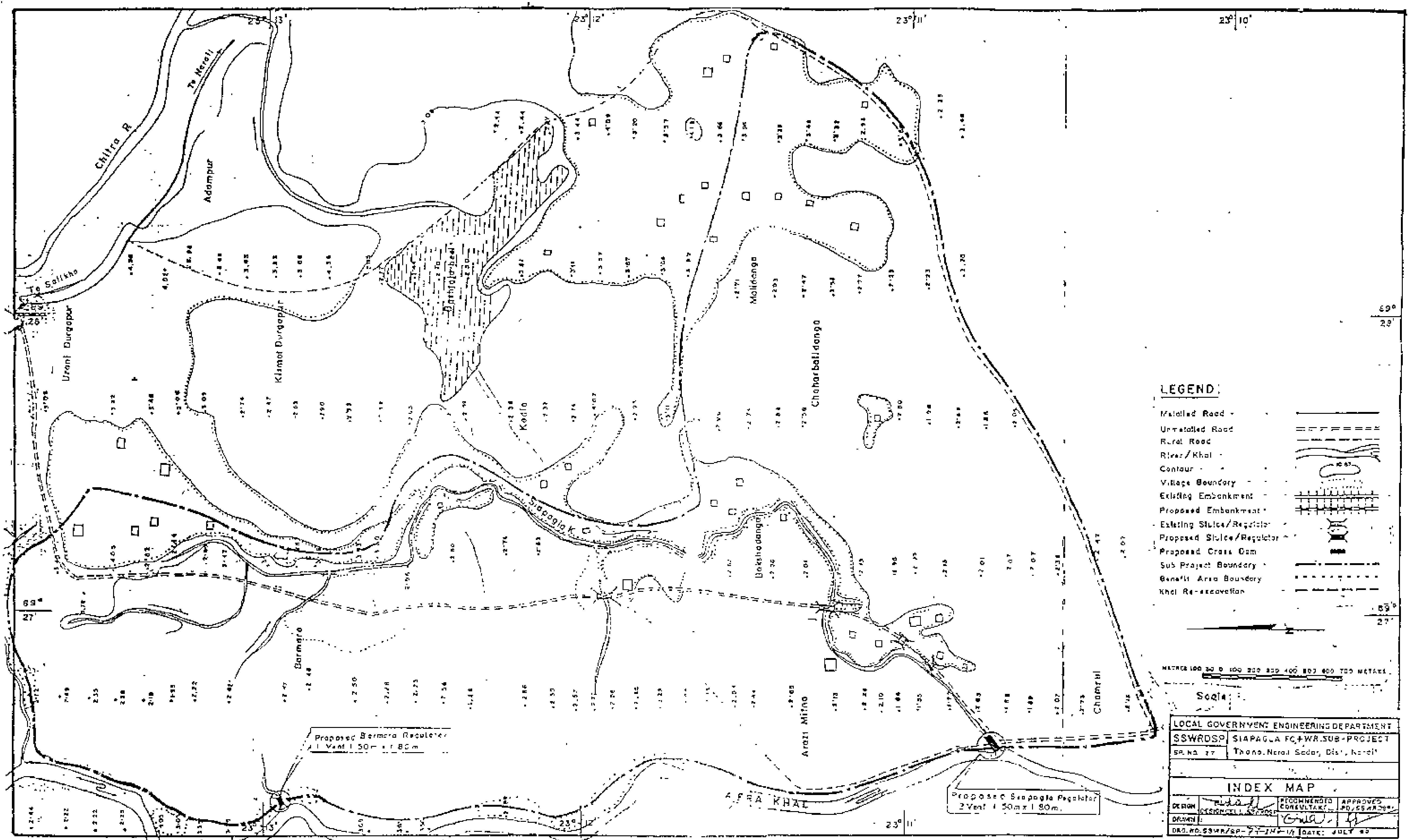


Figure 3.3 : Detail map of the sub project area

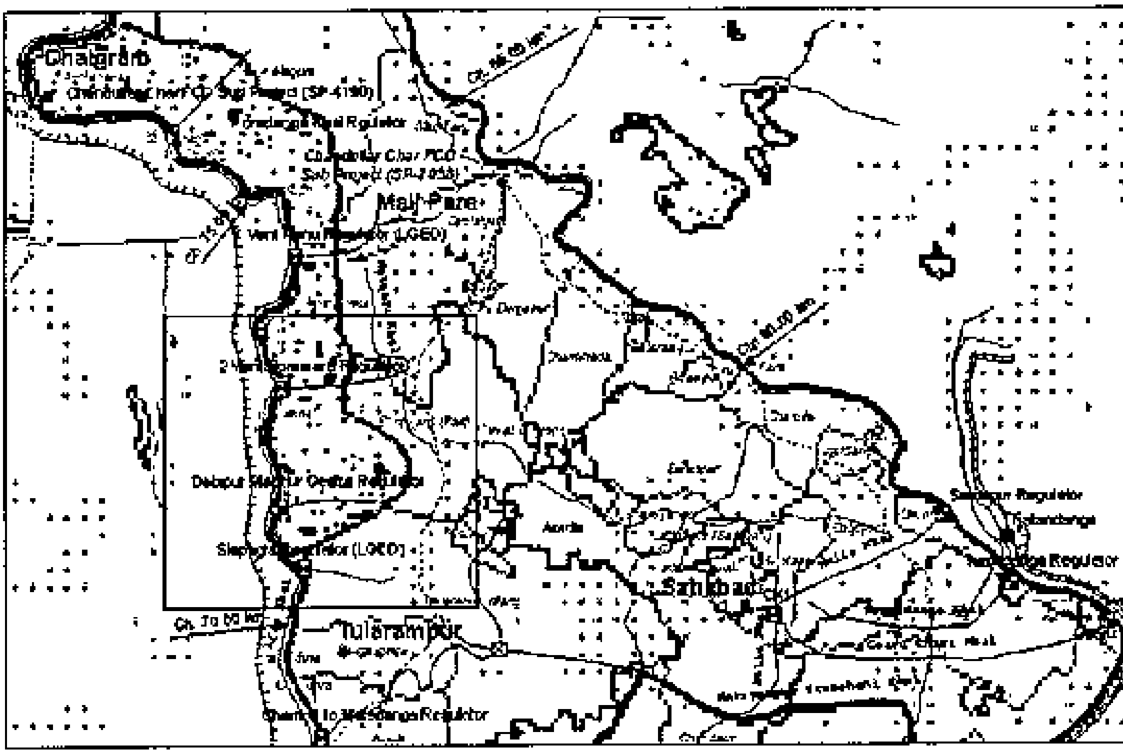


Figure 3.4: Siapagla FCD subproject area denoted by red rectangle.

Legend

- Project Boundary
- Compartment Boundary
- Compartment Boundary
- Existing Embankment
- Beels
- Existing LGED Project

3.2 Climate

Narail District experiences the sub-tropical monsoon climate typical of Bangladesh, with hot wet summers from May to September and cooler dry winter months. Narail District does not have a climatic station. Jessore (E-17) is the nearest station and is therefore used for the analysis of Narail District. There is only one rainfall station R-461 (Narail) located within the District. Rainfall stations that have influence on the Narail area mainly include R-462 (Salikha), R-411 (Madhukhali) and R-451 (Abhoynagar). Mean annual district rainfall is 1781 mm (ADB, BWDB and WARPO, 2004a).

Table 3.1 shows the mean monthly and 80% dependable data of Narail District. The table also shows that the rainfall is heavily concentrated during the wet season, which accounts for about 78% of the total annual rainfall (ADB, BWDB and WARPO, 2004a).

Maximum temperatures vary from 25.8 ^{0}C to 35.8 ^{0}C. The highest temperatures are experienced during the pre-monsoon period (Aril-May). Daily minimum temperature can fluctuate significantly during the year, ranging from about 11.6 ^{0}C to 25.9 ^{0}C (ADB, BWDB and WARPO, 2004a).

Table 3-1: Climatic data

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Maximum Temp (°C)	25.8	28.9	33.3	35.8	35.1	32.9	31.9	31.9	32.3	31.9	29.7	26.4	31.3
Mean Temp (°C)	18.9	21.6	26.4	29.8	30.1	29.4	28.9	28.9	29.0	27.7	23.9	19.5	26.2
Minimum Temp (°C)	11.6	14.2	19.5	23.7	25.0	25.8	25.9	25.9	25.6	23.3	18.0	12.4	20.9
Relative Humidity (%)	71.0	65.0	63.0	68.0	75	85.0	88.0	87.0	86.0	81.0	75.0	73	76.0
Wind speed (knots)	5.0	5.0	6.0	9.0	8	7.0	7.0	7.0	6.0	5.0	5.0	5.0	6.3
Sunshine (hrs/d)	7.8	8.1	8.0	8.1	7.7	5.2	4.0	4.8	5.0	7.1	7.8	7.7	6.8
ETo (mm/d)	2.9	3.9	5.41	7.12	6.97	4.65	4.49	4.42	4.09	4.07	3.33	2.73	1649
Mean Rainfall (mm)	9.0	26.0	42.0	89.0	194	312	358	334	260	124	23.0	12.0	1781
80% Dependable Rainfall (mm)	1.0	13.0	20.	61.0	150	257	293	266	188	82	7.0	1.0	1340

Source: BMD and WARPO (ADB, BWDB and WARPO, 2004a)

3.3 Topography

The ground elevation of cultivable land in the subproject varies between 1.6 and 4.5 m PWD (LGED, 1998).

Table 3.2 and Figure 3.5 show the existing land pattern.

Table 3.2: Land pattern

Land Type	Pre Project Area (ha)	Post Project Area (ha)	Change (ha)	Change (%)
Non cultivated High land	260	260	0	0
F0 (d<0.3m)	107	710	603	564
F1 (0.3m<d<0.9m)	195	265	70	36
F2 (0.9m<d<1.8m)	563	0	-563	-100
F3 d>1.8m)	110	0	-110	-100
Non cultivated low land	40	40	0	0
of which permanent water body	40	40	0	0
Floodplain Fish Habitat (F2+F3)	673	0	-673	-100
Net Area (F0+F1+F2+F3)	975	975	0	0

[F0=High land, not flooded; F1= Medium high land, Flood depth 30 to 90 cm; F2=Medium low land, Flood depth 90 to 180 cm, F3=Low land, Flood depth over 180 cm] (Source: LGED, 1998)

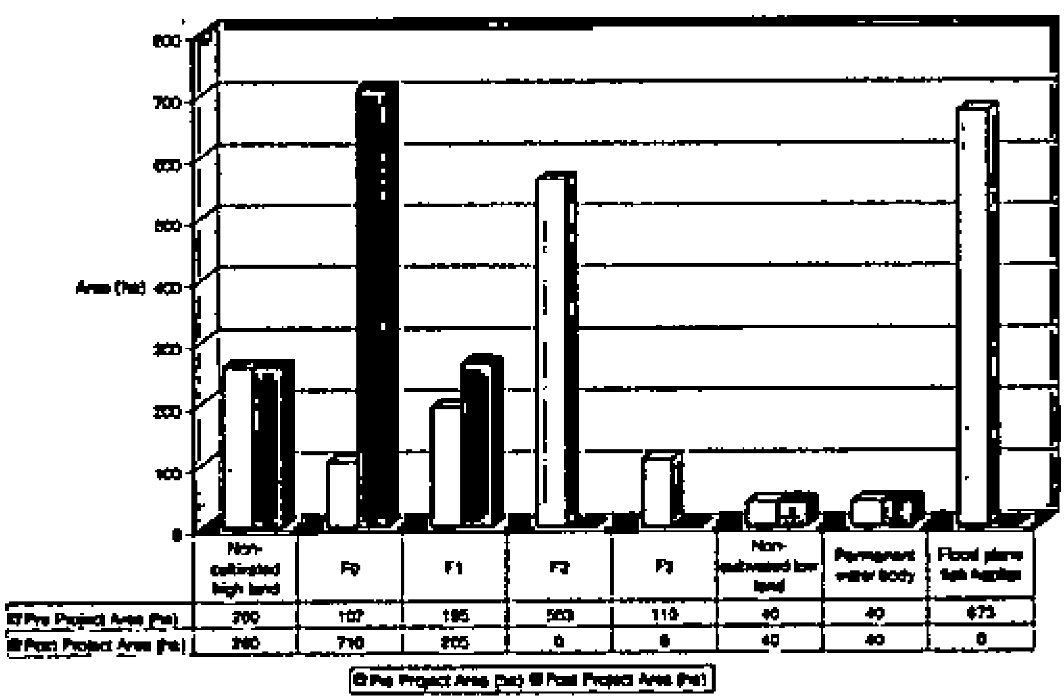


Figure 3.5: Land use and land types.

3.4 Hydro-Morphology

3.4.1 Hydrometric stations

The hydrological analysis was conducted on the basis of data from two hydrometric stations inside Narail district area. Table 3.3 shows the station name and number of these stations.

Table 3.3: Hydrometric stations relevant to the study area.

Station No	Name of Station	Type	Data Availability	
			Water Level	Discharge
55	Chitra River at Khaturmagura (upstream of the study area)	Tidal	Yes	No
30	Afra River at Afraghat (downstream of the study area)	Tidal	Yes	Yes

3.4.2 Afra river

The Afra River originates at the entrance of Narail District due to the bifurcation of the Chitra River. The river Afra flows East for about 1.5 km enters Jessore District and subsequently flows back into Narail District and bifurcates near Maijpara; one channel rejoins to the Chitra River while the second flows to the Bhairab River The river does not have any gauging stations (ADB, BWDB and WARPO, 2004a).

3.4.3 Drainage system

Nabaganga-Chitra-Afra-Bhairab Systems

This drainage area extends from the North-West to the South following the Fatki, Chitra, Afra and Bhairab Rivers as its internal drainage system.

In Narail District, the area lying between the Nabaganga and Chitra Rivers (Chenchuri Beel Project) forms a trough-like drainage basin, which also carries the drainage from the Magura District through the the Fatki River. The Fatki River is a distributary of the Nabaganga River, locally called the Begabati at the downstream reach. This drainage problem is further compounded by flood flows from the Nabaganga River, particularly in the Southern areas of the District. Depth and duration of flooding are further aggravated due to high water levels in the Madhumati at the Halifax Cut.

The area lying between the Chitra and Bhairab Rivers up to the Afra Khal is the drainage area of the Bhairab River. The drainage flows through the Chitra-Fatki enters into the Bhairab through the Afra Khal. The Bhairab River in the lower reach is susceptible to drainage congestion because of the high water levels in the Madhumati at the Halifax Cut in the monsoon season (ADB, BWDB and WARPO, 2004a).

3.5 Environment

Siapagla Flood Control and Drainage structure has modified the natural flow pattern, flooding and drainage which consequently bring changes in water levels and flows on both sides of the control structures; siltation ; erosion; flood regime; ground water level; soil moisture; potable and irrigation water availability and the conditions affecting human and animal health. Damage has caused to wild fish stocks, fisheries, natural flora and fauna (ADB, BWDB and WARPO, 2004a).

A major environmental impact is connected with the wash of agricultural residues into the wetlands/floodplains through bioaccumulation and biomagnifications that causes fish, shrimp disease and death. The blocking of migration routes, loss of nursery habitat and dry season refuges, combined with heavy fishing pressures, have had a profound impact on the fisheries sector, and the livelihoods of many poor people in rural areas who depend on fisheries or food and income. Indeed, aquatic biodiversity loss is of most concern to the poor. Studies have shown that the poor consume the highest diversity of fish, and trends towards reduction in diversity of fisheries and aquaculture systems are likely to be detrimental to the poorest groups (ADB, BWDB and WARPO, 2004a).

The pre-monsoon mean flood at 1.6m PWD is within the banks of the open Siapagla khal, but the 1:10 year pre-monsoon flood at 2.89m PWD and the monsoon mean and 1:10 year floods at 2.51 and 3.74 m PWD respectively damage Boro and Aus/ Aman crops. At the end of the monsoon all water drains from the khals and the soils become too dry for growing Rabi crops (LGED, 1998).

3.6 Resources and Livelihood

Resources

Afra khal is very rich in fish species and the water level at Afra Khal is adequate for fish species throughout the year.

The soil of the study area is fertile. Water is available and sufficient for irrigation. A wide range of cropping patterns is found in the area, but the major patterns are rice based. Pulses, oilseeds, vegetables, jute, wheat and spices are main non-rice crops.

Livelihood

Though the livelihood of the study area is mainly dominated by agriculture, a small portion of the local people depends on fishing. In terms of land holding, farmers can be categorized as small farmers (up to one hectare), medium farmers (one to three hectares) and large farmers (more than three hectares) (Paul, 1995). Fisher groups can be also categorized as "professional" or full time fishermen, seasonal or part time fishermen, and "subsistence" fishermen. Table 3.4 shows the livelihood pattern and Figure 3.6 and Figure 3.7 present the farm size distribution and occupational distribution, respectively.

Table 3.4: Household farm size distribution and occupation distribution.

Area - Occupation	Percent
Farm size distribution according to farmers inside the subproject	
0.0 to 0.50 acres	27%
0.51 to1.50 acres	30%
1.50 to 2.50 acres	24%
2.51 to 5.0 acres	14%
5.01+ acres	5%
Household occupation according to landless inside the subproject	
Farmers >0.51 acres	73%
Day Laborers	14%
Fishers and Navigators	1%
Trade, Transports etc.	8%
Others	4%

(Source: LGED, 1998)

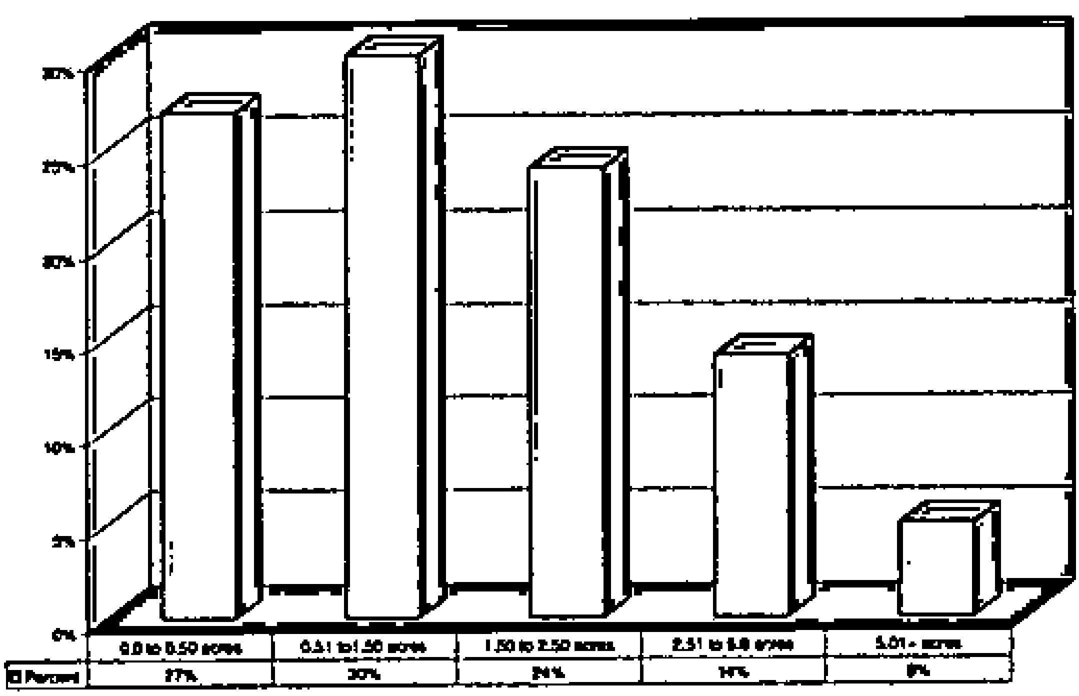


Figure 3.6: Farm size distribution.

(According to farmers inside the subproject)

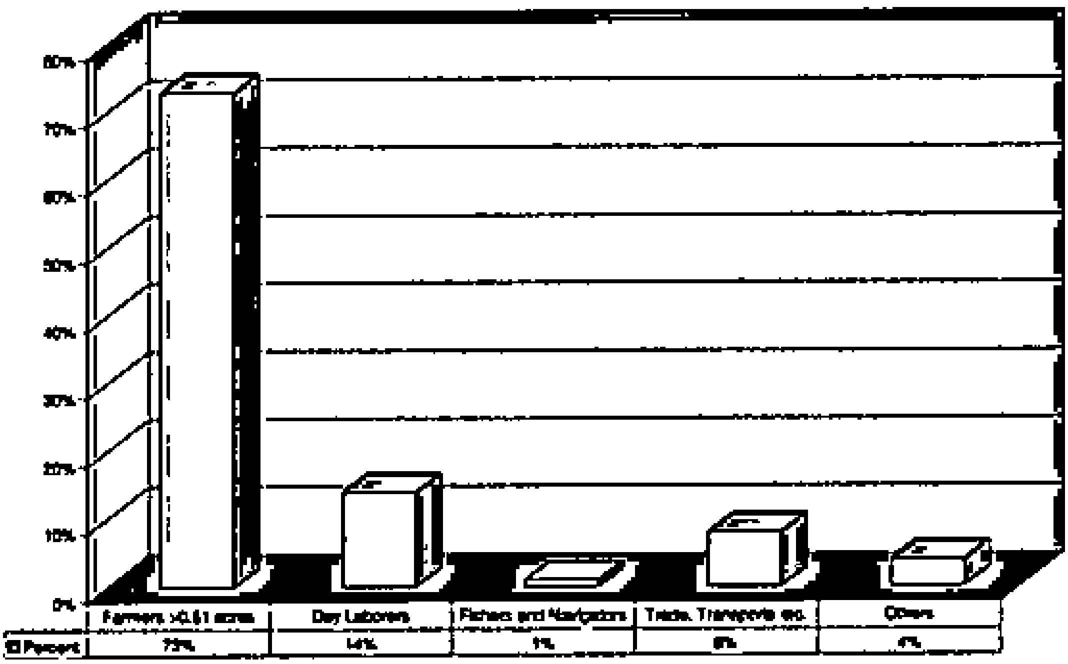


Figure 3.7: Occupational distribution of households.

(According to landless inside the subproject)

3.7 Agriculture Profile

In kharif-II (July-October), transplanted Aman is the main crop grown under rainfed conditions. Local T.Aman has a longer stem and can withstand some degree of flooding while short-stem HYVs are cultivated on lands with lower depths of flooding. B. Aman, i.e. deep water rice, is able to grow in deep water of more than 2 meters and is mainly cultivated in beels and depressed basins. It is a photosensitive crop with 7 to 8 month growth duration (ADB, BWDB and WARPO, 2004a).

Rabi (Nov-Feb) crops such as wheat, mustard, lentil, grasspee, spices and vegetables are mainly grown on residual moisture and sometimes with available irrigation water. HYV Boro is the main rice crop which is mainly irrigated by shallow tubewells (STWs). Lack of surface water during the dry season limits the expansion of low lift pumps (LLPs). An extensive area is still under local varieties, particularly during Aus and Aman seasons, producing low yields which indicate that there is still considerable potential to increase crop production in the district (ADB, BWDB and WARPO, 2004a).The dominant cropping patterns in our study area are Boro-Fallow-HYV T.Aman, Fallow-B.Aman, and Vegetables-Jute-T.Aman.

Table 3.5: Major cropping patterns in Narail.

Cropping Patterns		
Rabi	**Kharif-I**	**Kharif-II**
Boro	Fallow	T. Aman
Fallow	B.Aman	
Vegetables	Jute	T. Aman
Wheat	Jute	T. Aman
Pulses	Jute	T.Aman
Oilseeds	Aus	T.Aman
Wheat	Mung	T.Aman
Oilseeds	Jute	T.Aman

Source: District Agricultural Office (ADB, BWDB and WARPO, 2004a)

3.8 Fisheries Profile

The aquatic wealth i.e. the indigenous fish species are being depleted day by day along with the reduction of aquatic habitats. Narail is blessed with many potential beels/floodplains which had 260 fish species 2-3 decades earlier but now about 45% of fresh water species are threatened and critically threatened. This has occurred due to reduction of aquatic habitats (loss of aquatic habitats), over fishing, dewatering and water is withdrawn for irrigation. Therefore, a good number of sanctuaries have been established particularly in floodplains, over fishing have been established and the threatened fish species and floodplain/riverine resident species shall survive (ADB, BWDB and WARPO, 2004a). But, there is no sanctuary within the Siapagla FCD subproject area.

The inland fishery in Narail is at critical point in its development. The degradation and loss of fisheries habitats are increasing and a national perspective is essential for the sustainable development of our aquatic resources and fisheries. Ecosystems are threatened by fast changing land configurations, wetland loss, pollution and drying out rivers, khals and beels and destructive fishing is going on there during dry seasons (ADB, BWDB and WARPO, 2004a).

The physical conditions of Fisheries habitats (Rivers, beels, Baors and Khals) are being deteriorated considerably because of oversiltation every year as a result the topographical conditions have appeared at floodlands (flat) more or less. The following characteristics are in discernible (ADB, BWDB and WARPO, 2004a):

- Silted up beels, khals and rivers
- Reduction of Aquatic habitats everywhere but to a lesser extent
- Overfishing through smallest meshed size nets are called current jals. The perennial beels have been intensively fished by leaseholders/fishers/farmers for fishing.
- Dewatering is a common practice and reduction of fisheries habitats.
- Withdrawal of water for irrigation to paddy fields
- Filling up the deeper areas for paddy cultivation and thereby causing expansion of area for agriculture

Major Constraints

Loss of dry season fish habitat, loss of connections between dry season habitat and the floodplains, over fishing or fishing of undersized fishes, large scale abstraction of water for irrigate, alteration of spawning habitat by damming or changing of river cause and other such natural and manmade factors are responsible for the decline of open water fisheries. In the face of the above situation the strategy shall be to increase fish supply by way of major increases in aquaculture production, imports and conservation of fish stocks (ADB, BWDB and WARPO, 2004a).

The major constraints hindering the maintenance and development of Inland capture fisheries of Bangladesh have been reviewed in detail in recent years. The greatest problem identified has been caused by the extensive development of various flood protection projects, often linked with improved drainage and irrigation programs. Nationally, the overall effect of these programs has been converted a sizeable areas of seasonal wetlands which once supported productive fisheries into agricultural areas, principally for the purpose of increased rice production.

- Loss of aquatic habitats
- Interference with fish migrations
- Use of increased use of Agro-chemical to enhance crop production
- Lack of effective fisheries management
- Lack of information
- Reduced dry season river flows
- Water pollution
- Over-fishing
- Exploitation of juvenile & broods prior to breeding seasons
- Use of destructive gears
- Dewatering of beels, canals, rivers & other water bodies for irrigating the crops fields
- Compartmentalization of rivers thus blocking the river flow for aquaculture practices.

3.9 Project Objective of the Siapagla FCD Subproject:

The purpose of the Siapagla FCD subproject in the original proposal was to (i) construct one sluice at the outfall of Siapagla Khal to check inflow of tidal flood from the Afra Khal, (ii) Re-excavate the Khal to improve drainage, and (iii) construct embankments to prevent overland flood inflow in to the Siapagla Khal basin (LGED, 1998). Later, the SSWRDSP /BPPM team reviewed and revised on the basis of the information supplied from the field and on the results of standard social and technical analyses.

The revised elements of this subproject were (LGED, 1998):

- Subproject Type: CF and WC

- Concept- (i) check inflow of tidal floods into the sub project basin from the Afra Khal by constructing two sluice/regulator structures, one at the outfall of the Siapagla Khal and on a local drainage Khal in the North-western corner of the basin, and (ii) conserve water in the Khals for post monsoon cropping by closing the slide gates at the end of the monsoon season.(The capacities of the Khals are sufficient for the drainage of local runoff. the boundary roads and natural elevated grounds are high enough to prevent inflow of external floods)
- Subproject Boundary: A small low pocket of land along the Afra Khal in the North-western corner of the basin has been included in the sub project.
- Subproject Gross Area-1275ha.

So, from the above, we can conclude that the objectives of the subproject are:

1. To check saline intrusion (from the end of March to Mid June).
2. To conserve water at the end of monsoon season.

3.10 Major Cost Components of the Subproject

Siapagla FCD subproject is consisting of Siapagla two vent regulators and Barmara one vent regulator. The gross subproject area is 1275 ha and the net area is 975 ha (Source: LGED, 2007b). The project area is situated just left side of the Afra River and an embankment run parallel to the Afra River to protect it from flood.

Major cost components are given below-

Table 3.6: Major cost components of the Siapagla FCD subproject.

Item	Quantity	Rate	Cost
Re-excavation of khal	0.0 km	BDT 18.32/m3	BDT 0
Sluice/ Rgulator (2 vent 1.5m x 1.8m)	1 no	BDT 1800000	BDT 1800000
Sluice/ Rgulator (1 vent 1.0m x 1.8m)	1 no	BDT 1100000	BDT 1100000
Total			BDT 2900000

(Source: LGED, 1998)

3.11 Beels under the Siapagla FCD Subproject

The Kajla and Khamar beels are under the full control of Siapagla FCD subproject. There are also few beels (Chamrul beel, Kuri beel, Kurir Dob beel, Chandar Kuri beel, Mandartola beel, Machimara beel) which are under partial influence of the Siapagla FCD project.

Annual cycle of these non perennial beels can be described as follows-

Table 3.7: Characteristics of four cyclic phases of floodplain.

Characteristics	Phase 1	Phase 2	Phase 3	Phase 4
Phase Type	Resting	Preparatory	Growth	Decay
Period	January-March	April-June	July-September	October-December
Water	Almost Dry	In canals	Entire beel	Water recedes
Fishes	Shelter	Prepare for spawning	Grow	Move to shelter
Fishing	Residue	Almost nil	Moderate	Peak
Paddy	Boro grow/ no paddy	Boro harvest/ germinate	Aean Grow	Harvest
Decay	Dry	Germinate	Grow	Peak Decay
Water hyacinth	Rest	Germinate	Grow	Decay

(Source: Paul, S.K. and Majid, M.A., 1997)

Generally Beels are divided into five categories based on the limnobiological features They are- open, closed, perennial, Semi closed, semi open. Both the Kajla beel and the Khamar beel are under closed system due to the flood protection embankment with water regulators. The regulators operate in summer and late winter. The beels are shallow in a flat basin. A huge portion (70-80%) of these beels are covered thickly with paddy, water hyacinth coverage does not exceed 10%, while aquatic vegetation covers 10-20%. The paddy areas hold considerable amounts of macrophytes as well. Water of these category floodplains contains low DO (2-5ppm), low pH (6.0-6.5), low turbidity (40-50 ppm) and moderate conductance (100-150 us/sec). Plankton count is on low side (phytoplankton 25-40 u/ml; zooplankton 300-400 u/ml). Beels under this category are dominated with detritus food chain (Paul, S.K. and Majid, M.A., 1997).

3.12 Water Management and Governance

The Small Scale Water Resources Development Sector Project (SSWRDSP) is designed in such a manner that the water management and governance of the projects are carried out by the beneficiaries themselves. For this purpose, the stakeholders formed a Water Management Cooperative Associations (WMCA) in every subproject. The WMCA is formed by the direct vote of beneficiaries, and is mainly facilitated by LGED. WMCA consists of a President, Vice President, Secretary, Cashier and at least 6 to 8 members. WMCA is the proper authority to manage the SSWRDSP. One of the prime responsibilities of WMCA is to collect the 2% (average) of the implementation costs of the project from the beneficiaries. The personnel of WMCA are trained by LGED/ others organization on the fish culture practices, integrated pest management, as well as the use of compost and green manure fertilizers The optimum benefits on agriculture and fisheries from the subproject area largely depend on the active and proper involvement of WMCA.

The WMCA of Siapagla FCD sub project under SSWRDSP was formed on 27th October, 1997; registered on 10th April, 1998. The WMCA registration no. is 9 (LGED, 1998). Though it was very active at initial stage, but day by day it became less active for several reasons. Some of them are: irregular meetings, communication gap among members, lack of proper documentation, etc. This is verified from the field survey through FGD and interview. The members of Siapagla WMCA are: 1 President, 1 Vice President and Secretary, 1 Treasurer and 420 general members.

The present conditions of WMCA are given in the following tables (LGED 2007a):

Table 3.8: General information.

WMCA Reg Date	09/Nora 10/2/98
No. of household in Sub-Project Area	515
No. of beneficiary household in Sub-Project area	886
No. of household having land in Sub-Project area	340
No. of household having membership of WMCA	300
Cost of Sub-Project (Lac taka)	24.53

Objective of Sub-Project	Flood Management	
Infrastructure		
1) Embankment (km)		
2) Canal (khal) excavation/re-excavation	No.	
	KM	
3) Construction	Regulator	2
	Weir	
	Sluice	
	Others	

Table 3.9: Institutional information.

Total No. of WMCA Members	348
1) Male	262
2) Female	86
Percentage of total household being member of WMCA	75%
Percentage of total land owners being member of WMCA	70%
Date last General Meeting	24/08/2006
Monthly Meeting (Regular/Irregular)	Regular
Weekly Meeting (Regular/Irregular)	Irregular

Table 3.10: Financial management.

Total Capital	Tk 1,21,180.00
1) Share	Tk 22,360.00
2) Savings	Tk 91,950.00
3) Others	Tk 6 870 00
Micro Loan	Tk 3,08,000.00
Loan repayment rate	75%
How many members were given loan?	46
1) Male	32
2) Female	14
How many members were given pass book	
Date of last audit	20/06/2006
Are all audit dispute settled?	Yes/No

Table 3.11: WMCA/Sub-Project area visited by field level officers of LGED.

WMCA Activity	Exec. Eng.	Upaz. Eng.	Asst. Eng.	Sociologist	Sub-Asst. Eng.	Community Organizer	Comment
Yearly General Meeting		1	1	1	1	1	
Monthly Meeting		2	5	6	3	6	
Weekly Meeting			2	10	4	6	
Maintenance	3	3	6	6	12	3	
Training for Project Area			2	6		2	
Micro Loan	1	2	3	12	4	5	

Table 3.12: Operation and maintenance (O&M).

Date of O&M committee formation	18/10/06		Current year's planned/completed works
Trained on O&M			Silt excavation/weed removal/gate painting/greasing/changing of rubber seal/ others
Joint O&M Account No.			
Bank : Sonali Bank	Branch : Tularampur		Condition of structures
Date of joint inspection for Sub-project infrastructure	16/11/06		a) Embankment : Renovation needed b) Khaal(canal)/drain : Silt excavation needed
O&M budget for current year	Tk 16,14,047		c) Regulator/gate : Quite OK
Unutilized amount of previous year's budget	Tk 2,047		d) Culvert :
Current year's collection of O&M purpose	Tk. 32,000		e) O&M Shade
Voluntary maintenance work	Tk 6,32,390		

Table 3.13: Information on other sub-committee.

Subject	Agriculture related	Fisheries related	Gender related	Poverty alleviation related
Date of formation	10/09/2006	18/11/2006	20/10/2004	05/10/2004
No. of trained personnel and topic				
Yearly				
Planned yearly production				
Exhibition farm				
Inspection by Upazilla level officers				
Inspection by Union level officers				

(Source: LGED, 2007a)

CHAPTER FOUR
METHODOLOGY

4.1 Selection of the Study Area

The main criterion of selecting the study area was the existence of conflicts between irrigation and fisheries due to completion of the water resources development project. Secondary literature gave a clear indication of the source of conflicts, impact of water resources interventions (e.g.; FCD/I, embankment, etc) on irrigation, fisheries, wetland, ecology, etc. in the region. Six subprojects - Khatnur Beel WCS Subproject, Siapagla FCD Subproject, Bahirgram Subproject, Debbhog Subproject, Panu Khal DR & WCS Subproject and Chanduliar Char FCD Subproject were visited to finalize selection of the study area. FGD with local stakeholders, interviews with local people including farmers, fishermen, women, and a detail reconnaissance survey were conducted to identify the study area Resource factor, time constraint and the size of the study area were also considered for such selection. Finally Siapagla FCD (FC & WC type) sub project was selected for the study.

4.2 Data Collection

Both qualitative and quantitative data have been collected on Siapagla FCD subproject area from primary as well as secondary sources as per requirement of the study to address the objectives. Qualitative data have been collected from the field mainly while most of the quantitative data have been collected from the secondary sources. A number of methods i.e. Focus Group Discussions (FGDs), structured and non structured interviews, stakeholder workshops along with collection of data from secondary sources, measurement of water level at the two regulators (Baramara and Siapagla) , collection of water level and rainfall data for several years from CEGIS and BWDB have been used for data collection of the study.

Data collection focused on the flood control and drainage interventions and their impacts on livelihood and use of wetland resources. Particularly data on agriculture, fisheries and aquatic ecosystem were collected to identify water use conflicts, its management practices, options to minimize the conflicts in the study area.

4.2.1 Primary data collection

4.2.1.1 Focus group discussions (FGDs)

A total of eleven (11) FGDs have been conducted with different stakeholders such as fishers, farmers, female group, members of WMCA (water management cooperative association) and mixed groups of community people with similar interest. Guidelines to conduct FGDs were developed on the basis of the objectives of the study. A list of the FGDs conducted at different locations has been given in Table 4.1:

Table 4.1: FGDs at different locations.

Sl. No	Type of respondents	Locations
1	Members of WMCA	Khatnur Beel WCS Subproject
2	Members of WMCA	Siapagla FCD Subproject
3	Members of WMCA	Bahirgram Subproject
4	Members of WMCA	Debbhog Subproject
5	Members of WMCA	Panu Khal DR& WCS Subproject
6	Members of WMCA	Chanduliar Char FCD Subproject
7	Female group	Siapagla FCD Subproject
8	Farmers	Siapagla FCD Subproject
9	Fishermen	Siapagla FCD Subproject
10	A mixed group of similar interest	Siapagla FCD Subproject
11	Female group	Siapagla FCD Subproject

4.2.1.2 Interviews

Key Informant Interviews (KII) is an important method for collection of information on the overall aspects of the study based on observations and experiences of the local community. KIIs were conducted where necessary and feasible in the light of the objectives to gather qualitative information on water use conflicts and possible remedy for such conflicts.

Structured Interviews with resource persons of different organizations (LGED, Agriculture Department, Fisheries Department, NGOs – Bachte Shekha, Shabolombi) have been conducted with a target to collect both qualitative and quantitative information on certain aspects as per requirement of the study.

The list of interviews is given below:

Table 4.2: List of interviews with interviewee.

Sl No.	Type of Interview	Interviewee
1	KII	Fisherman
2	Structured	Fisheries Facilitator, LGED
3	Structured	Sociologist, LGED
4	Structured	Field facilitator, LGED
5	KII	Gate operator of Baramara Regulator
6	KII	Gate operator of Siapagla Regulator
7	Structured	Agriculture Officer, Narail Sadar
8	Structured	Agriculture Sub assistant officers, Tolarampur Union
9	KII	Local farmers
10	Structured	Senior Upazila Fisheries Officer, Narail Sadar Upazilla
11	Structured	Assistant Fisheries Officer, Narail Sadar Upazilla
12	Structured	Agriculture Engineer, Narail sadar Upazilla
13	KII	WMCA members
14	Structured	Member, Bachte Shekha
15	Structured	Member, Shabolombi

4.2.1.3 Stakeholder workshops

Two stakeholder workshops have been arranged to identify agreeable mitigation measures and to explore the feasibility of using such workshop in future as a platform for conflict resolution. The stakeholder workshop at union level held near Siapagla regulator with local stakeholders and the stakeholder workshops held at Narail Sadar level with UNO, Narail Sadar; officials of LGED, BWDB, NGO's etc.

4.2.1.4 Field reconnaissance

Field reconnaissance were done five times in the subproject area to have a clear idea about the location, people, socio economic activities, project boundary, livelihood of general people, impact of FCD intervention particularly on agriculture, fisheries and aquatic ecosystem, that helped in arranging FGDs and identifying people for key informant interviews.

4.2.2 Secondary data collection

Related publications (books, journals, research reports, articles published in the newspapers) have been consulted for collection of relevant secondary data on study area. Beyond these, secondary data have also been collected from different government sources like agriculture extension offices, fisheries offices, LGED, BWDB and non government sources like IWM, CEGIS, NGO's (Bachte Shekha, Shabolombi) etc.

4.3 Limitations

Time and resource constraints are the main limitation of this study. The field visits were conducted only during the dry season. The study would provide a much better picture of the area if the field surveys were done throughout the year. Measurement of hourly water level was done only for two days from 6 am to 9 pm. Similar water level measurements during different seasons of the year would provide a more representative water level variation, particularly during the Spring and Neap tides. Though this study proposed a feasible platform for conflict resolution, but the suitability of this feasible platform could not be checked due to time and resource constraint. Disruption in aquatic ecosystem requires a detailed investigation which was not possible within a very short time. Due to the same reasons, the detail assessment of socio-economic and environmental conditions, limnological parameters of wet lands was not done.

Details of the field visits are given in Appendix A.

CHAPTER FIVE
IMPACT ASSESSMENT

5.1 Introduction

To ensure food security for the rapidly increasing population, the government of Bangladesh has undertaken large scale agriculture development programs, focused primarily on rice production. A major element of these programs is water management for flood control and irrigation. For this, a number of FCDI schemes have been implemented. Siapagla FCD subproject is an example of that scheme.

To determine the impact of flood control and drainage project on livelihood, agriculture, fisheries and aquatic resources, focus group discussions (FGDs) with the fisher groups, farmer groups, female groups, mixed groups of similar interest and interviews with local people, and resource persons have been conducted. The information included their observation on the resources and their use, management since long back and reported the changes of wetland (khal and beel) resources due to the intervention. The impact as found in the study has been described below-

5.2 Impact on Livelihood

Beels play an important role in the livelihood of general people as they provide fishery resources for many households in terms of income and food. This is particularly important for the poorer households as they have a very few options for income generation. In spite of the importance of these resources, policy makers have ignored the inland capture fisheries sector in Bangladesh Most development policies prioritized agriculture neglecting or giving less priority to fisheries sector (World Fish Centre, 2007a). As a result, a major portion of the beels came under agricultural activities due to beel dewatering under the FCD subprojects. This promoted agricultural activities and food grain production almost three times as much the pre-project situation. Surely, this benefits the people whose livelihood depends directly or indirectly on agriculture. Rapid agriculture intensification has created local employment opportunities for the poor people and fisher's income increased from business opportunities and rural transport over the years. In contrast they have reduced income from fish trade, livestock and other sources (World Fish Centre, 2007b).

According to a survey report of World Fish Centre, it was found that the fishing community in Bangladesh is characterized by the poor with the majority possessing very little assets. The fishers rely primarily on fishing for their livelihoods. The declining trend of fish production from capture fisheries over the last three decades has negatively affected their livelihoods.

Most of the people dependent on fishing and other aquatic resources for maintaining their livelihoods for ages have been compelled to change their professions and engage in agricultural practices, van/ rickshaw pulling, small trades and other professions around the areas such as different upazillas, districts and even divisional towns causing social and economic hardship in their livelihoods (Ali, 2006). They are unable to move to other profitable income earning activities due to limited access to finance. Again their access to lakes, rivers and floodplains is strongly affected by the people who control aquatic resources at the local level, particularly the rich and elites. The same condition prevails in the Siapagla FCD subproject area. At the pre project condition, fishing activity was accessible to all and the economic condition of the fishermen was quite satisfactory. But at the post project condition, the fishing community suffer from extreme poverty and this FCD sub-project causes severe negative impact on the livelihood of the fisherman. So, they are changing their livelihood. It was also found that the fishing community is not properly compensated and only solvent people are allowed to catch fish in the khal.

5.3 Impact on Agricultural Resources

At pre project condition, single crop cultivation was the major feature in the Kajla beel and Khamar beel area. Salinity problem was severe and affected the crop yield. But, at the post project condition, the cultivated area has increased in the low land The Boro cropped area has increased in the surrounding areas of the beel because of early recession of inundation water due to the project interventions. Boro cultivation area has increased not only in the lowlands but also in the most of the medium low lands due to regulating the water level. Recently, Boro HYVs replaced the local varieties of Boro paddy almost throughout the project with the control of pre-monsoon floods and an expansion of mechanized irrigation. Mobile machines for threshing paddy and rice mills were also found in the project area. There is also some negative impact on agriculture as the exclusion of floods has obstructed silt deposition in the project area which has decreased soil fertility.

Agriculture has become the highest single labour intensive activity. This is because of the changes in agricultural pattern with the introduction of high yielding varieties (HYV) and modern technologies in the fields, which have raised tremendous increase of crop production through irrigation, cultivation of two crops in the same land.

The main purpose of the subproject is to increase the crop production. The appraisal report (LGED, 1998) shows an overall increase of 2705 tons (84%) for cereals; production of pulses will increase by 343 tons (47%). Table 5.1 illustrates crop area, yield and production by land type under both pre and post sub project conditions. Figure 5.1, 5.2 and 5.3 show comparison of agricultural land type at pre and post project condition, comparison of cultivated crop area per land type at pre and post project condition and comparison of crop production per land type at pre and post project condition respectively. Figure 5.4 and 5.5 illustrate the comparison of cultivable area and crop production by year respectively.

Table 5.1: Area, yield and production by land type.

Pre-Subproject			
Crop	Area (ha)	Yield (t/ha)	Production (t)
F0	107		
B. Aus	25	2.1	52.5
HYV T. Aman	106	4.1	434.6
Wheat	48	2.6	124.8
Jute	81	2.5	202.5
Pulses	29	1.4	40.6
Oil Seeds	29	1	29
Totals	318		884
F1	195		
B. Aus	113	2.1	237.3
IT Aman	64	2.3	147.2
HYV Aman	132	4.1	541.2
Wheat	112	2.6	291.2
Jute	83	2.5	207.5
Pulses	69	1.4	96.6
Oil Seeds	15	1	15
Totals	588		1536
F2	563		
B. Aus	169	1.2	202.8
Mix B. Aus	113	1.1	124.3
Mix DWR	113	1	113
B. DWR	281	1.3	365.3
IT Aman	169	1.4	236.6
Pulses	298	0.7	208.6
Totals	1143		1250.6
F3	563		
Mix DWR	110	1.7	187
HYV Boro	110	4.8	528
Totals	220		715

Post-Subproject			
Crop	Area (ha)	Yield (t/ha)	Production (t)
F0	710		
B. Aus	546	2.1	1146.6
IT. Aman	341	2.3	784.3
HYV T. Aman	369	4.1	1512.9
Wheat	160	2.6	416
Jute	164	2.5	410
Pulses	506	1.4	708.4
Oil Seeds	44	1	44
Totals	2130		5022.2
F1	265		
B. Aus	155	2.1	325.5
IT Aman	155	2.3	356.5
HYV Aman	110	4.1	451
HYV Boro	110	4.8	528
Wheat	152	2.6	395.2
Pulses	3	1.4	4.2
Totals	685		2060.4
F2	0		
			0
Totals	0		0
F3	0		
			0
Totals	0		0

[F0=High land, not flooded; F1= Medium high land, Flood depth 30 to 90 cm; F2=Medium low land, Flood depth 90 to 180 cm, F3=Low land, Flood depth over 180 cm]

(Source: LGED, 1998)

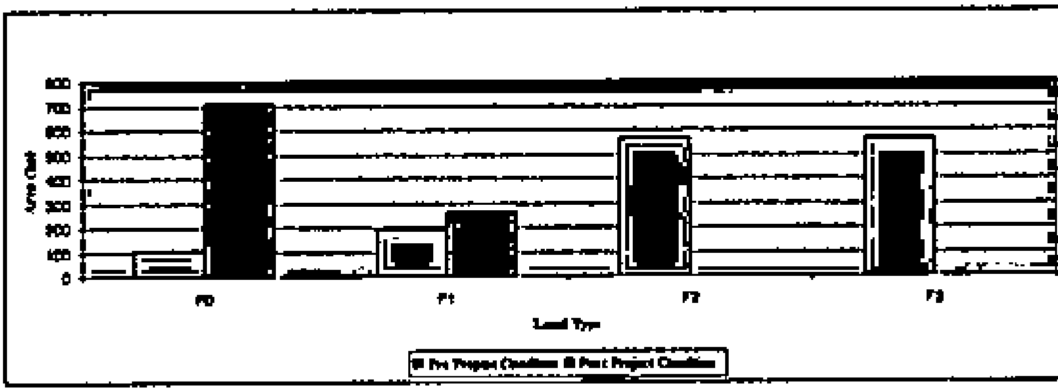


Figure 5.1: Agricultural land at pre and post project condition.

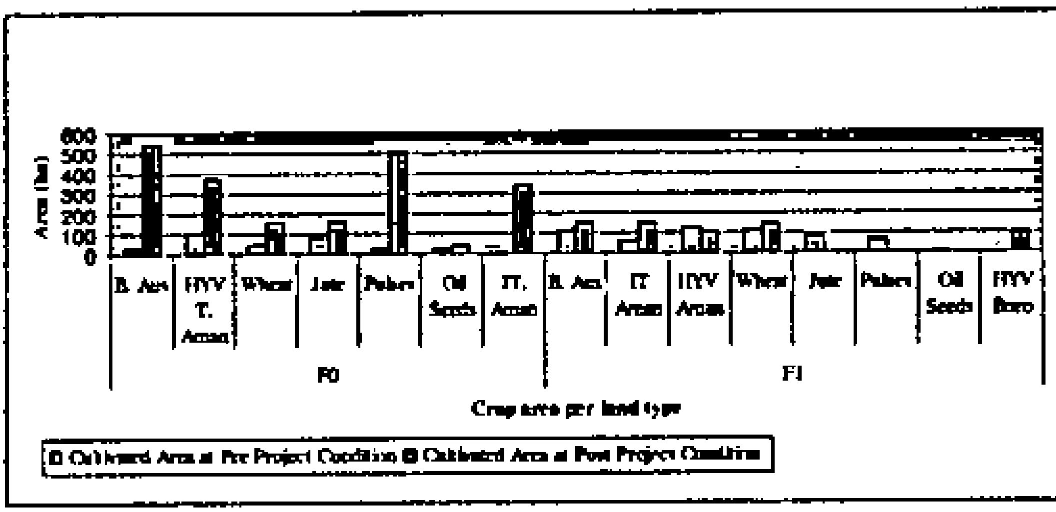


Figure 5.2: Cultivated area at pre and post project condition.

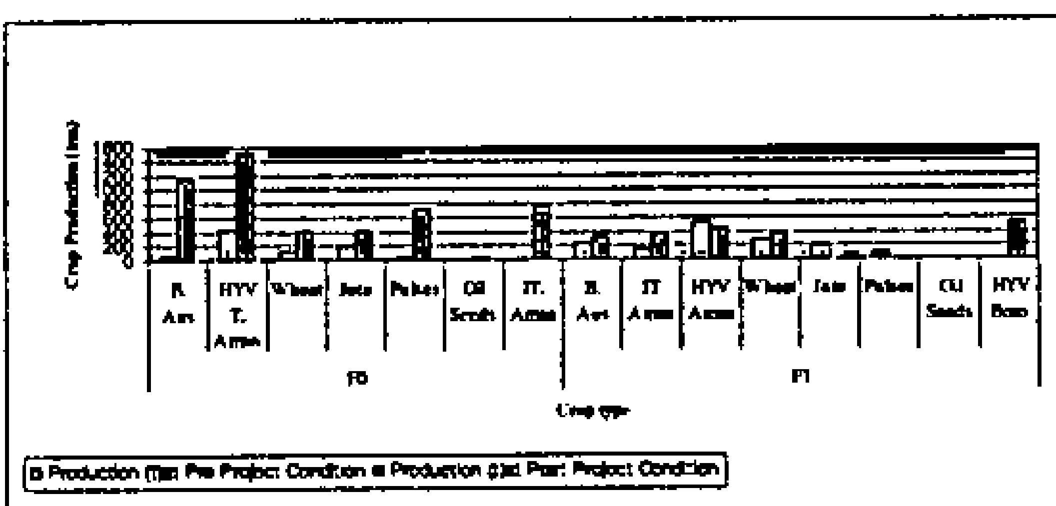


Figure 5.3: Crop production at pre and post project condition.

Table 5.2: Actual production by year.

Year	Crop Season	Area (ha)		Production (m ton)	
		Cereal	Non Cereal	Cereal	Non Cereal
1997	Kharif-1/Aus (Pre monsoon)	420.00	274.00	631.20	685.00
1997	Kharif-2/ (Monsoon)	865.00	0.00	1836.20	0.00
1997	Rabi/Boro (Winter)	270.10	439.90	944.90	459.70
		1555.10	713.90	3412.30	1144.70
1999	Kharif-2/Aman (Monsoon)	865	0	2148.9	0
		865	0	2148.9	0
2000	Kharif-1/Aus (Pre monsoon)	430.2	283	680.6	846.2
2000	Kharif-2/ (Monsoon)	865	0	2036.1	0
2000	Rabi/Boro (Winter)	304.3	466.7	1166.3	541.1
		1599.5	749.7	3883	1387.3
2001	Kharif-1/Aus (Pre monsoon)	428.3	277.3	710	774
2001	Kharif-2/ (Monsoon)	868.4	0	2722.5	0
2001	Rabi/Boro (Winter)	330.4	488.7	1150.6	403.9
		1627.1	766	4583.1	1177.9
2002	Kharif-1/Aus (Pre monsoon)	433.2	295.5	767.4	809.4
2002	Kharif-2/ (Monsoon)	822.6	0	2945.7	0
2002	Rabi/Boro (Winter)	448.6	541.6	1735.8	689.2
		1704.4	837.1	5448.9	1498.6
2003	Kharif-1/Aus (Pre monsoon)	115	182	235.9	449.5
2003	Kharif-2/ (Monsoon)	835	0	3200.6	0
2003	Rabi/Boro (Winter)	366	231	1732.7	403.9
		1316	413	5169.2	853.4
2004	Kharif-1/Aus (Pre monsoon)	158.7	221	392.5	547
2004	Kharif-2/ (Monsoon)	870.5	0	2709.2	0
2004	Rabi/Boro (Winter)	439.3	0	2278.6	0
		1468.5	221	5380.3	547

(Source: LGED, 2006)

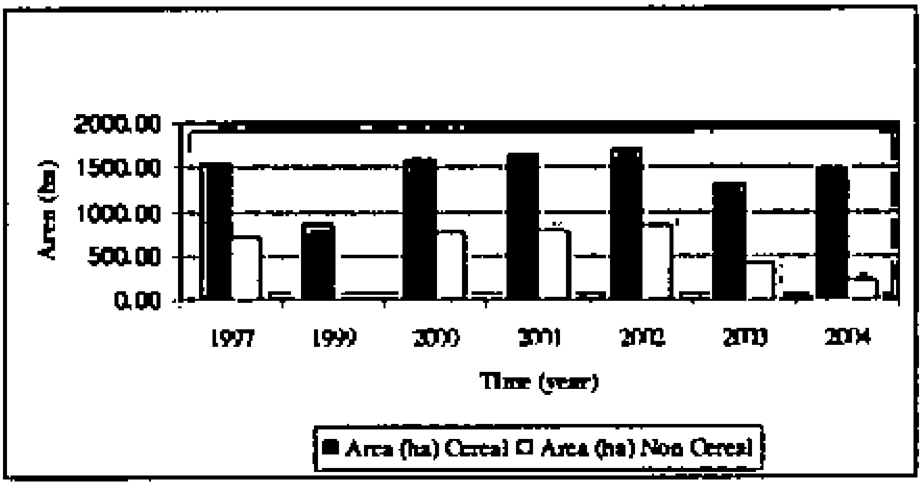


Figure 5.4: Comparison of cultivable area by year.

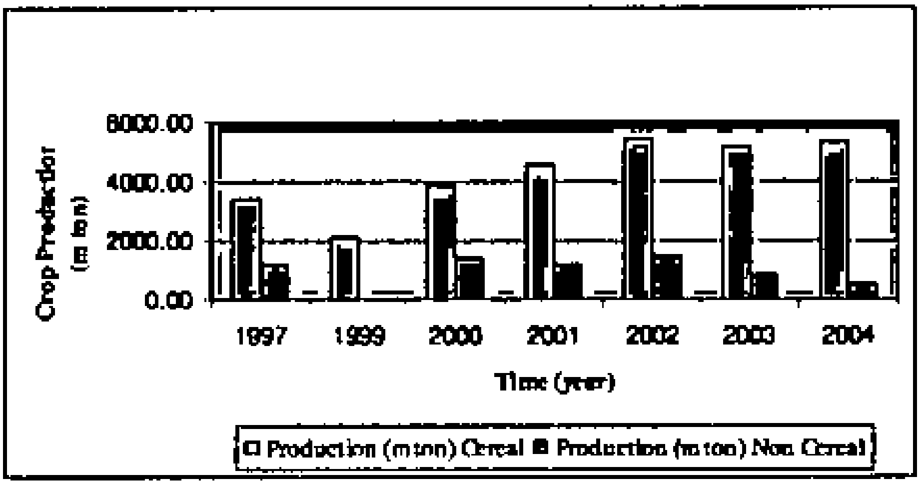


Figure 5.5: Comparison of crop production by year.

5.4 Impact on Fisheries Resources

Abundance of fish, variation of species, its changes and causes with regard to harvesting and conservation of fish have been considered to determine the impact on fisheries resources and management. Before the implementation of the project, there were plenty of fishes and fisheries resources were easily available and accessible to the general people. The vast open water fishing areas of the beel would not require any management intervention. The traditional Hindu fishers (Rajbongshi) only would harvest fish as per their customary rights of fishing in the beel since time immemorial.

The women were not involved in the fishing activity except its processing and drying up at home.

But after the project, wetlands and low lying flood plain areas that previously flooded for prolonged periods have been transformed in to agricultural lands. As a result, extensive areas of floodplain wetlands that had served as feeding and breeding habitat for small and large native species of fish have been converted and migration routes have been disrupted.

Furthermore, general intensification of agriculture practices in irrigated areas is likely to lead increased use of agrochemicals, Pesticides, in particular, are a threat to local fish stocks. The traditional poor fishers have lost their fishing access due to the involvement of influential non fishers (mainly rich farmers). They have taken control over potential fishing grounds and manage the overall fishing activity. The traditional poor Hindu fishers have changed their profession and being engaged as labourers in fishing, day labourers, agri- labourers and in other works, whatever available to maintain their livelihoods.

As a general rule the Indian carp species can not breed naturally in still waters, so that sexually mature fish have to migrate from beels to rivers and travel considerable distances upstream in order to reach suitable spawning grounds. This takes place during the early flood, i.e. May and June. The masses of fertilised eggs (spawn) then drift back to downstream, hatching out an route and as the floods continue to rise are swept from the rivers and distributed across the inundated floodplain where they grow, over wintering in perennial water bodies such as beels. Blockage of either the May / June spawning run or of the subsequent return of young fish, inevitably results in the decline and eventual extinction of such fish stocks from both the beel areas concerned and rivers (FAP 12, 1991), which exactly happened in our study area.

A range of species of other kinds of fish live permanently in static water and can breed in pools, flooded ditches or in the beels. This group also includes snake heads (Shol and Gajar), cat fish (including Magur, Boal and Shingi) and anabas (Koi), which has accessory air breeding organs enabling them to survive in marshy conditions or even periods of semi drought. Of secondary importance and low value in the past, these fish are now the principal components of the capture fisheries in FCD affected areas (FAP12, 1991).

The important potential adverse impacts on fisheries (FAP 12, 1991) due to this FCD project are listed below-

i. Loss of fish production due to the loss of flood habitat during the monsoon.

ii. Obstruction to the movements of fish (adults, juveniles and hatchlings) between external rivers and floodplains.

iii. Reduced diversity of fish by preventing migratory species entering floodplains.

iv. Increased fishing pressure on smaller areas of water during the monsoon resulting in damage to the long term sustainability of fisheries.

v. Reduction of dry season habitat which results in higher fishing pressureand increased catch ability of over wintering fish brood stock. The increased abstraction of water from beel to irrigate surrounding rice fields was a articular concern.

vi. Reduced ground water recharge resulting in a lower water table in the dry season which in turn could lead to a reduction in the area of perennial beel. Dry season rice production dependent on tubewell irrigation was also thought to be at risk from lowered ground water levels as well as increasing the problems for drinking water supplies.

vii. Loss of high value migratory species such as major carps and catfish by preventing migrations between rivers and floodplains and thereby interfering their life cycles.

viii. Increase fish disease by the creation of adverse environmental conditions such as stagnation of standing waters which could trigger disease out breaks in already stressed and modified fish communities.

The appraisal report (LGED, 1998) shows the adverse impact on fisheries due to the Siapagla FCD subproject. Table 5.3 and Figure 5.6 illustrate the estimated potential unmitigated fisheries impacts, in terms of habitat, yield and production changes. FCD subproject was expected to adversely impact fisheries habitat in the area. The entire floodplain area (F2+F3 land) which was 673 ha at pre project condition would be eliminated. The total annual loss in fish production was estimated at about 78 tons.

Table 5.3: Fisheries habitat, yield and production.

Habitat (ha)	Pre project	Post project	Change	Change (%)
Floodplain area (F2+F3)	673.00	0.00	-673.00	-100.00
Permanent Water body Area	40.00	40.00	0.00	0.00
Pond Area	0.00	0.00	0.00	NA
Yield (kg/ha)	**Pre project**	**Post project**	**Change**	**Change (%)**
Floodplain yield	100.00	40.00	-60.00	-60.00
Permanent Water body yield	450.00	180.00	-270.00	-60.00
Pond yield	NA	NA	NA	NA
Production	**Pre project**	**Post project**	**Change**	**Change (%)**
Floodplain Production	67.30	0.00	-67.30	-100.00
Permanent Water body production	18.00	7.20	-10.80	-60.00
Pond production	0.00	0.00	0.00	NA
TOTAL PRODUCTION	85.30	7.20	-78.10	-91.56

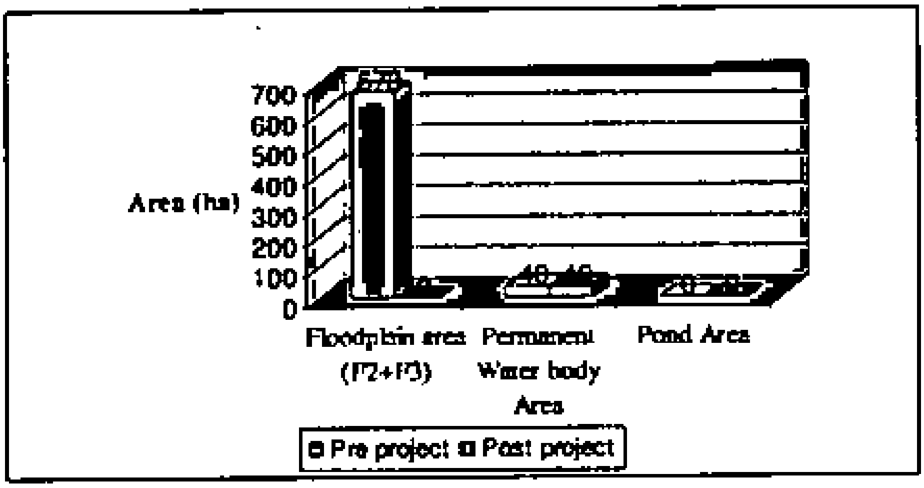


Figure 5.6: Impact of fish habitat.

The MIS report for the sub-project (updated on 28.01.2008) verifies this decreasing trend. The table 5.4 shows the decreasing rate of fisherman, fish production.

Table 5.4: Impact on fish by year (at post project condition).

Year	Fisherman (nos)	Fish Farmer (nos)	Fish Production		Status	
			Flood Plain	Permanent water body	Fisherman	Fish Farmer
1998	16	0	67.3	18	Base Case	Base Case
1999	16	3	0.5	0	Deteriorated	No change
2000	16	3	18	0	Deteriorated	Deteriorated
2001	45	0	56	0.5	Deteriorated	Deteriorated

(Source: LGED, 2008)

To minimize the effects, some habitat expansion / improvement could be achieved through water retention in the khals. Also improvements in fish production would depend substantially on efforts directed towards stocking and expanding pond aquaculture.

Residual impacts on subsistence fishers (primarily landless and small/ marginal farmers) are expected to be partially or entirely compensated by positive employment and nutritional impacts associated with increased agricultural activity and production. Fishing as a primary occupation is reported to be 1% of subproject residents. There is a need for the WMCA to address the requirement for rehabilitation of this group.

5.5 Impact on Environment and Ecology

The development intervention taken for increased crop production has seriously affected the wetland ecosystem and their resources. Construction of two regulator structures, one at the outfall of the Siapagla khal and one on a local drainage khal in the North-western corner of the basin (Siapagla and Baramara regulators) and embankment along the river (Afra Khal) has affected the natural flow of water, migration of fish and other aquatic species, and accelerated siltation of water bodies resulting serious natural imbalance

Beel dewatering has created vulnerable, disastrous and critical ecological conditions. The beel bed has been raised due to rapid siltation. The confluences of the rivers and canals with the beels have been silted up. This situation has caused serious negative impact on the ecology of the beels. The fish and other aquatic species are unable to enter in the beel for breeding, spawning, feeding and growing The habitats of fish and other aquatic flora and fauna have been also affected adversely.

The mollusks, mainly snails and bivalves, are important indicators of a balanced environment. At the post project condition, there were plenty of these shellfishes (bivalves and snails) but now they are decreasing rapidly and rarely observed in the study area due to destruction of habitat, massive hunting and use as poultry feed including production of calcium oxide.

Again, since there is very little flooding of the crop fields due to project interventions in the normal years, no silt is deposited reducing the level of natural fertility of soils. The agriculture production, however, has been doubled at the cost of wetland (khal, beel, river, etc.) ecology, environment and its resources. But the agricultural production or the loss of ecology, whichever is higher, could not be assessed without full accounting of wetland values including habitats and biological diversity (Ali, 2006).

5.6 Impact on Women

The main difference between the pre and post project conditions is that women get more opportunity for earning money through different activities after the project. Very few women were engaged in income earning activities- mainly in rice husking, pottery, sewing and weaving before the implementation of the project.

At pre project condition, the cultivable land and the cropping intensity were lower than post project. Women's participation in agriculture activities during this period was only limited to winnowing, parboiling, drying and milling paddy within the homestead. These activities were done by two classes of women: women within the family and wage labourer women. Within the project area, the number of wage labourers was small in the pre project and they were responsible for processing a smaller part of the total crop. However, the earnings from these types of employment were often their only source of income and therefore critical for their family welfare. Dheki (a foot operated mortar and pestle); a traditional method of husking was more common in the pre project time. Big farmers usually engaged wage labourers for doing dheki work, which was largely replaced by husking machines in the post project period. Within the homestead women were involved in mat weaving which is still a very common skill among the village women and sometimes used for generating income (FAP 12, 1991).

Employment opportunities have increased within the project area as a result of the FCD project which mainly benefited wage labour households and landless people. The FCD project changes the cropping pattern and as a consequence cropped land post harvest activities (e.g. winnowing, parboiling, drying and milling) increased significantly. This has created a higher female workload and also provided better wage earning opportunities for wage labourer women (FAP 12, 1991).

Such development intervention contributes a lot towards women development in terms of social and economic status through providing with opportunities of work in diversified fields. Women themselves got scope to work for income earning with their male counterparts to contribute to their family income to improve their socio economic conditions. Such opportunities of employment and increase of mobility of the women helped them to raise their confidence and social empowerment (Ali, 2006).

The same above mentioned situation was observed in the Siapagla subproject area. The FCD project itself is another special source of employment. A number of female labourers have taken part in canal excavation, earthwork for embankment, etc.

LGED being the implementing agency formed a group of Water Management Cooperative Association (WMCA). The prime responsibility of the WMCA is to look after the sluice gates/ regulators. It also dispatch loan to female members to encourage them to take part in different earning activities (hen, cattle rearing, mat weaving, tailoring etc.). It was also observed from field that few female members of WMCA bought tractor to help agriculture activities. When women have money in their hand, they can take part in decision making and become influential family members. LGED also arranged trainings in different development centres on savings, income generation, sewing etc. for some selected WMCA female members. As a secondary effect of the project, a number of government and NGO programmes for income and employment have been promoted in the post project period. This will facilitated by better road communication within the project area. There was an increase in self awareness as a result of these programmes.

5.7 Social and Institutional Impact

Land ownership in the project area is highly unequally distributed at both the pre and post project situations. The village affairs are managed by the village Matbars (leaders) who were members of the big land holding and traditional families. The leaders of Water Management Cooperative Association (WMCA) also belong to this group.

Due to the FCD project, the Kajla and khamar beels have contributed to an increase in HYV Boro production. This results an improvement of the socio economic condition of the villagers around the beel area. The villagers also felt mentally strong due to this project. Improvement of agriculture, in terms of acreage and production make the farmers confident. A subsequent development of 'kutcha' roads was also seen. The improved road communications have facilitated occupational diversification in to jobs, e.g. petty traders, van pullers, rice husking etc. This has also facilitated some social development services.

5.8 Economic Impact

The project has accomplished its primary goal of increasing crop production. The economic gains of the project were anticipated implicitly in terms of increased production, employment and farmers income. There are also other forms of tangible and intangible benefits from improvement of road communication and expansion of petty traders. Embankment cum road of the project area has opened up self employment opportunities in non farm economic activities, which has differential impact on different groups.

Prior to the implementation of the project, open water capture fishing in the beels was a major source of income for the professional fishermen and the only grounds for subsistence fishing by the villages. The major disbenefits are loss of capture fisheries and loss of aquatic habitat.

CHAPTER SIX
RESULTS AND DISCUSSIONS

6.1 Conflict Identification

6.1.1 Conflict identification on the basis of focus group discussions (FGDs), interviews

FCD project has both positive and negative impacts on the lives and livelihoods of people of the project area. Conflicts arise due to these impacts Identification of conflicts from different perspectives is very difficult since the conflict is not always apparent. The weaker section of the society may lose their dispute though they may have resentment and pain in their mind. Sometimes, they express their discontent when they are alone or away from their counter part but rarely they express it in front of their stronger rivals.

Field investigations were carried out to understand the prevailing situations that have created or indicated the conflicts These situations are summarized below-

1. Rapid intensification of agriculture and drastic decline in open water capture fisheries due to the FCD project creates a conflicting situation between farmers and fishers.
2. Most fishermen were not aware about the project at the project formulation process.
3. Severe impact on the livelihood of the fisherman. This results extreme poverty in the fishing community.
4. The fishing community is not properly compensated.
5. Only solvent people are allowed to catch fish in the khal during a portion of the year.
6. Both the beel area of Siapagla and khamar khal has lost their aquatic habitat.
7. The condition of khamar beel (adjacent to khamar khal) is more deplorable than the Kajla beel area around Siapagla khal One powerful, rich farmer obstructs

the flow of water by constructing a cement-concrete barrier. At high tide, fishes overflow the barrier but they can't return back in to the river due to this barrier No fisherman except the owner of that barrier is only allowed to catch fish. This creates resentment among the general people, especially in the fishing community.

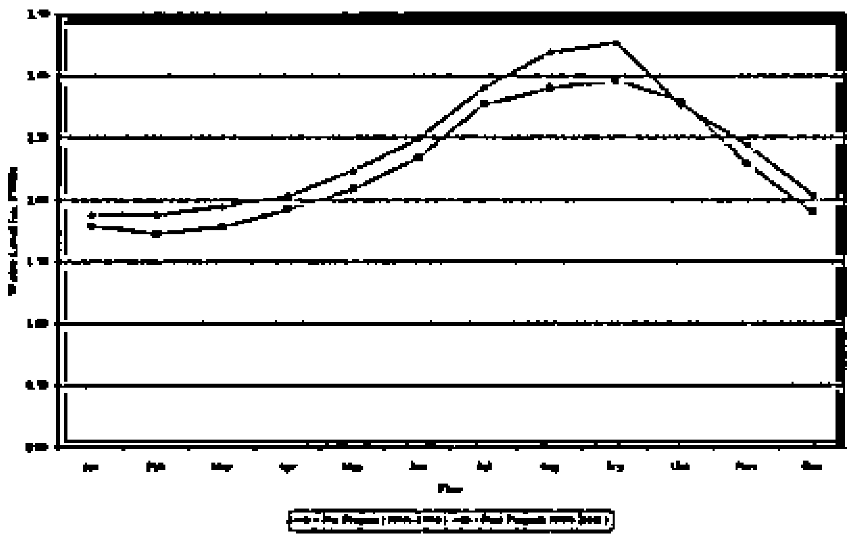
8. Heavy siltation was found particularly in the Siapagla khal. This siltation obstructs the free flow of water, creates drainage congestion which in the long run has negative impact on fisheries. So, there is an urgent need for khal excavation. Some project beneficiaries and LGED have proposed that excavated soil be deposited on the bank of the khal. But this is strongly opposed by the land owners in those areas.
9. WMCA is responsible for the maintenance of the two regulators. But it was found from the field that WMCA is not doing its maintenance properly. One of the sluice gate (right side) of Siapagla regulator has not been working at all for more than a year. As a result, inflow into the khal from the river has been reduced. Heavy silt deposition was found at both sides of that closed gate. This has created adverse situation for fish habitat and migration.
10. WMCA was supposed to rehabilitate the affected communities by sanctioning loan, giving training, providing a training room for female members, etc. But in fact they are approving loan to them who are favourable to their interests. The weaker portion, especially the fisher group, did not gain any benefit from WMCA.

6.1.2 Conflict identification on the basis of analysis of hydrological data

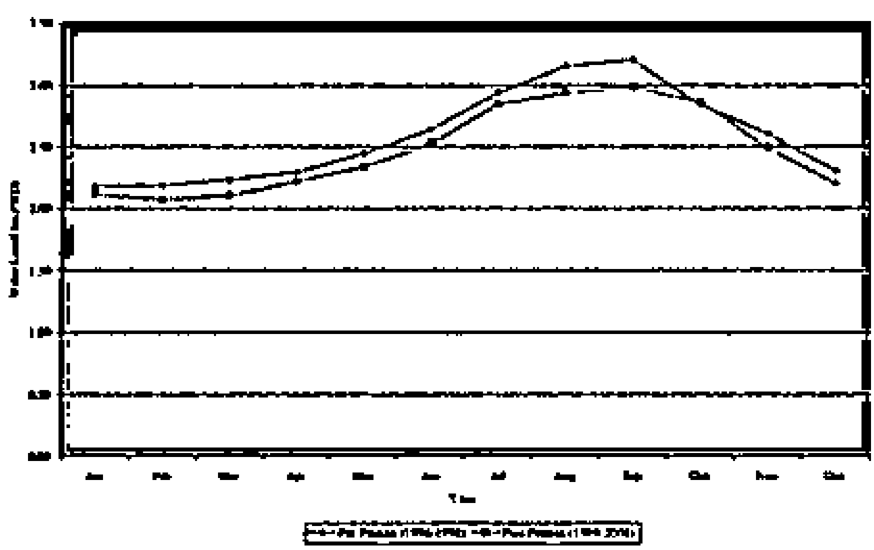
6.1.2.1 Pre project and post project water levels

Figure 6.1 shows the water level in the khal (outside the gate) has been lowered in general in the post project period (1999-2008). The water levels have been estimated from correlation between observed data at the site and long term data from the secondary source for a BWDB station (Station ID 30). Details of the data analysis procedure are given in Appendix B.

The maximum water level in the post project situation is approximately 3.0 m PWD in mid September. The range of water level variation in the Khamar Khal is approximately 1.24 m PWD and in the Siapagla Khal is approximately 0.88 m PWD. The difference between the pre and post project water levels ranges from 0.08 m to 0.28 m in the Khamar Khal and from 0.06 m to 0.22 m in the Siapagla Khal.



(a): Khamar Khal.



(b) Siapagla Khal.

Figure 6.1: Water level variations at pre and post project conditions in the study area.

6.1.2.2 Water level variations in the khals

To assess the impact of flood control regulators (Siapagla and Baramara), one of the necessary things is to understand the variation in water level inside the khals. Generally, farmers choose to operate the sluice gates to allow controlled entry of Afra River water to prevent saline water intrusion and conserve water in the khals for the post monsoon cropping season.

Table 6.1 and 6.2 give the post project water levels in the khamar khal and Siapagla khal (inside the gate) respectively. These water levels were obtained from the gate operators and were verified with the local people. Maximum water levels maintained in the khals by gate operators are 2.30m and 2.41m for the Khamar Khal and Siapagla Khal respectively. Figure 6.2 and 6.3 shows the monthly water level variation and indicates the periods when sluice gates are opened or closed.

Table 6.1: Post project water level variation at Khamar Khal.

Month	Post Project WL in Khamar Khal (1999-2008)	Explanation
Jan	0.91	When the sluice gate is open, the water level variation is due to the fluctuation of Afra River and Rainfall. But when the sluice gate is closed, the water level variation depends only on rainfall.
Feb	0.83	
Mar	0.90	
Apr	1.20	
May	1.25	
Jun	1.30	
Jul	2.13	
Aug	2.30	
Sep	2.37	
Oct	2.16	
Nov	1.53	
Dec	1.05	

Table 6.2: Post project water level variation at Siapagla Khal.

Month	Post Project WL at Siapagla Khal (1999-2008)	Explanation
Jan	2.24	When the sluice gate is open, the water level variation is due to the fluctuation of Afra River and Rainfall. But when the sluice gate is closed, the water level variation depends only on rainfall.
Feb	2.23	
Mar	2.24	
Apr	2.26	
May	2.27	
Jun	2.28	
Jul	2.39	
Aug	2.41	
Sep	2.41	
Oct	2.39	
Nov	2.31	
Dec	2.26	

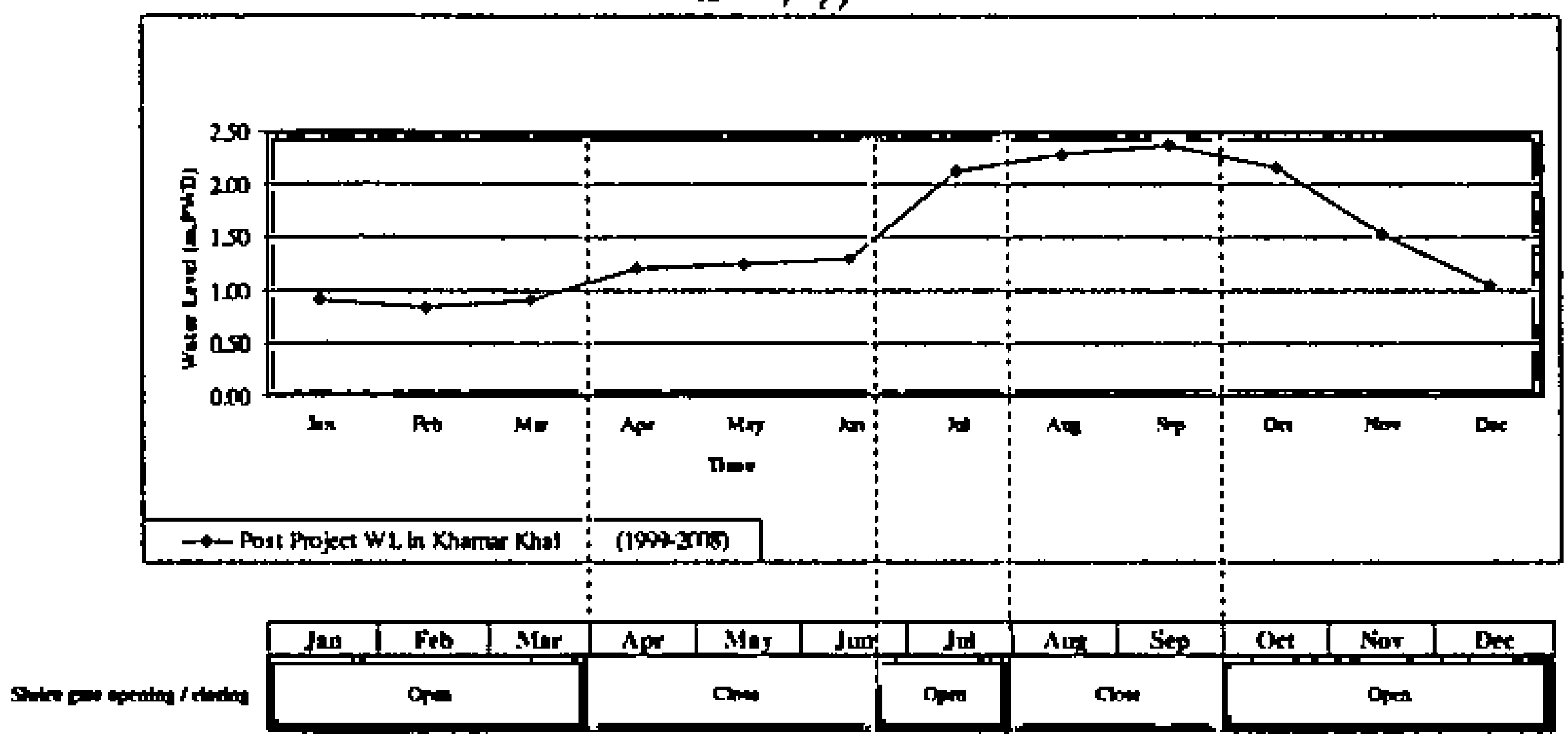


Figure 6.2: Post project water level variation at Khamar Khal (1999-2008).

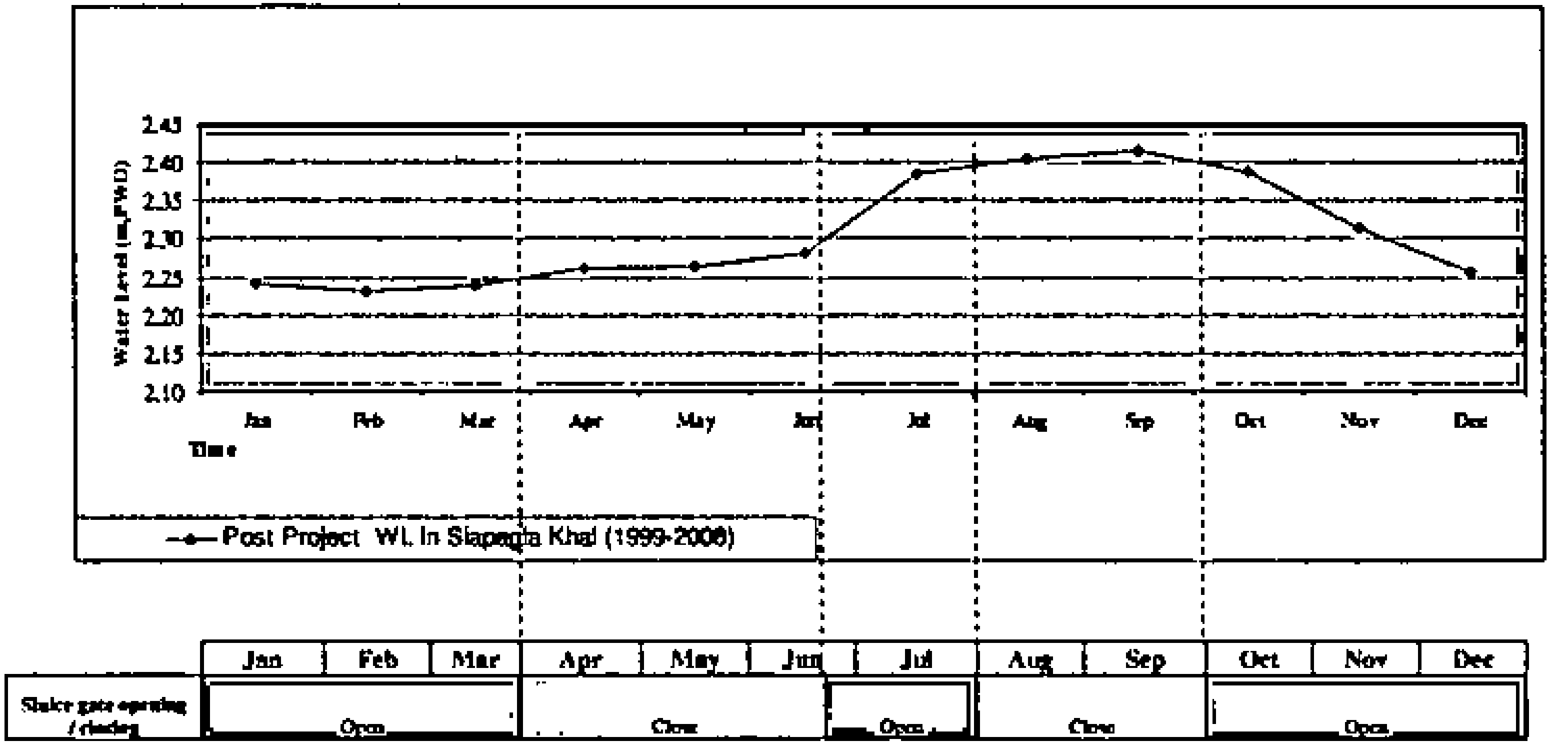


Figure 6.3: Post project water level variation at Siapagla Khal (1999-2008).

6.1.2.3 Hamper of fish migration due to sluice gate

Both Siapagla and Baramara regulators reduce fish migration between the river (Afra Khal) and floodplains (Kajla Beel, Peruli Beel, Khamar Beel) in two ways. First, by reducing the number of entry points on to floodplains and thereby concentrating fish into fewer channels where they were more susceptible to capture. Field study showed that during neap tide, when sluice gate is open and water level at khal is very low, village people (both male and female) were engaged in fishing activity in the khals. They were even catching fish by straining the muddy soil of the khals. Second, by closing gates of regulators for extended periods during the pre monsoon and monsoon.

The table 6.3 describes the fish migration pattern of Carp and Cat fish species. The dark cells in the table indicate the fish migration period. Types of seasonal migration are described in section 2.3.2.

Table 6.4 shows the periods when different types of migration are hampered due to closing of the regulator gates. For example, "dispersed of young over floodplain" for the carp fish takes place during 21 May to 31 October. However, since the gates are closed during 01 April to 20 June and 01 August to 30 September, this type of migration will be affected during 01 to 20 June and 01 August to 30 September.

Table 6.3: Seasonal migration of fish species at different stages of life cycle.

Category: Carp Fish

Period	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Spawning migration					■	■	■					
Fingerling migration							■	■				
Dispersal of young over floodplain						■	■	■	■	■		
Return of young to beel and river									■	■	■	
Harvesting beel and river	■	■	■								■	■

Category: Cat Fish

Period	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Spawning migration					■	■	■	■				
Migrate to floodplain			■	■	■							
Dispersal and Growth						■	■	■	■			
Return of young to standing water										■	■	■
Dry season residence in standing water	■	■	■	■							■	■

(Source: Ghosh, 2007)

Table 6.4: Seasonal migration of fish species affected by the regulators at different stages of life cycle.

Category: Carp Fish

Period	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Spawning migration												
Fingerling migration						Hamper		Hamper				
Dispersal of young over floodplain						Hamper		Hamper				
Return of young to beel and river									Hamper			
Harvesting beel and river												

Category: Cat Fish

Period	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Spawning migration												
Migrate to floodplain				Hamper								
Dispersal and Growth						Hamper		Hamper				
Return of young to standing water												
Dry season residence in standing water												

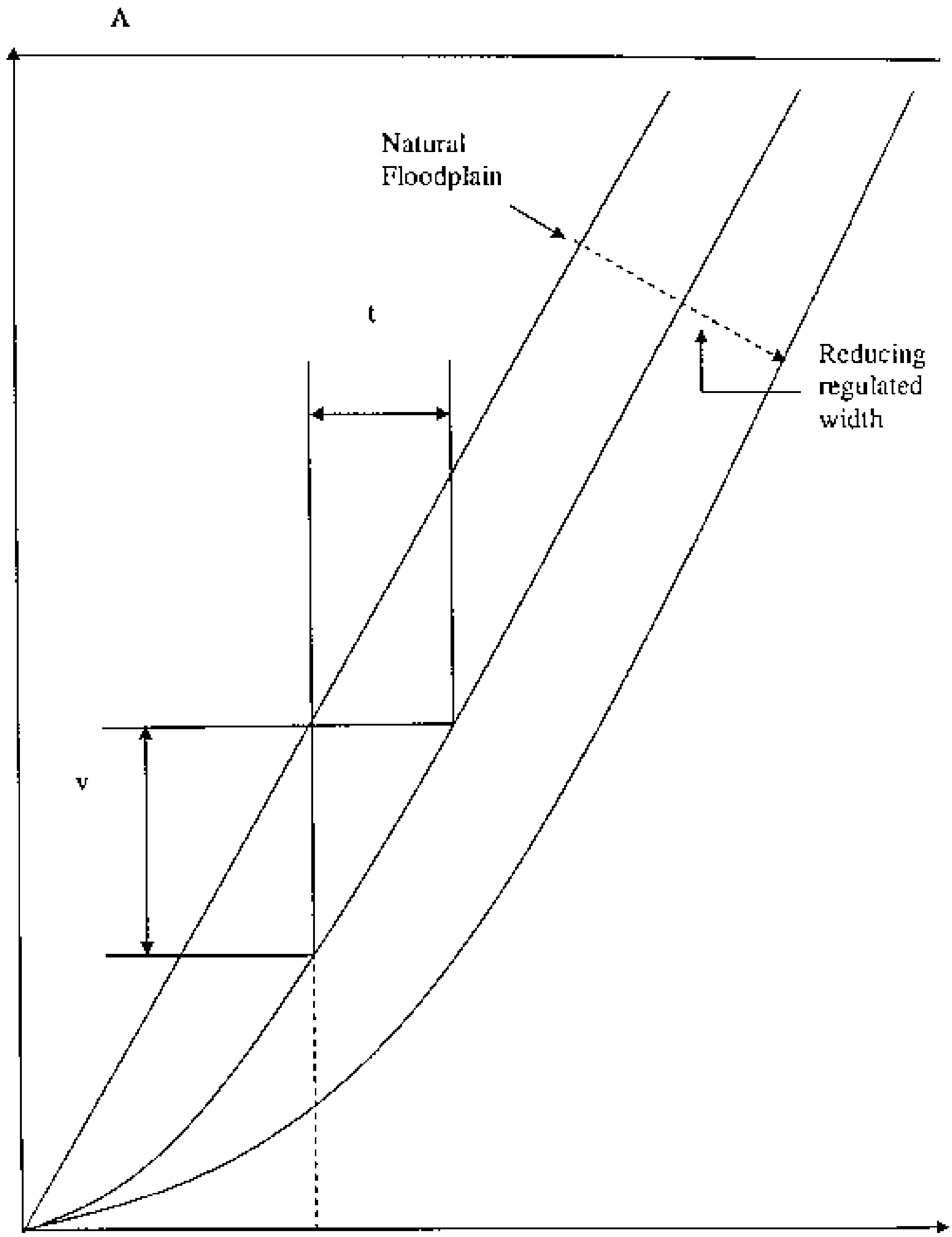
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Sluice gate opening / closing		Open				Close	Open		Close		Open	

6.1.2.4 Pattern of regulated flow on to the floodplain

The pattern of flow on to the floodplain may be changed merely by the presence of the regulators, by the gate mode used and by the gate operation programme (FAP17, 1994).

Both the secondary data and field study indicates a significant reduction of water area coverage for fish species due to the impact of Siapagla and Baramara regulators.

Pattern of regulated flow is illustrated in Figure 6.4. The volume in natural floodplain is increasing linearly with time. The lag increases as the regulator width reduces. If line A represents an allowable volume, then the regulated floodplain will reach it later than the natural floodplain would, provided the river level continues to rise above or holds a peak for some time at the level represented by A. Otherwise the regulator will cause a shortfall in the volume of water on the floodplain (FAP17, 1994).



t= time lag to reach a given flood plain volume
v= reduction in floodplain volume at a given time

(Source: FAP 17, 1994)

Figure 6.4: Pattern of regulated flow on to the floodplain.

Assuming that there is sufficient volume of water on the floodplains (Kajla Beel, peruli Beel, Khamar Beel), the total amount of fish passing through and dispersing relative to the natural floodplain will depend on whether the time lag inherent in the use of Siapagla and Baramara regulators. If the slow build up in volume of the floodplain in the early stage of the cycle coincides with the greatest abundance of fish fry or adults then the regulated floodplain will not be as accessible to fry and adults as before.

6.1.2.5 Rainfall runoff analysis

Rainfall runoff for the study area was estimated from mean monthly rainfall for the Narail Station. Table 6.5 gives the rainfall and other climatic data for the Narail Station.

Runoff coefficient for the study area was estimated from mean monthly rainfall using the Khosla's Formula (Subramanya, 2006). The coefficient was estimated to be 0.42, which is in good agreement with suggested values for agricultural lands. (Garg, 2005). Table 6.6 gives the calculation procedure of the runoff coefficient.

Figure 6.5 shows the monthly runoff in the study area that contributes to the water stored inside the project area.

Figure 6.6 shows a digital elevation model of the study area. The deeper areas indicate the higher storage areas for rainfall runoff. Table 6.7 and Figure 6.7 give the relationship between a given elevation and cumulative area below that elevation.

The digital elevation map (Fig 6.6) and area elevation curve (Fig 6.7) clearly indicate that due to the closing operation of the gates of the Siapagla and Baramara regulators, a large portion of the beels remain dry when the outside water level is relatively high. The annual runoff depth is 0.76 m and it can inundate only about 425 hectares. This indicates an increase of agricultural land. On the other hand change in inundation pattern of the areas inside the project has caused disruption of aquatic ecosystem and fish habitat.

Table 6.5: Climatic data

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Maximum Temp (°C)	25.80	28.90	33.30	35.80	35.10	32.90	31.90	31.90	32.30	31.90	29.70	26.40	31.30
Mean Temp (°C)	18.90	21.60	26.40	29.80	30.10	29.40	28.90	28.90	29.00	27.70	23.90	19.50	26.20
Minimum Temp (°C)	11.60	14.20	19.50	23.70	25.00	25.80	25.90	25.90	25.60	23.30	18.00	12.40	20.90
Relative Humidity (%)	71.00	65.00	63.00	68.00	75.00	85.00	88.00	87.00	86.00	81.00	75.00	73.00	76.00
Wind Speed (knots)	5.00	5.00	6.00	9.00	8.00	7.00	7.00	7.00	6.00	5.00	5.00	5.00	6.30
Sunshine (hrs/day)	7.80	8.10	8.00	8.10	7.70	5.20	4.00	4.80	5.00	7.10	7.80	7.70	6.80
ETo (mm/day)	2.90	3.90	5.41	7.12	6.97	4.65	4.49	4.42	4.09	4.07	3.33	2.73	1649.00
Mean Rainfall (mm)	9.00	26.00	42.00	89.00	194.00	312.00	358.00	334.00	260.00	124.00	23.00	12.00	1781.00
80% Dependable Rainfall (mm)	1.00	13.00	20.00	61.00	150.00	257.00	293.00	266.00	188.00	82.00	7.00	1.00	1340.00

Source: BMD and WARPO (ADB, BWDB and WARPO, 2004a)

Khosla's Formula

Rm = Pm-Lm

Lm = 0.48Tm for Tm > 4.5°C

Where,

Rm = monthly runoff in cm and Rm >=0

Pm = monthly rainfall in cm

Lm = monthly losses in cm (The losses due to evapotranspiration)

Tm = mean monthly temperature of the catchment in °C

Annual Runoff = ∑Rm

Table 6.6: Calculating runoff from mean monthly rainfall using Khosla's formula:

Parameter	Mean Rainfall (mm)	Mean Rainfall (cm)	Mean Temp (°C)	Monthly losses (cm)	monthly runoff (cm)	monthly runoff (cm)	Annual Runoff (cm)
		Pm	Tm	Lm = 0.48Tm	Rm = Pm-Lm	Lm>Pm, Rm=0	∑Rm
Jan	9.00	0.9	18.90	9.072	-8.172	0	75.58
Feb	26.00	2.6	21.60	10.368	-7.768	0	
Mar	42.00	4.2	26.40	12.672	-8.472	0	
Apr	89.00	8.9	29.80	14.304	-5.404	0	
May	194.00	19.4	30.10	14.448	4.952	4.952	
Jun	312.00	31.2	29.40	14.112	17.088	17.088	
Jul	358.00	35.8	28.90	13.872	21.928	21.928	
Aug	334.00	33.4	28.90	13.872	19.528	19.528	
Sep	260.00	26	29.00	13.92	12.08	12.08	
Oct	124.00	12.4	27.70	13.296	-0.896	0	
Nov	23.00	2.3	23.90	11.472	-9.172	0	
Dec	12.00	1.2	19.50	9.36	-8.16	0	

Annual runoff coefficient = Annual Runoff/ Annual Rainfall
= 75.58*10/1781
= 0.42

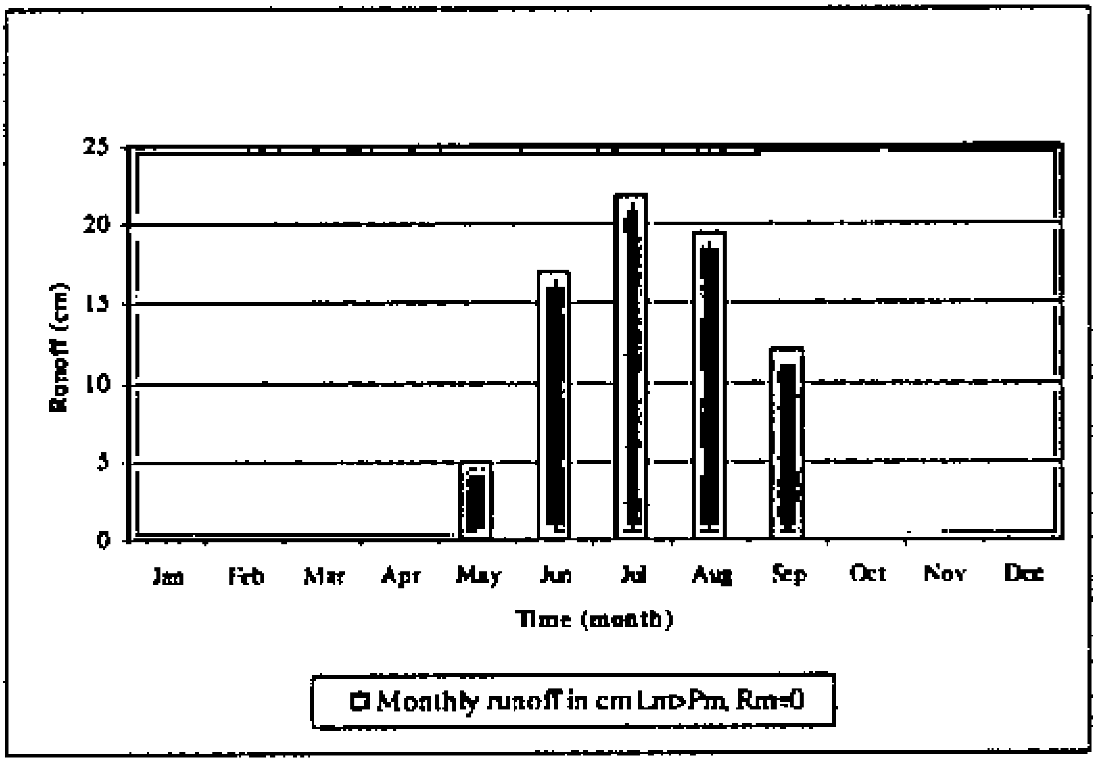


Figure 6.5: Monthly runoff in the catchment's area.

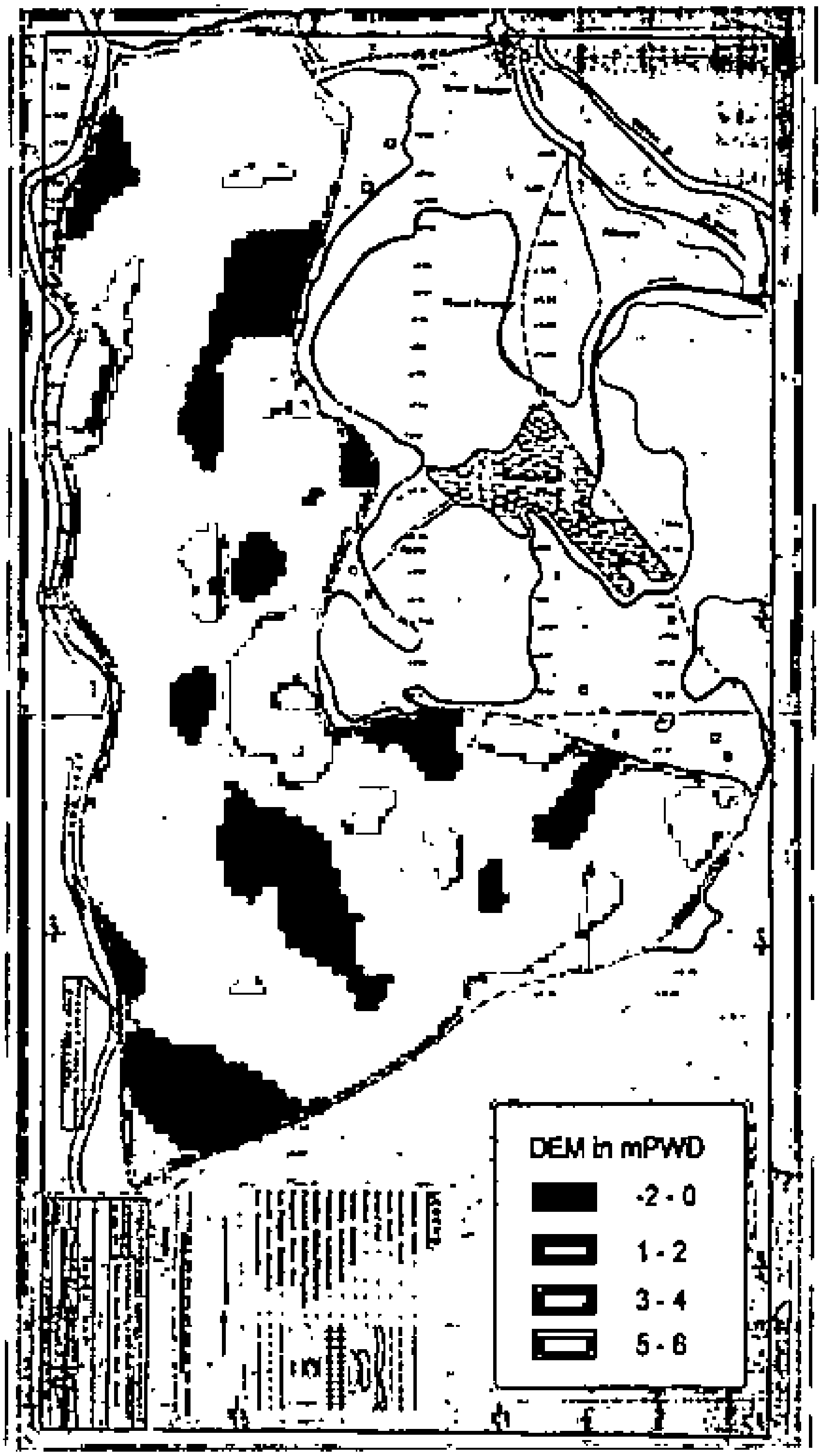


Figure 6.6: Digital Elevation Model (DEM) of the study area.

Table 6.7: Estimation of area from DEM.

Value	Count	grid area (50m grid)	count area (sqm)	cumulative area (sqm)	area in ha
0	911	2500	2277500	2277500	227.75
1	1091	2500	2727500	5005000	500.50
2	1177	2500	2942500	7947500	794.75
3	888	2500	2220000	10167500	1016.75
4	689	2500	1722500	11890000	1189.00
5	374	2500	935000	12825000	1282.50
6	137	2500	342500	13167500	1316.75
7	26	2500	65000	13232500	1323.25
8	21	2500	52500	13285000	1328.50

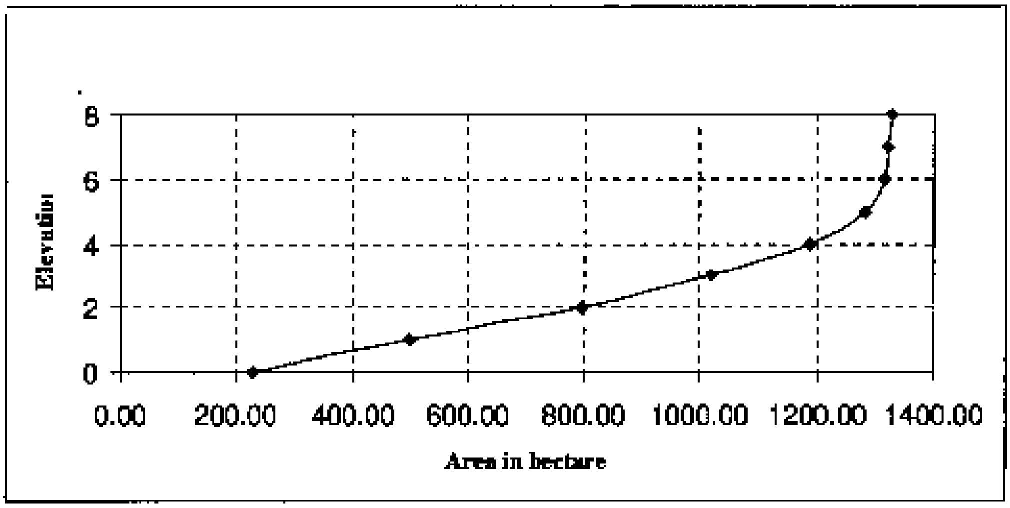


Figure 6.7: Area-Elevation curve.

6.2 Water Requirement Conflicts

6.2.1 Irrigation water requirement

Different types of crops and vegetables are grown in the study area. The irrigation requirements for this crops and vegetables vary in application amount and time. The Table 6.8 presents the total water requirement for different crops and vegetables of the study area. From this table it can be concluded that the minimum water requirement in Siapagla is 120 cm.

Table 6.8: Irrigation water requirement.

<table>
<tr><th colspan="3">Crop</th><th>Total Water Requirement (cm)</th></tr>
<tr><td rowspan="4">Rice Crops</td><td>Stages</td><td>Water Requirement (mm/season)</td><td rowspan="4">120</td></tr>
<tr><td>Land Preparation</td><td>200-250</td></tr>
<tr><td>Crop Water Requirement</td><td>450-550</td></tr>
<tr><td>Percolation losses</td><td>250-450</td></tr>
<tr><td colspan="3">Wheat</td><td>30</td></tr>
<tr><td colspan="3">Maize</td><td>35</td></tr>
<tr><td colspan="3">Lentil</td><td>20</td></tr>
<tr><td colspan="3">Cabbage</td><td>26</td></tr>
<tr><td colspan="3">Cauliflower</td><td>22</td></tr>
<tr><td colspan="3">Potato</td><td>28</td></tr>
<tr><td colspan="3">Radish</td><td>18</td></tr>
<tr><td colspan="3">Carrot</td><td>18</td></tr>
<tr><td colspan="3">Tomato</td><td>25</td></tr>
<tr><td colspan="3">Brinjal</td><td>35</td></tr>
<tr><td colspan="3">Onion</td><td>20</td></tr>
</table>

(Source: Website BARI, 2008)

6.2.2 Fisheries water requirement

Distributions of fish concentration by depth class proposed by EGIS (1997) are as follows: 44% in depth class 1 (1-15cm); 285 in depth class 2 (16-30 cm), 16% in depth class 3 (31-90 cm); 9% in depth class 4 (91-180 cm); and 3% in depth class 5 (>180 cm). Fish respond to changes in water level with increased movement and concentration shift between depth classes. The highest fisheries concentration and biomass occur in depth class in 1 and decline throughout other depth classes; the lowest concentration of fish and biomass occur in the deepest portion of the floodplain in depth class 5. However, the number of species and alpha biodiversity are the highest in deep water (depth class 4 and 5) and lowest in shallow water (depth class 1 and 2) (EGIS, 1997).

Fish exhibit a preference for habitat by concentrating within certain habitat. Species of prawn, perch, gorami, barb, gobie, eel, small catfish and puffer prefer habitat in shallow water (depth class 1 and 2, or 1 to 30cm). Glass fish do not indicate a strong habitat preference; instead they utilize all depth classes. Cyprineid, snakehead, and cyprinidone species show a strong preference for the shallowest depth class (1 -15cm). Exotic species indicate a strong preference for depth class 2 (16-30 cm), while knife fish species prefer depth class 3 and depth class 5. Species in the clupeid carp, large catfish and mullet guilds exhibit a strong preference for deeper water (depth class 4 and 5, 91 – 180 cm and deeper). Therefore, the minimum water requirement for fish species is 180cm.

Table 6.9: Post project water level in Siapagla khal.

Month	Post Project WL in Siapagla Khal (1999-2008)
Jan	2.24
Feb	2.23
Mar	2.24
Apr	2.26
May	2.27
Jun	2.28
Jul	2.39
Aug	2.41
Sep	2.41
Oct	2.39
Nov	2.31
Dec	2.26

Table 6.10: Post project water level in Khamar Khal.

Month	Post Project WL in Khamar Khal (1999-2008)
Jan	0.91
Feb	0.83
Mar	0.90
Apr	1.20
May	1.25
Jun	1.30
Jul	2.13
Aug	2.30
Sep	2.37
Oct	2.16
Nov	1.53
Dec	1.05

The water depth in the Siapagla khal is adequate for fish species but that in the Khamar khal is not adequate, especially in the dry season for the species clupeid carp, large catfish and mullet guilds as they exhibit a strong preference for deeper water (depth class 4 and 5, 91 – 180 cm and deeper).

It was found from the field survey that 3 LLPs, 210 nos STWs (run by diesel) and 18 nos STWs (run by electricity) were active in the subproject area during the dry season. These numbers indicate that the irrigation system in the study area is mainly dominated by groundwater irrigation. The khal water was mainly used for seed bed preparation, jute rotation, etc. Jute rotation pollutes the khal water which negatively impacts the fish species.

So there was almost no conflict between surface water irrigation and fisheries in the khal.

The conflict mainly rose due to the beel dewatering in Kajla and Khamar beel for agricultural purposes. The required water depth or fish species, especially for depth class 3, 4 and 5 was not maintained at all.

6.3 Platform for Conflict Resolution

Conflict resolution may be the most difficult process when there is a range of different interest groups, each with their own objectives and values with regard to the use of water resources. Differences in values are reinforced when such groups have differential access to information and differing perceptions of the issues at stake. Even where groups are well informed there can be differences in their ability to influence decision making processes, or even simply to communicate their concerns to others (Khoa and Smith, 2004).

Conflict resolution/ management refer to a broad array of tools used to anticipate, prevent and react to conflicts. Identifying which tool to select depends on the root causes of the conflict, as well as the type of conflict and its location Conflict management tools can be classified in to three types:

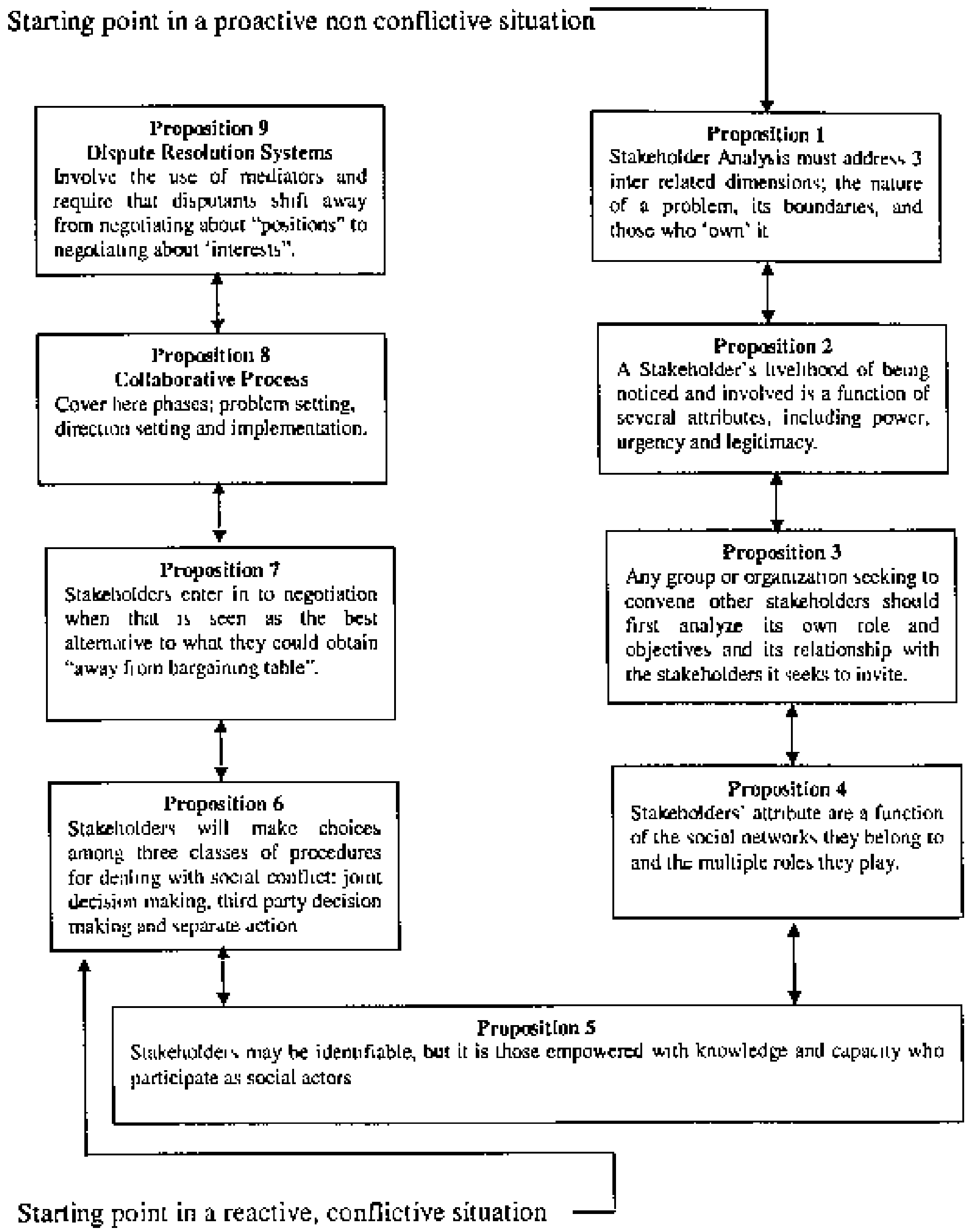
a. interventions for conflict management
b. decision support tools
c. tools for consensus building.

A conflict resolution/ management strategy will involve a combination of these types of tools. In most water resource cases the tools encourage stakeholders to move beyond positional bargaining and the claim/ counter claim process. They try to help stakeholders identify the interests which lie behind each side's position, and to jointly construct "win-win" solutions based on meeting those interests. It must be stressed, however, that not all situations can be resolved with win-win outcomes – at least not in the short term. Trade off and compromise is often necessary. Conflict management involves both social change and social learning. It has many benefits. Conflict management can help to develop quick procedures and solutions to dispute settlement; more control over solutions by those closest to the issues; greater flexibility for crafting solutions than is offered in formal legal mechanisms and time and cost savings. It is most important to stress that the ultimate mechanism for conflict resolution is the law and legal procedures (GWP, 2003).

As part of this study Stakeholder analysis was performed on the basis of field surveys and two stakeholder workshops were arranged to assess the suitability of a platform for conflict resolution. In conflict assessment, four types of stakeholders are expected: those with claims to legal protection, those with potential clout, those with power to block negotiated agreements and those with moral claims to public sympathy (Susskind and Cruikshank, 1987). They can be categorized as follows (Ramirez, 1999)

- Primary, secondary and key stakeholders
- Internal or external to the organization
- Stakeholders, clients beneficiaries and
- Stakeholder typologies on macro to micro continuum and on the basis of their relative importance and influence.

Figure 6.8 presents a conceptual framework in a situation where multiple stakeholders interact.



(Source: Ramirez, 1999)

Figure 6.8: Conceptual framework for stakeholder analysis and conflict management.

6.3.1 Stakeholder analysis

Stakeholder analysis can be defined as an approach for understanding a system by identifying the key actors or stakeholders in the system and assessing their respective interest in that system (Ramirez, 1999).

This definition is useful since it defines stakeholder analysis as a natural resource management approach and acknowledges its limits. It can not be expected to solve all problems or guarantee representation (Ramirez, 1999). It should be done prior to the management of conflicts and resolution of disputes. Stakeholder analysis for the Siapagla subproject area was done in the following manner-

6.3.1.1. Stakeholders

The stakeholders in the Siapagla sub-project were identified as follows through several FGDs and interviews: LGED, UNO, Agriculture Officers (AO), Agriculture Engineers, Fisheries Officers (FO), Foreign Consultant (FC), Donor Agency, NGO, UP Members/Chairmen, Farmers, Fishermen, Scheme managers, WMCA, Local Inhabitants (Except farmers and fishermen), BWDB,DPHE,WARPO

6.3.1.2. Stakeholders prioritization:

After identifying the stakeholders they were prioritized in order of degree of influence and degree of importance to facilitate the stakeholder analysis. Table 6.11 gives the criteria for prioritizing the stakeholders and table 6.12 gives a matrix of stakeholders in the study area prioritized in order of degree of influence and degree of importance

Table 6.11 Matrix for prioritizing key stakeholders.

Degree of Influence ←

Degree of Importance	High Influence	Low Influence
High importance	Box A **Stakeholders who stand to lose or gain significantly from the project AND whose actions can affect the project's ability to meet its objectives** The project needs to ensure that their interests are fully represented in the coalition. Overall impact of the project will require good relationships to be developed with these stakeholders.	Box B **Stakeholders who stand to lose or gain significantly from the project BUT whose actions cannot affect the project's ability to meet its objectives** The project needs to ensure that their interests are fully represented in the coalition
Low importance	Box C **Stakeholders whose actions can affect the project's ability to meet its objectives BUT who do not stand to lose or gain much from the project** They may be a source of risk, and you will need to explore means of monitoring and managing that risk	Box D **Stakeholders who do not stand to lose or gain significantly from the project AND whose actions can not affect the project's ability to meet its objectives** They may require limited monitoring or informing of progress but are of low priority. They are unlikely to be the subject of project activities or involved in project management

Table 6.12: Prioritizing key stakeholders in Siapagla FCD subproject.

Degree of Influence ←

Degree of Importance	High Influence	Low Influence
High importance	**BOX A** WMCA, UP Members/ Chairmen, Farmers	**BOX B** Fishermen, Women, Local Inhabitants
Low importance	**BOX C** LGED, Agriculture Department, Fisheries Department, NGO, UNO	**BOX D** BWDB, Donor Agency, DPHE, WARPO

6.3.1.3 Stages of analysis

The stakeholder analysis was performed in three stages to accomplish study objectives. In every stage, it was checked through FGDs and interviews which stakeholders are relevant to be involved in the process and whether the stakeholders have the same "rights". The role and involvement of the stakeholder may differ from stage to stage. Each stage of analysis focuses on a specific question that leads to the answer for that stage. The roles and involvements of the stakeholders are clarified while answering these questions.

The analysis results are presented on a stakeholder diagram, which help to identify the differences, similarities and relationships among the stakeholders. On the stakeholder diagrams, the stakeholders are arranged in three tiers: Co-operating, Co-thinking and Co-knowing; and four quadrants: Experts, Decision-makers, Implementers and Users.

To identify the initial stage of conflicts, the role of stakeholders in the planning stage was analyzed, which is the main goal of stage one. Second stage leads to water use conflict and third stage attempts to find the feasible platform for conflict resolution. Stakeholder list for stage one, two and three are given in table 6.13, 6.14 and 6.15, respectively on the basis of degree of involvement of every stakeholder per stage.

In stage one, the planning stage, farmers play a decision making role because of their strong position in the community power structure. Since the fishermen and women are relatively weak, they play merely a co-knowing role during the planning process. LGED and the donor agency also play a cooperating implementer role since they actively participate in the project area selection process and provide funds to implement the project. Although fisheries officers are experts and could play a very important role so that no harmful acts affect the fisheries resources, their degree of involvement at this stage is only co-knowing as they are just informed about the project. The conflict between agriculture and fisheries starts from this point.

In stage two, the roles of water users in the sub-project area were analyzed. Figure 6.11 shows that farmers, fishermen, women and other local inhabitants are all affected, positively or negatively, because of the project interventions. Water use conflict is apparent in this stage. Farmers are the only stakeholders who are benefited, whereas many of the others are adversely affected. Moreover, since WMCA consists of mostly farmers the rights and privileges of the weaker groups are neglected in their decisions.

In stage three, the conflict resolution process, the farmers, fishermen, women, local inhabitants, WMCA and fisheries officers are the main stakeholders. The Union Porishod may play the most important role in this stage since it has a decision making position.

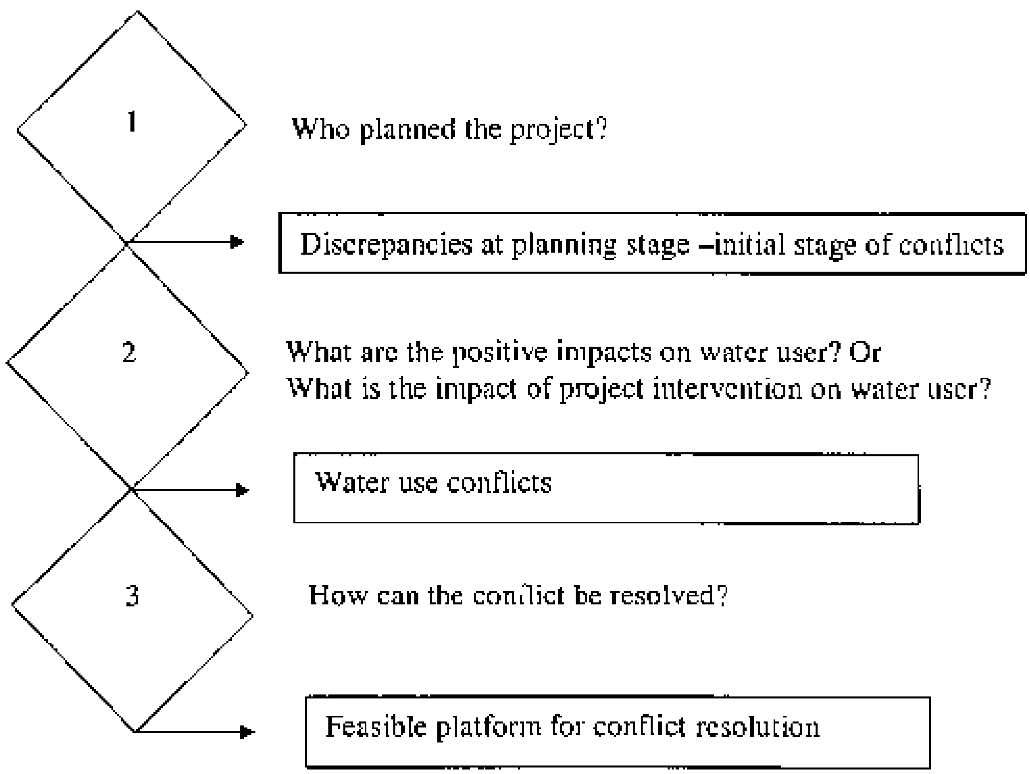


Fig 6.9: Different stages of the water use conflict process.

Table 6.13: Stakeholders for stage 1 (Pre Project Stage – Who planned the project?).

Group	Actors	Degree of involvement	Role
LGED	Implementer	Co-operating	Actively participate in the project area selection process
Farmers	Decision Maker	Co-operating	Actively participate in the initial project selection process
Fishermen	User	Co-knowing	Affected by the FCD project
Local Inhabitants	User	Co-knowing	Affected by the FCD project
Women	User	Co-knowing	Affected by the FCD project
UP Members / Chairmen	Decision Maker	Co-operating	Participate in decision making process
Agriculture officer (AO)	Expert	Co-thinking	Provide information about the agriculture benefits
Fisheries officer (FO)	Expert	Co-knowing	Just informed about the project
Foreign Consultant (FC)	Expert	Co-operating	Actively participate in design
Donor Agency (ADB)	Implementer	Co-operating	Provide fund to implement the project
NGO	Expert	Co-knowing	Informed about the project
UNO	Decision Maker	Co-thinking	Took participate in the final decision making process

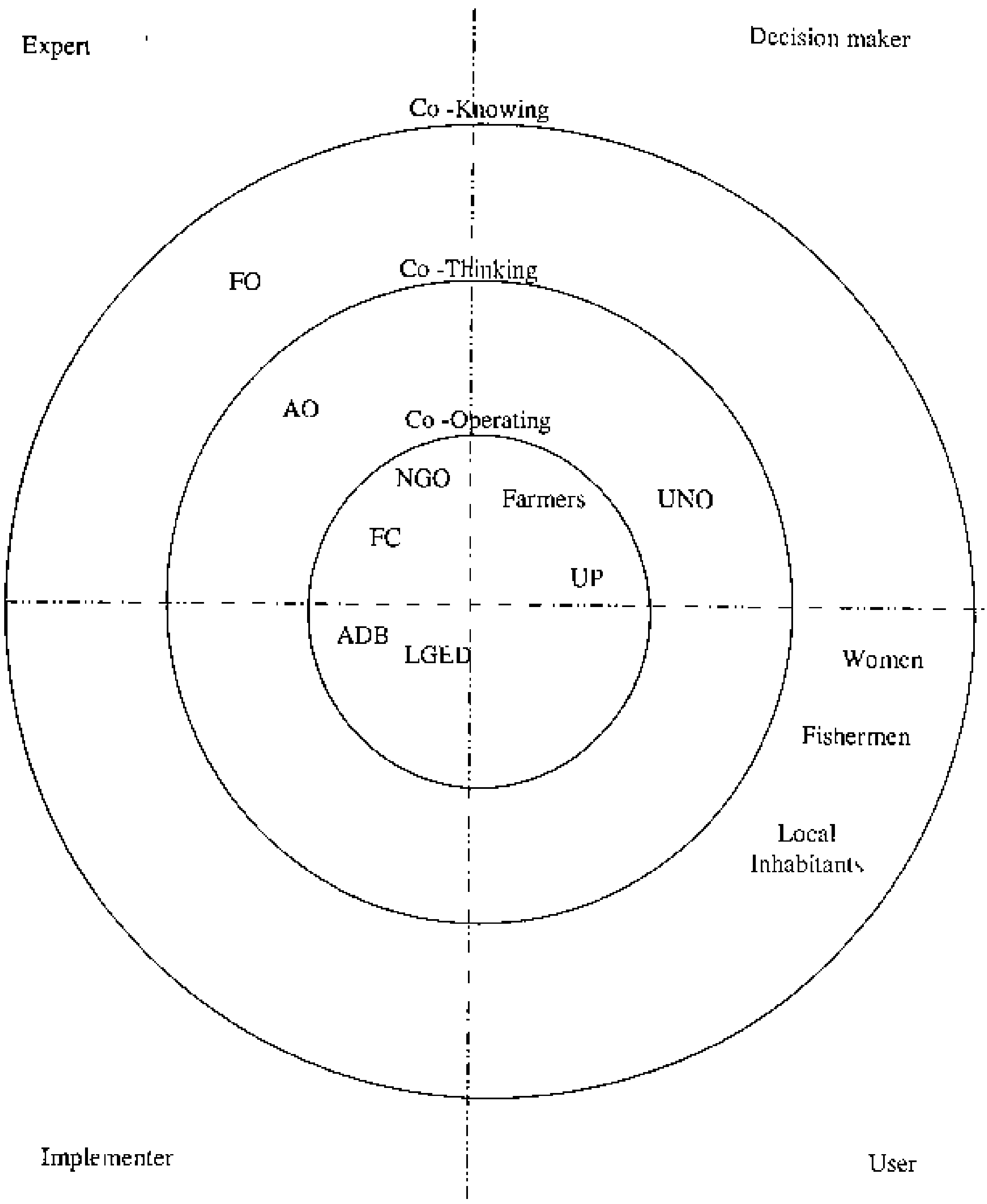


Figure 6.10 Stakeholder diagram for stage-1.

Table 6.14: Stakeholders for stage 2 (Post Project Stage - What are the positive impacts on water user or what is the impact of project intervention on water user?).

Group	Actors	Degree of involvement	Role
WMCA	Implementer	Co-operating	Control Sluice gate operation and benefited group
Farmers	User	Co-operating	Increase of potential command area, protected from saline water intrusion , benefited group
Fishermen	User	Co-operating	Negative impact on livelihood
Local Inhabitants	User	Co-operating	Positive impact on livelihood
Women	User	Co-operating	Positive & negative impact
UP Members/Chairmen	Decision Maker	Co-operating	Participate in decision making process of gate operation
LGED	Expert	Co-Knowing	Informed about the situation
UNO	Expert	Co-Knowing	Informed about the situation
Agriculture officer (AO)	Expert	Co-thinking	Actively participate with farmers to observe and provide guidance in agriculture process
Fisheries officer (FO)	Expert	Co-knowing	Informed about situation
NGO	Expert	Co-thinking	Provide suggestion to increase positive impact

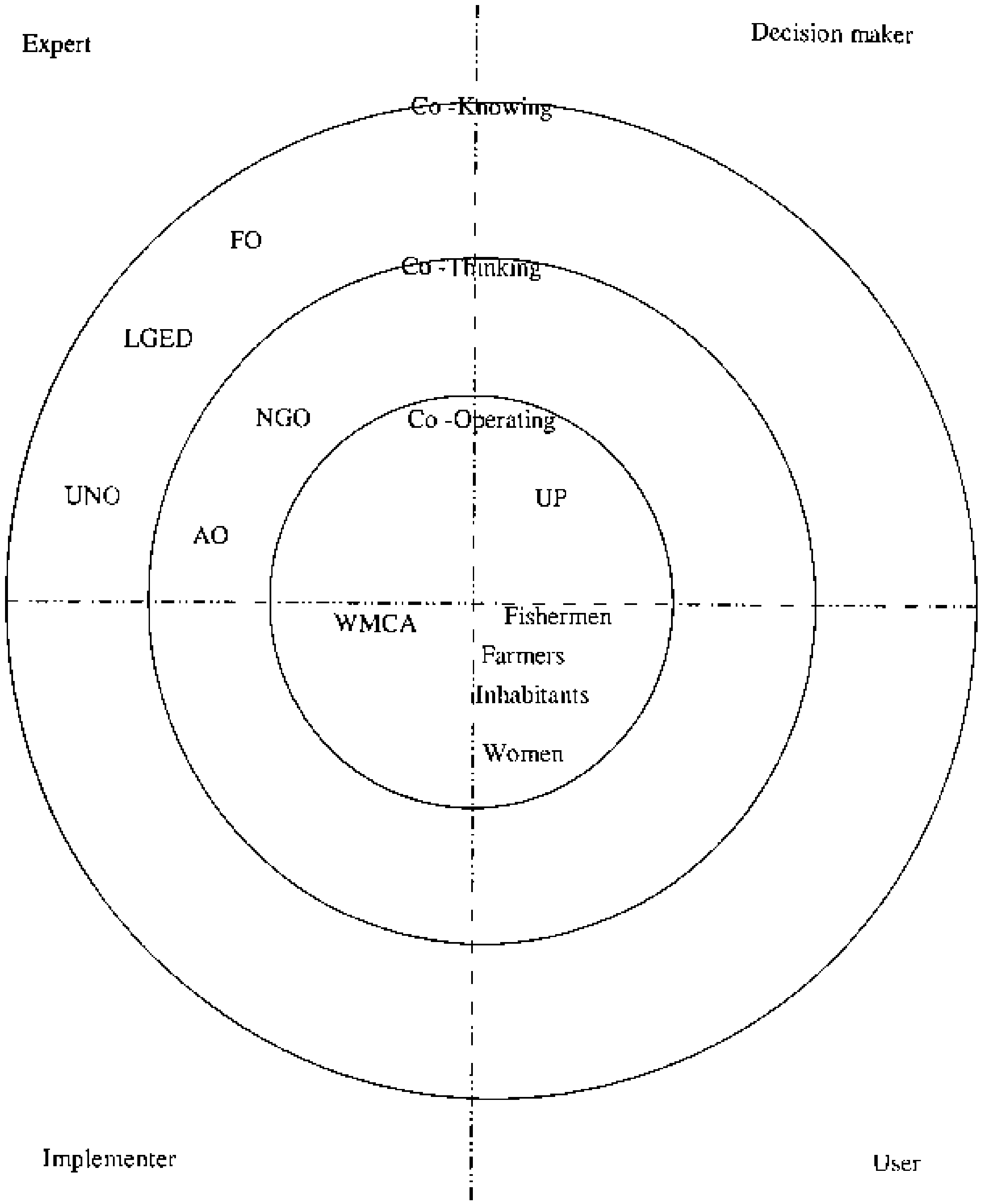


Figure 6.11 Stakeholder diagram for stage-2.

Table 6.15: Stakeholders for stage 3 (How can the conflict be resolved?).

Group	Actors	Degree of involvement	Role
WMCA	Implementer	Co-operating	Consult with each and every stakeholder and responsible for conflict reduction
Farmers	User	Co-operating	Involved in agriculture practice
Fishermen	User	Co-operating	Informed about situation
Local Inhabitants	User	Co-operating	Informed about situation
UP Members/Chairmen	Decision Maker	Co-thinking	Participate in decision making process of conflict resolution
LGED	Expert	Co-thinking	Ensure a balance trade-offs
UNO	Expert	Co-thinking	Ensure a balance trade-offs
Agriculture officer (AO)	Expert	Co-knowing	Provide guidance in agriculture process
Agriculture Engineer (AE)	Expert	Co-thinking	Provide guidance for water delivery system, maximum utilization of water use can be ensured
Fisheries officer (FO)	Expert	Co-operating	Minimize negative impact on fish species
NGO	Expert	Co-thinking	Rehabilitate the negatively impacted group

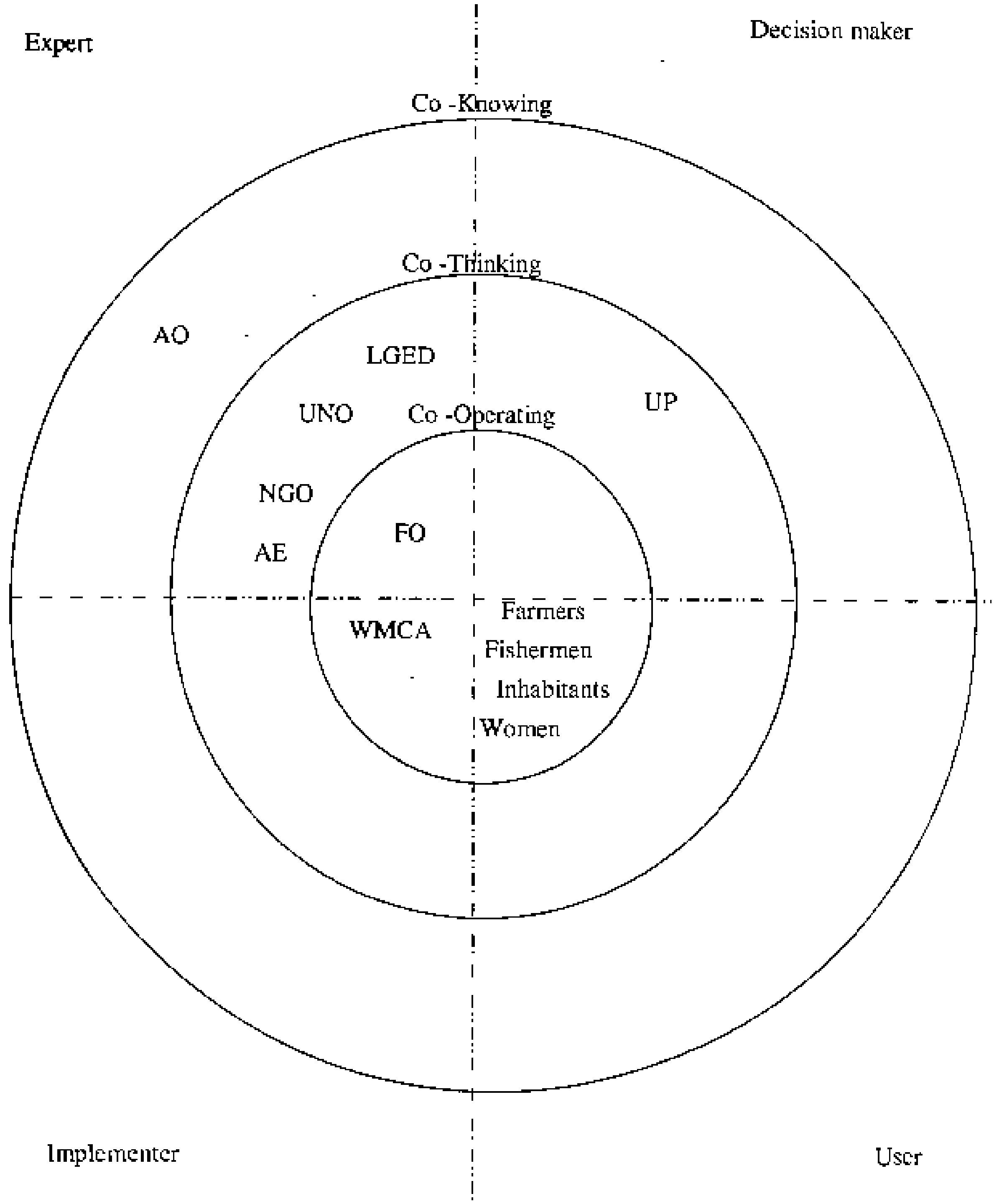


Figure 6.12 Stakeholder diagram for stage-3.

The main findings of the stakeholder analysis are summarised below:

1. An unbalanced, farmer dominated power structure group prevail in the village community.
2. There is a lack of active participation of local inhabitants and fishermen and women at project planning stage.
3. Although these FCD interventions have been beneficial to dry season agriculture, fisheries and the aquatic ecosystem have been adversely affected. The fishermen group suffers a lot as their livelihood is under threatening condition.
4. There is also an apparent discontent among the fishing community that their needs, priorities and alternate livelihood options have not been properly considered in the project formulation process.
5. The role of LGED at post project situation (to ensure the benefits and balance tradeoffs) should be co-operating or at least co-thinking not co-knowing.
6. Fisheries officers were not closely involved in FCD sub projects. But, their involvement is a must to alleviate the conflict.
7. To lessen the conveyance loss and to ensure efficient water delivery system, the role of agricultural engineers must be very active. Their degree of involvement should be cooperating.
8. The involvement of an external powerful group, such as UNO, is required for conflict minimization.

6.3.2 Stakeholder workshop

Procedures for dealing with conflict can be grouped into three classes along a continuum (Pruitt and Carnevale, 1993). Numerous factors influence why stakeholders (or 'disputes' in negotiation terminology) will opt for one over another, depending on the nature of conflict, the stage of the negotiation and the attributes of the stakeholders (Ramirez, 1999). During stakeholder workshops for conflict management, the feasibility of the following three classes was considered.

- Joint Decision-making
    - Negotiation

    - Mediation
- Third –party decision making
    - Adjudication
    - Arbitration
    - Autocratic decision making
- Separate action
    - Retreat
    - Struggle
    - Tacit coordination

The decision of stakeholders to engage in negotiation is influenced by many factors, not simply self interest (Ramirez, 1999). The following aspects were considered during the stakeholder workshops.

- Other interests beyond self;
- Norms;
- Relationships, group process, and networks;
- Coalitions;
- Power to negotiate;
- Mediation; and
- Internal organizational dynamics

Two stakeholder workshops, one at the Administrative level and another at the local level, were arranged for this study.

6.3.2.1 Stakeholder workshop at administrative level

The stakeholder workshop was arranged in the conference room of Local Government of Engineering Department (LGED).

Purpose: The intention of the workshop was to identify stakeholder priorities, needs and challenges, understand how to address them and identify stakeholders to engage in ongoing research.

Participants: The participants were from different levels of administration: Executive Engineer of Local Government of Engineering Department (LGED), Assistant Engineer of LGED, Upazilla Nirbahi Officer, Upazilla Agricultural officer, Upazilla Fisheries officer, Upazilla somobay officer, President of Narail Press club, Senior representative from Bachte Shekha (NGO), Executive director of Sabolombi (NGO), Upazilla Agricultural Engineer, Executive Engineer of BWDB etc.

Findings:

i. Saline water intrusion is a major problem in the study area.
ii. Fisher group suffers a lot due to the impact of FCD structures.
iii. Disruption of aquatic ecosystem exists in the study area.
iv. Conjunctive use of water is needed in the sub-project area
v. Local stakeholder participation is a must prior to initialization of any development project.
vi. The development works in the water sector must be economically viable, technological feasible, environmental sustainable, socially acceptable.

6.3.2.2 Stakeholder workshop at local level

The stakeholder workshop at local level was arranged at a location beside the Siapagla two vent regulator, as it was easily accessible to all especially the women group.

Purpose: The aim of the workshop was to find the possible solutions to the conflicts between irrigation and fisheries due to the Siapagla FCD subproject.

Participants: The participants were from different groups representing different stakes of the subproject. The following participants were present in the stakeholder workshop-

i. President, vice president and members of WMCA.
ii. Influential persons who are not members of WMCA
iii. Fisher group (5 to 6 persons)
iv. Farmers group (8 to 9 persons)
v. Women group (7 to 8 persons)

Issues: The discussion was based on the following issues-

i. Regular maintenance of the sluice gate
ii. Siapagla khal excavation
iii. The negative impact of FCD structures on fishers
iv. The cement-concrete barrier in the Khamar khal, constructed by an influential powerful person with a purpose to catch fish
v. The achievable benefits for female groups from WMCA

Findings: There was lots of commotion between two influential powerful groups (one group representing the members of WMCA and another group were not the members of WMCA). However the fisher group remained almost silent and women group just mentioned in a sentence one or two how they can get more benefits. But the whole discussion was very haphazard and it was very difficult to facilitate the discussion toward the objectives. The possible solutions to the above mentioned issues that emerged from the workshop are summarized below:

i. WMCA will repair the sluice gate (that is closed for more than one year) as soon as possible but they did not mention any time frame.
ii. The process of excavating the Siapagla khal was stopped since some objection arose from the farmers of the land near the Siapagla khal. They will approve the khal excavation only if LGED officials can prove the adverse effects of siltation.
iii. The fisher group should be compensated and trained properly so that they can change or adjust to their livelihood.
iv. The people near khamar khal should officially complain about the cement concrete barrier in the khamar khal. Otherwise no action will be taken against it. The chances of official complain is very less as the owner of the barrier is very powerful.

v. Women group wants a room for their training and meeting purpose and proper sanctioning of loan.

Final observation: Stakeholder workshop at the local level is not an effective tool for conflict management in a situation where an unbalanced power structure prevails. The control of an external powerful group (e.g. UNO, LGED/ BWDB officials, fisheries officers, agriculture officers, etc.) is essential for the success of such stakeholder workshops. However, only one local stakeholder workshop was arranged due to time limitation. At least four or five stakeholder workshops at the local level may give possible solutions to the conflicts.

During the workshops, the weaker groups felt very uncomfortable to express their condition, feelings and demands in front of the powerful groups. They gave many possible solutions to the conflicts during the FGDs and interviews, but remained almost silent during the stakeholder workshops. So, stakeholder workshop at the local level in a community having unbalanced power structure may not be a feasible platform for conflict resolution. In these situations, regulatory or legal approaches may be more effective.

6.4 Usefulness of the Study Outcome to the South West Integrated Water Resources Management Project

Siapagla Flood Control and Drainage subproject is a part of the Small Scale Water Resources Development Sector Project (SSWRDSP). It is also a component of the South West Integrated Water Resource Management Project (SWIWRMP).One of the overall objectives of these projects is to enhance economic growth and reduce poverty in the rural areas of the selected sub-regions in the South West of Bangladesh (ADB, BWDB and WARPO, 2004a). The specific observations of the current study described below may be useful to the SWIWRMP in future.

In general, the economic growth of the Siapagla project area has increased after project implementation. Since most of the local people are farmers and the project is conducive to agriculture, the project helped them to improve their standard of living. However, a small portion of the local people, mainly fishermen, were ignored and neglected during planning and implementation of the project. Although the intermediate objective of the SWIWRMP is to enhance and sustain water security and livelihoods of the rural people within the hydrological boundaries (ADB, BWDB and WARPO, 2004a), the livelihood of the fisher group is in a very vulnerable condition. The approaches taken to minimize the negative impacts on the fisheries sector (involvement of DOF, improvement of aquaculture management techniques, adoption of paddy cum fish culture, etc.) by SWIWRMP are not yet followed. The Siapagla khal is severely silted up, which has been creating drainage congestion in the areas near the khal. Since one of the two-vent regulators is out of order, the regulator could not perform at its full capacity. There is a strong conflict between the water requirements for agriculture and fisheries in the project area. This has already caused a silent social conflict between the relatively powerful farmers and poor fishermen. The project success will be undermined if proper steps to rehabilitate the fisher group are not taken immediately. Long term consequences of the structural interventions, and particularly an effective way for operation and maintenance should be considered in future. The overall success of the future projects will depend on devising mechanisms to reduce these conflicts starting from the planning stage.

CHAPTER SEVEN

CONCLUSION AND RECOMMENDATION

7.1 Conclusion:

The risk of conflict between beel dewatering and fisheries tends to increase with increasing scarcity of water resources. The diversification of such conflicts indicates that their probability of occurrence is significant. The nature causes and ways to manage the conflicts are summarized below.

- The conflicts may not be always expressed because of suppression of the voice of the week in the community power structure.

- Beel dewatering to increase agricultural land is the main reason for the current conflict. Besides, exclusion of the fishing community prior to implementation of the project, absence of proper compensation to cope with post project situation, non-functioning of WMCA (irregular meeting, partiality in loan disbursement, improper maintenance of sluice gates, khal excavation), unbalanced community power structure (farmer-dominated community) are some sources of conflicts between agriculture and fisheries.

- Hydrological analyses show that fish migration pattern is adversely affected due to project interventions. It also indicates a remarkable difference between pre and post project water levels at the Siapagla and Khamar Khal. Pattern of regulated flow on to the floodplain also illustrates a significant reduction in water area coverage for fish species due to the Siapagla FCD subproject.

- The digital elevation map (Fig 6.6) and area elevation curve (Fig 6.7) clearly show that due to the closing operation of the gates of the Siapagla and Baramara regulators, a huge portion of the beels remain dry when the outside water level is relatively high. The annual runoff depth is 0.76 m and it can inundate only about 425 hectares. This indicates an increase of agricultural land.

- Engineering solutions alone fail to solve such social conflicts that arise from conflicting water requirements. Solution to such problems lies in a sociotechnical approach that would consider the technical and social issues in an integrated way. Stakeholder participation from all levels of the society is necessary to address the conflicts, enter into the depth of the problems, and find a suitable means for conflict resolution.

- Identification of stakeholders was done on the basis of FGDs and interviews. Stakeholders were prioritized based on the degree of influence and degree of importance. The stakeholder analysis shows that weaker fishermen were not involved in the planning stage. Farmers, fishermen, women and other local inhabitants are all affected, positively or negatively, because of the project interventions. Since the WMCA consists of mostly farmers, the rights and privileges of the weaker groups are neglected in their decisions. The Union Porishod may play the most important role in the conflict resolution stage as it has a decision making position.

- Many good solutions may come from FGDs and interviews. But in a stakeholder workshop, where multiple stakeholders interact, the weaker groups may remain silent in front of the powerful groups. Powerless, marginal fisher community usually does not feel comfortable and reassured to express their feelings and opinions.

- Stakeholder involvement is essential in conflict identification and reduction, but the ultimate mechanism for conflict management may be the regulatory and legal procedures, especially in a community where unbalanced power structure exists.

7.2 Recommendation

a) For the project:

i. Sluice gates of the Siapagla and Baramara regulators should be operated in a fish-friendly way so that fish can enter the beel during early monsoon breeding season.

ii. Regular maintenance of the sluice gates is required for efficient inflow and outflow through the gates, so that the required flow in the khals can be maintained.

iii. To ensure a permanent habitat for fish and other aquatic species, silted up canals (e.g. Siapagla khal) should be re-excavated.

iv. Involvement of an external powerful, fair, unbiased authority is vital to resolve the social conflicts.

v. Fish sanctuaries should be established in permanent / excavated water bodies.

b) For further study:

vi. The intensity of the use of pesticides, insecticides, and chemical fertilizers in the agriculture fields should be monitored so that their excessive use and damaging effects could be controlled.

vii. Assessment of water quality (using parameters such as, DO, BOD, COD, temperature, pH, etc.) of the Siapagla khal and Khamar Khal would indicate the suitability of the aquatic habitat.

viii. User participation (including women) in planning and operation of the water resources project should be ensured.

ix. Catching of brood fish, fries and fingerlings should be prohibited particularly during the breeding season.

x. Awareness should be built against detrimental fishing activities such as fishing by 'current' net (jal), small mesh sized net, etc.

xi. Feasibility of the conflict management options should be investigated.

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Appendix A

Field Visit Summary

(a) First Field Visit

Purpose: The purpose of the first reconnaissance visit was to identify the specific research area and the central research question.

Six subprojects area were visited from 29th Oct to 30th Oct, 2007. The subprojects are:

- Khatnur Beel WCS Subproject - Completed
- Siapagla FCD Subproject - Completed
- Bahirgram Subproject – Proposed
- Debbhog Subproject – Proposed
- Panu Khal DR& WCS Subproject - Completed
- Chanduliar Char FCD Subproject – Completed

Activities:

i. Meeting with LGED officials

ii. Six FGD with the members of Water management cooperative associations (WMCA)

iii. Three interviews

  - Interview with the fisheries facilitator of LGED
  - Brief interview with a fisherman, Mr. Shribash Rai at Siapagla FCD Subproject
  - Interview with the Sociologist of LGED

(b) Second Field Visit

Purpose: To identify conflicts in water use for irrigation and fisheries, and preliminary assessment of the project interventions' impact on irrigated agriculture and fisheries.

Duration: 8th January, 2008 to 10th January, 2008

Activities:

- Meeting with LGED officials
- FGD with
  - Women
  - Farmers
  - Fishermen
  - A group of local people

(c) Third Field Visit

Purpose: To determine water requirements for irrigation, fisheries and the aquatic ecosystem, and assess the impact of project interventions on irrigated agriculture and fisheries.

Duration: 6th March, 2008 to 9th March, 2008

Activities:

Date: 7th March

i. Field Survey
ii. Meeting with two gate operators to gather information on gate operation
iii. Selection of two persons to measure the water level at the sluice gate
The selected persons are –

a. Lovely Rani Biswas, Father: Sannyashi Charan Biswas, Village: Peruli,Undergraduate student, Mathematics Department, Jessore M M College

b. Rupa Biswas, Father: Sunil Kumar Biswas, Student of class ten, Debipur High School

iv. Interview with Mr. Md. Sarawar Hossain, Agriculture Officer to obtain information on agriculture

Date: 8th March:

i. Interview with Ms. Tahmina Hossain and Mr. Md. Mahbubur Rahman; Agriculture Sub Assistant Officers, Tolarampur Union

ii. Field survey to check water level measurement activity, irrigation practices (LLP's, STW, etc), water distribution channels (drains), etc.

iii. Interview with Mr. Sunil Kumar Biswas, farmer

iv. FGD with female group to assess the impact of FCDI and possible solution of the negative impacts.

Date: 9th March:

i. Interview with Mr. S. M. Enamul Haque, Senior Upazila Fisheries Officer and Mr. Sharif Amin Nasir, Assistant Fisheries Officer, Narail Upazilla

ii. Interview with Mr Shumon Chandra Kundo, Agriculture Engineer

iii. Brief interview with two farmers.

iv. General discussion with two groups (consist of 8-10 persons) to assess the impact of Shiapagla FCD Sub project.

v. Interview with A.K Ajad, member of WMCA, Shiapagla Subproject.

(d) Fourth Field Visit

Purpose: To find the options to minimize the conflict, and explore the feasibility of developing a platform for conflict resolution/reduction.

Duration: 14th May, 2008 to 19th May, 2008

Activities:

Date: 15th May, 2008

i. Interview with Mr. S. M. Enamul Haque, Senior Upazila Fisheries Officer and Mr. Sharif Amin Nasir, Assistant Fisheries Officer, Narail Upazilla

ii. Interview with NGO officials (Bachte Shekha, Shomota)

Date: 16th May, 2008 and 17th May, 2008

i. Field survey to explore the feasibility of developing a platform for conflict resolution/reduction

ii. Motivating people to participate in the stakeholder workshop at union level

Date: 18th May, 2008

i. Field survey to explore the feasibility of developing a platform for conflict resolution/reduction

ii. Motivating and inviting people (both government and non government officials) to participate in the stakeholder workshop at Narail Sadar level

(e) Fifth Field Visit

Purpose: To arrange a stakeholder workshop.

Duration: 31st May 2008 to 2nd June, 2008

Activities:

Date: 1st June, 2008

i. Field survey to recheck the schedule of stakeholder workshop

ii. Stakeholder workshop at Narail Sadar level with UNO, Narail sadar; LGED, BWDB, NGO's etc.

iii. Stakeholder workshop at union level

Appendix B

Water Level Data Analysis

Steps of Data Processing:

1. Hourly water level was measured for two days at the two regulators from 6am to 6pm.
2. Water level data from the hydrometric station Afraghat (Station ID 30) located on the Afra River (downstream of the study area) were collected.
3. The data were processed and a correlation was established between field data and the recorded data of the hydrometric stations.
4. Water levels at the regulators were computed from the data recorded at Afraghat station using the correlation equation.
5. All hydrological analysis was done using these recalculated data.

Water Level Data Observed / Measured At the Field

Location: Khamar Khal Sluice Gate (One Vent Regulator)

Date:08.03.08
Saturday

Time	Water Level	
	Inner Gate (m)	Outer gate (m)
6:00 AM	2.70	2.70
7:00 AM	2.40	2.40
8:00 AM	2.20	2.10
9:00 AM	2.00	1.90
10:00 AM	1.80	1.70
11:00 AM	1.60	1.50
12:00 PM	1.50	1.40
1:00 PM	1.40	1.30
2:00 PM	1.40	1.20
3:00 PM	2.00	2.00
4:00 PM	2.40	2.30
5:00 PM	2 60	2.60
6:00 PM	2.70	2.70
7:00 PM	2.50	2.40
8:00 PM	2.20	2.10
9:00 PM	1.90	1.90

Date:09.03.08
Sunday

Time	Water Level	
	Inner Gate (m)	Outer gate (m)
6:00 AM	2.80	2.80
7:00 AM	2.60	2.50
8:00 AM	2.30	2.20
9:00 AM	2.00	2.00
10:00 AM	1.90	1.80
11:00 AM	1.70	1.70
12:00 PM	1.50	1.50
1:00 PM	1.40	1.30
2:00 PM	1.40	1.20
3:00 PM	1.80	1.80
4:00 PM	2.30	2.20
5:00 PM	2.50	2.50
6:00 PM	2.70	2.70
7:00 PM	2.80	2.80
8:00 PM	2.40	2.30
9:00 PM	2.20	2.10

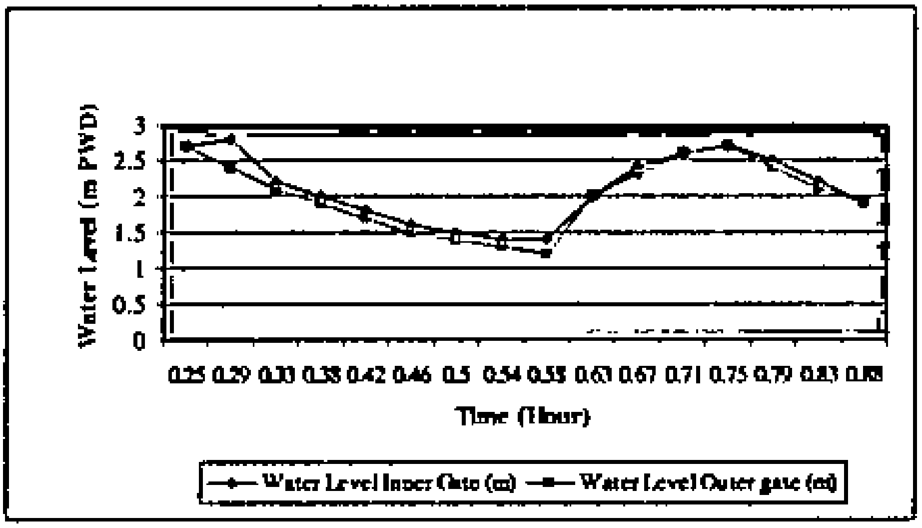


Fig 1: Water level variation with time for one vent regulator on 08.03.08.

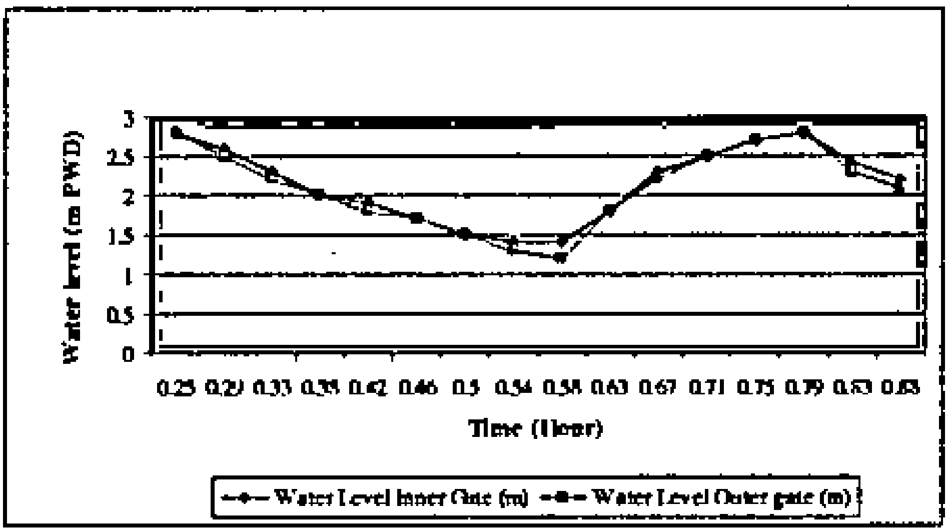


Fig 2: Water level variation with time for one vent regulator on 09.03.08.

Location : Siapagla Sluice Gate (Two Vent Regulator)
Date:08 03.08
Saturday

Time	Water Level	
	Inner Gate (m)	Outer gate (m)
6:00 AM	2.40	2.80
7:00 AM	2.40	2.50
8:00 AM	2.40	2.30
9:00 AM	2.40	2.10
10:00 AM	2.30	1.90
11:00 AM	2.20	1.80
12:00 PM	2.20	1.80
1:00 PM	2.00	1.80
2:00 PM	1.90	1.70
3:00 PM	2.00	2.20
4:00 PM	2.10	2.50
5:00 PM	2.30	2.70
6:00 PM	2.30	2.80
7:00 PM	2.40	2.60
8:00 PM	2.40	2.30
9:00 PM	2.40	2.10

Date:09.03.08
Sunday

Time	Water Level	
	Inner Gate (m)	Outer gate (m)
6:00 AM	2.40	2.90
7:00 AM	2.40	2.70
8:00 AM	2.40	2.40
9:00 AM	2.40	2.20
10:00 AM	2.40	2.00
11:00 AM	2.30	1.90
12:00 PM	2.20	1.80
1:00 PM	2.20	1.80
2:00 PM	2.10	1.80
3:00 PM	2.00	2.10
4:00 PM	2.10	2.40
5:00 PM	2.30	2.70
6:00 PM	2.30	2.90
7:00 PM	2.40	2.80
8:00 PM	2.40	2.50
9:00 PM	2.40	2.40

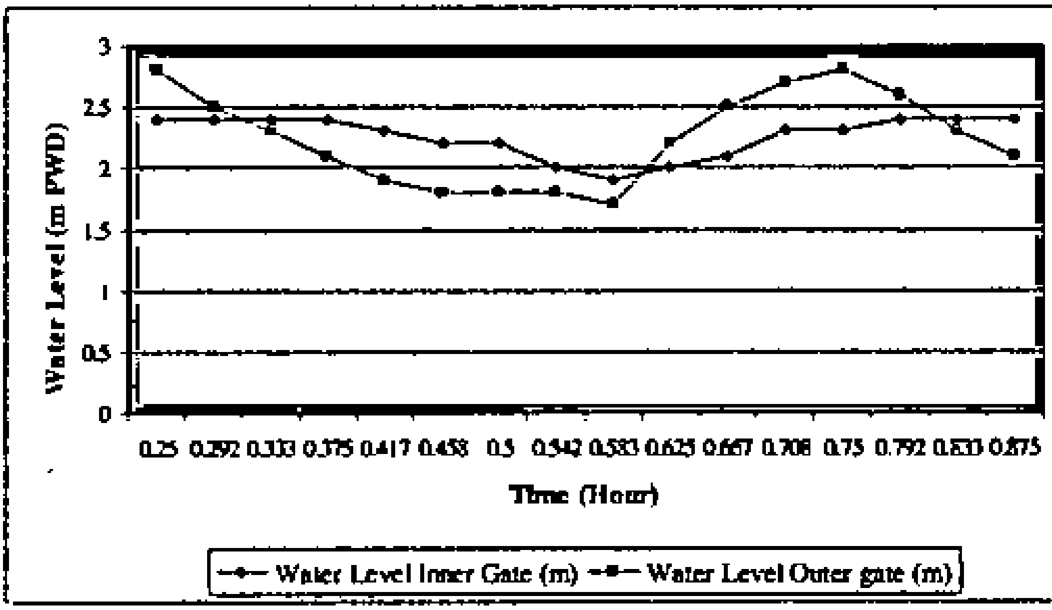


Fig 3: Water level variation with time for two vent regulator on 08.03.08.

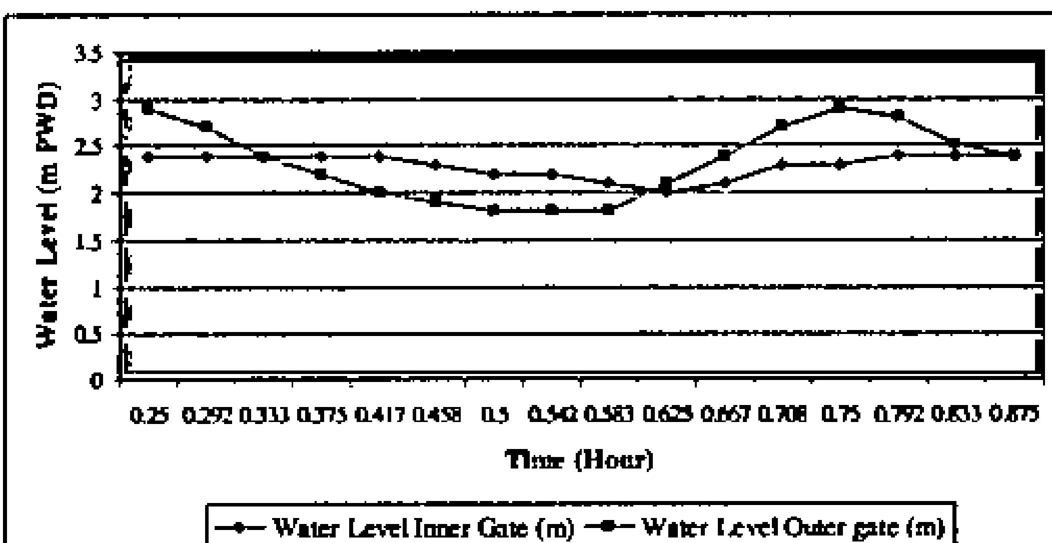


Fig 4: Water level variation with time for two vent regulator on 09.03.08.

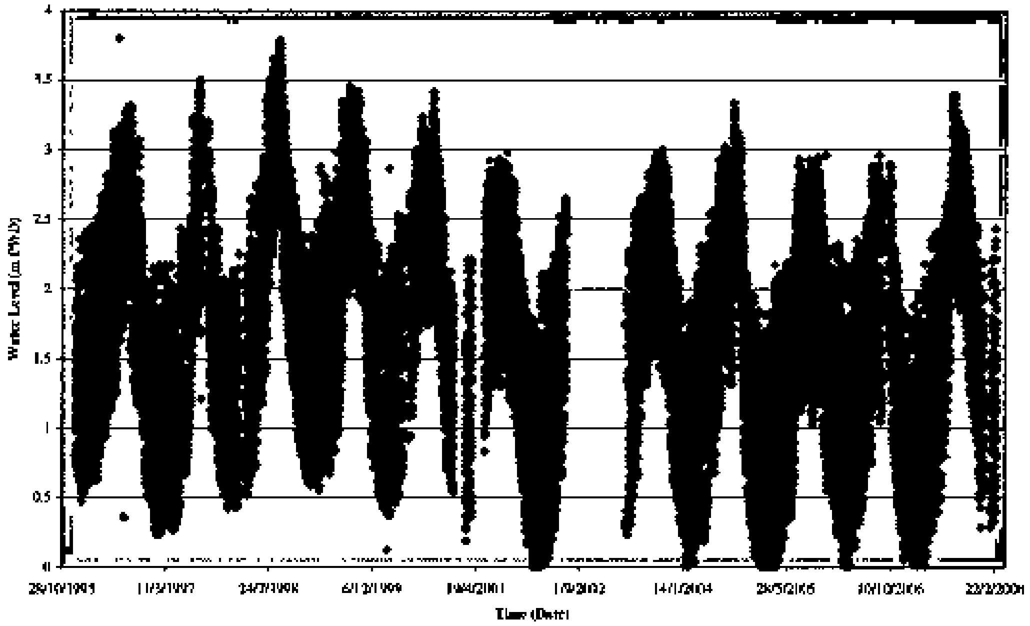


Fig 5: Water level (1996-2008).

Water Level (Only for the Month of March)

Station No. 30
Station Name: Afraghat (Afra River at Afraghat-downstream of the study area)

Station ID	Date	Time	Water Level (m PWD)
SW30	06/03/1996	06:00:00	2.1
SW30	06/03/1996	18:00:00	2.1
SW30	06/03/1996	15:00:00	1.56
SW30	06/03/1996	09:00:00	1.34
SW30	06/03/1996	12:00:00	0.86
SW30	06/03/1996	13:30:00	0.65
SW30	07/03/1996	06:30:00	2.16
SW30	07/03/1996	06:00:00	2.14
SW30	07/03/1996	18:00:00	2.14
SW30	07/03/1996	09:00:00	1.41
SW30	07/03/1996	15:00:00	1.32
SW30	07/03/1996	12:00:00	0.92
SW30	07/03/1996	14:00:00	0.67
SW30	20/03/1996	18:00:00	2.37
SW30	20/03/1996	06:00:00	2.35
SW30	20/03/1996	15:00:00	1.94
SW30	20/03/1996	09:00:00	1.49
SW30	20/03/1996	12:00:00	0.98
SW30	20/03/1996	13:30:00	0.77
SW30	21/03/1996	06:00:00	2.44
SW30	21/03/1996	18:00:00	2.38
SW30	21/03/1996	15:00:00	1.67
SW30	21/03/1996	09:00:00	1.54
SW30	21/03/1996	12:00:00	1.04
SW30	21/03/1996	14:00:00	0.78
SW30	11/03/1997	06:00:00	2.17
SW30	11/03/1997	18:00:00	2.13
SW30	11/03/1997	09:00:00	1.34
SW30	11/03/1997	15:00:00	1.25
SW30	11/03/1997	12:00:00	0.79
SW30	11/03/1997	14:30:00	0.43
SW30	12/03/1997	07:00:00	2.07
SW30	12/03/1997	06:00:00	2.03
SW30	12/03/1997	18:00:00	1.97
SW30	12/03/1997	09:00:00	1.43
SW30	12/03/1997	12:00:00	0.83
SW30	12/03/1997	15:00:00	0.44
SW30	12/03/1997	15:20:00	0.43
SW30	25/03/1997	18:00:00	1.89
SW30	25/03/1997	06:00:00	1.83
SW30	25/03/1997	15:00:00	1.3
SW30	25/03/1997	09:00:00	1.03
SW30	25/03/1997	12:00:00	0.53
SW30	25/03/1997	13:30:00	0.39
SW30	26/03/1997	06:00:00	1.93
SW30	26/03/1997	18:00:00	1.83
SW30	26/03/1997	15:00:00	1.24
SW30	26/03/1997	09:00:00	1.14
SW30	26/03/1997	12:00:00	0.67
SW30	26/03/1997	14:10:00	0.37
SW30	03/03/1999	18:00:00	2.2
SW30	03/03/1999	06:00:00	2.08
SW30	03/03/1999	15:00:00	1.48
SW30	03/03/1999	09:00:00	1.38
SW30	03/03/1999	12:00:00	0.95
SW30	03/03/1999	14:00:00	0.7
SW30	04/03/1999	06:20:00	2.29
SW30	04/03/1999	06:00:00	2.27
SW30	04/03/1999	18:00:00	2.14
SW30	04/03/1999	09:00:00	1.49
SW30	04/03/1999	15:00:00	1.37
SW30	04/03/1999	12:00:00	0.98
SW30	04/03/1999	14:25:00	0.74
SW30	19/03/1999	18:00:00	2.48
SW30	19/03/1999	06:00:00	2.44
SW30	19/03/1999	15:00:00	1.68
SW30	19/03/1999	09:00:00	1.57
SW30	19/03/1999	12:00:00	1.01
SW30	19/03/1999	13:10:00	0.73
SW30	20/03/1999	06:30:00	2.49
SW30	20/03/1999	18:00:00	2.46
SW30	20/03/1999	06:00:00	2.45
SW30	20/03/1999	09:00:00	1.68
SW30	20/03/1999	15:00:00	1.28
SW30	20/03/1999	12:00:00	1.08
SW30	20/03/1999	14:10:00	0.71
SW30	07/03/2000	18:00:00	2.11
SW30	07/03/2000	06:00:00	1.91
SW30	07/03/2000	15:00:00	1.57
SW30	07/03/2000	09:00:00	1.47
SW30	07/03/2000	12:00:00	0.81
SW30	07/03/2000	13:30:00	0.59
SW30	08/03/2000	06:00:00	2.25
SW30	08/03/2000	18:00:00	2.21
SW30	08/03/2000	09:00:00	1.49
SW30	08/03/2000	15:00:00	1.41
SW30	08/03/2000	12:00:00	1.11
SW30	08/03/2000	14:00:00	0.6
SW30	22/03/2000	18:00:00	2.26
SW30	22/03/2000	06:00:00	2.19
SW30	22/03/2000	09:00:00	1.38
SW30	22/03/2000	15:00:00	1.36
SW30	22/03/2000	12:00:00	0.87
SW30	22/03/2000	13:30:00	0.64
SW30	23/03/2000	06:00:00	2.23
SW30	23/03/2000	18:00:00	2.03
SW30	23/03/2000	09:00:00	1.45
SW30	23/03/2000	12:00:00	1.01
SW30	23/03/2000	15:00:00	1.01
SW30	23/03/2000	14:00:00	0.64
SW30	11/03/2001	18:00:00	2.17
SW30	11/03/2001	06:00:00	1.97
SW30	11/03/2001	15:00:00	1.33
SW30	11/03/2001	09:00:00	1.24
SW30	11/03/2001	12:00:00	0.74
SW30	11/03/2001	13:40:00	0.37
SW30	12/03/2001	06:00:00	2.21
SW30	12/03/2001	18:00:00	2.13
SW30	12/03/2001	09:00:00	1.43
SW30	12/03/2001	15:00:00	0.87
SW30	12/03/2001	12:00:00	0.84
SW30	12/03/2001	14:20:00	0.43

Station No. 30

Station Name: Afraghat (Afra River at Afraghat-downstream of the study area)

Station ID	Date	Time	Water Level (m PWD)
SW30	27/03/2001	06:00:00	2.19
SW30	27/03/2001	18:00:00	2.19
SW30	27/03/2001	15:00:00	1.37
SW30	27/03/2001	09:00:00	1.23
SW30	27/03/2001	12:00:00	0.79
SW30	27/03/2001	14:00:00	0.52
SW30	28/03/2001	06:30:00	2.21
SW30	28/03/2001	06:00:00	2.17
SW30	28/03/2001	18:00:00	2.13
SW30	28/03/2001	09:00:00	1.43
SW30	28/03/2001	15:00:00	1.16
SW30	28/03/2001	12:00:00	0.82
SW30	28/03/2001	14:30:00	0.47
SW30	28/02/2002	18:00:00	1.88
SW30	28/02/2002	06:00:00	1.26
SW30	28/02/2002	15:00:00	1.26
SW30	28/02/2002	09:00:00	1.24
SW30	28/02/2002	12:00:00	0.41
SW30	28/02/2002	13:00:00	0.16
SW30	01/03/2002	18:00:00	2.02
SW30	01/03/2002	06:00:00	1.92
SW30	01/03/2002	15:00:00	1.21
SW30	01/03/2002	09:00:00	1.16
SW30	01/03/2002	12:00:00	0.58
SW30	01/03/2002	14:00:00	0.23
SW30	15/03/2002	06:00:00	1.69
SW30	15/03/2002	18:00:00	1.58
SW30	15/03/2002	15:00:00	0.97
SW30	15/03/2002	09:00:00	0.88
SW30	15/03/2002	12:00:00	0.35
SW30	15/03/2002	13:30:00	0.14
SW30	16/03/2002	06:30:00	1.67
SW30	16/03/2002	06:00:00	1.65
SW30	16/03/2002	18:00:00	1.61
SW30	16/03/2002	09:00:00	0.87
SW30	16/03/2002	15:00:00	0.81
SW30	16/03/2002	12:00:00	0.34
SW30	16/03/2002	14:00:00	0.13
SW30	09/03/2004	6:30	1.85
SW30	09/03/2004	6:00	1.83
SW30	09/03/2004	18:00	1.8
SW30	09/03/2004	9:00	1.03
SW30	09/03/2004	15:00	0.99
SW30	09/03/2004	12:00	0.4
SW30	09/03/2004	14:00	0.23
SW30	10/03/2004	6:00	1.9
SW30	10/03/2004	18:00	1.86
SW30	10/03/2004	9:00	1.52
SW30	10/03/2004	15:00	0.93
SW30	10/03/2004	12:00	0.79
SW30	10/03/2004	14:40	0.22
SW30	22/03/2004	18:00	2.07
SW30	22/03/2004	6:00	2
SW30	22/03/2004	15:00	1.63
SW30	22/03/2004	9:00	1.19
SW30	22/03/2004	12:00	0.64
SW30	22/03/2004	13:30	0.43
SW30	23/03/2004	6:20	2.07
SW30	23/03/2004	18:00	2.07
SW30	23/03/2004	6:00	2.06
SW30	23/03/2004	9:00	1.25
SW30	23/03/2004	15:00	1
SW30	23/03/2004	12:00	0.65
SW30	23/03/2004	14:00	0.47
SW30	12/03/2005	6:00	1.83
SW30	12/03/2005	18:00	1.71
SW30	12/03/2005	15:00	1.06
SW30	12/03/2005	9:00	0.91
SW30	12/03/2005	12:00	0.32
SW30	12/03/2005	13:45	0.1
SW30	13/03/2005	6:40	1.79
SW30	13/03/2005	6:00	1.73
SW30	13/03/2005	18:00	1.7
SW30	13/03/2005	15:00	1
SW30	13/03/2005	9:00	0.98
SW30	13/03/2005	12:00	0.39
SW30	13/03/2005	14:20	0.11
SW30	27/03/2005	18:00	2.03
SW30	27/03/2005	6:00	1.62
SW30	27/03/2005	15:00	1.36
SW30	27/03/2005	9:00	0.88
SW30	27/03/2005	12:00	0.36
SW30	27/03/2005	13:30	0.22
SW30	28/03/2005	6:20	2
SW30	28/03/2005	18:00	1.98
SW30	28/03/2005	6:00	1.84
SW30	28/03/2005	15:00	1.25
SW30	28/03/2005	9:00	0.99
SW30	28/03/2005	12:00	0.456
SW30	28/03/2005	14:00	0.22
SW30	01/03/2006	18:00	2.1
SW30	01/03/2006	6:00	1.99
SW30	01/03/2006	15:00	1.67
SW30	01/03/2006	9:00	1.09
SW30	01/03/2006	12:00	0.5
SW30	01/03/2006	14:00	0.22
SW30	02/03/2006	6:00	2.18
SW30	02/03/2006	18:00	2.09
SW30	02/03/2006	9:00	1.22
SW30	02/03/2006	15:00	1.12
SW30	02/03/2006	12:00	0.52
SW30	02/03/2006	14:20	0.22
SW30	15/03/2006	18:00	1.65
SW30	15/03/2006	6:00	1.52
SW30	15/03/2006	15:00	1.29
SW30	15/03/2006	9:00	0.76
SW30	15/03/2006	12:00	0.22
SW30	15/03/2006	12:40	0.11
SW30	16/03/2006	6:00	1.75
SW30	16/03/2006	18:00	1.74
SW30	16/03/2006	15:00	1.14
SW30	16/03/2006	9:00	0.89

Station No. 30

Station Name: Afraghat (Afra River at Afraghat-downstream of the study area)

Station ID	Date	Time	Water Level (m PWD)
SW30	16/03/2006	12:00	0.31
SW30	16/03/2006	13:00	0.19
SW30	05/03/2007	6 00	1.71
SW30	05/03/2007	18 00	1.67
SW30	05/03/2007	15:00	1.01
SW30	05/03/2007	9 00	0.8
SW30	05/03/2007	12 00	0.21
SW30	06/03/2007	6 00	1.66
SW30	06/03/2007	18.00	1 66
SW30	06/03/2007	9 00	0.88
SW30	06/03/2007	15·00	0.87
SW30	06/03/2007	12 00	0.3

Station ID	Date	Time	Water Level (m PWD)
SW30	21/03/2007	18 00	2 18
SW30	21/03/2007	6 00	2.03
SW30	21/03/2007	15 00	1 77
SW30	21/03/2007	9·00	1 08
SW30	21/03/2007	12 00	0.48
SW30	22/03/2007	6 00	2 07
SW30	22/03/2007	18.00	2 07
SW30	22/03/2007	9:00	1 17
SW30	22/03/2007	15:00	1.17
SW30	22/03/2007	12.00	0 6

Observed Data at the One Vent Regulator of the Study Area and Recorded Data at the Afraghat

		Recorded Data at the Afraghat																					
Time	Obsreved Data	Mar-96	Mar-96	Mar-97	Mar-97	Mar-99	Mar-99	Mar-00	Mar-00	Mar-01	Mar-01	Mar-02	Mar-02	Mar-04	Mar-04	Mar-05	Mar-05	Mar-06	Mar-06	Mar-07	Mar-07	Mean	Obsreved Data
0																							
1																							
2																							
3																							
4																							
5																							
6	2.7	2.1	2.35	2.17	1.83	2.08	2.44	1.91	2.19	1.97	2.19		1.69	1.83	2	1.83	1.62	1.99	1.52	1.71	2.03	1.97	2.7
7	2.4													1.85								1.85	2.4
8	2.1																						2.1
9	1.9	1.34	1.49	1.34	1.03	1.38	1.57	1.47	1.38	1.24	1.23		0.88	1.03	1.19	1.19	0.88	1.09	0.76	0.8	1.08	1.18	1.9
10	1.7																						1.7
11	1.5																						1.5
12	1.4	0.86	0.98	0.79	0.53	0.95	1.01	0.81	0.87	0.74	0.79		0.35	0.4	0.64	0.32	0.36	0.5	0.22	0.21	0.48	0.62	1.4
13	1.3	0.65	0.77		0.39		0.73												0.11			0.53	1.3
14	1.2			0.43		0.7			0.64	0.37	0.52		0.14	0.23	0.43	0.1	0.22	0.22				0.36	1.2
15	2	1.56	1.94	1.25	1.3	1.48	1.68	1.57	1.36	1.33	1.37		0.97	0.99	1.63	1.63	1.36	1.67	1.29	1.01	1.77	1.43	2
16	2.3																						2.3
17	2.6																						2.6
18	2.7	2.1	2.37	2.13	1.89	2.2	2.48	2.11	2.26	2.17	2.19		1.58	1.8	2.07	1.71	2.03	2.1	1.65	1.67	2.18	2.04	2.7
19	2.4																						2.4
20	2.1																						2.1
21	1.9																						1.9
22																							
23																							
24																							
25																							
26																							
27																							
28																							
29																							
30	2.8	2.14	2.44	2.03	1.93	2.27	2.45	2.25	2.23	2.21	2.17	1.92	1.65	1.9	2.06	1.73	1.84	2.18	1.75	1.66	2.07	2.04	2.8
31	2.5	2.16		2.07		2.29	2.49				2.21		1.67		2.07	1.79	2					2.08	2.5
32	2.2																						2.2

Time	Obsreved Data	Recorded Data at the Afraghat																					Obsreved Data
		Mar-96	Mar-96	Mar-97	Mar-97	Mar-99	Mar-99	Mar-00	Mar-00	Mar-01	Mar-01	Mar-02	Mar-02	Mar-04	Mar-04	Mar-05	Mar-05	Mar-06	Mar-06	Mar-07	Mar-07	Mean	
33	2	1.41	1.54	1.43	1.14	1.49	1.68	1.49	1.45	1.43	1.43	1.16	0.87	1.52	1.25	0.98	0.99	1.22	0.89	0.88	1.17	1.27	2
34	1.8																						1.8
35	1.7																						1.7
36	1.5	0.92	1.04	0.83	0.67	0.98	1.08	1.11	1.01	0.84	0.82	0.58	0.34	0.79	0.65	0.39	0.456	0.52	0.31	0.3	0.6	0.71	1.5
37	1.3																		0.19			0.19	1.3
38	1.2	0.67	0.78		0.37	0.74	0.59	0.6	0.64	0.43	0.47	0.23	0.13	0.22	0.47	0.11	0.22	0.22				0.43	1.2
39	1.8	1.32	1.67	0.44	1.24	1.37	1.28	1.41	1.01	0.87	1.16	1.21	0.81	0.93	1	1	1.25	1.12	1.14	0.87	1.17	1.11	1.8
40	2.2																						2.2
41	2.5																						2.5
42	2.7	2.14	2.38	1.97	1.83	2.14	2.46	2.21	2.03	2.13	2.13	2.02	1.61	1.86	2.07	1.7	1.98	2.09	1.74	1.66	2.07	2.01	2.7
43	2.8																						2.8
44	2.3																						2.3
45	2.1																						2.1
46																							
47																							
48																							

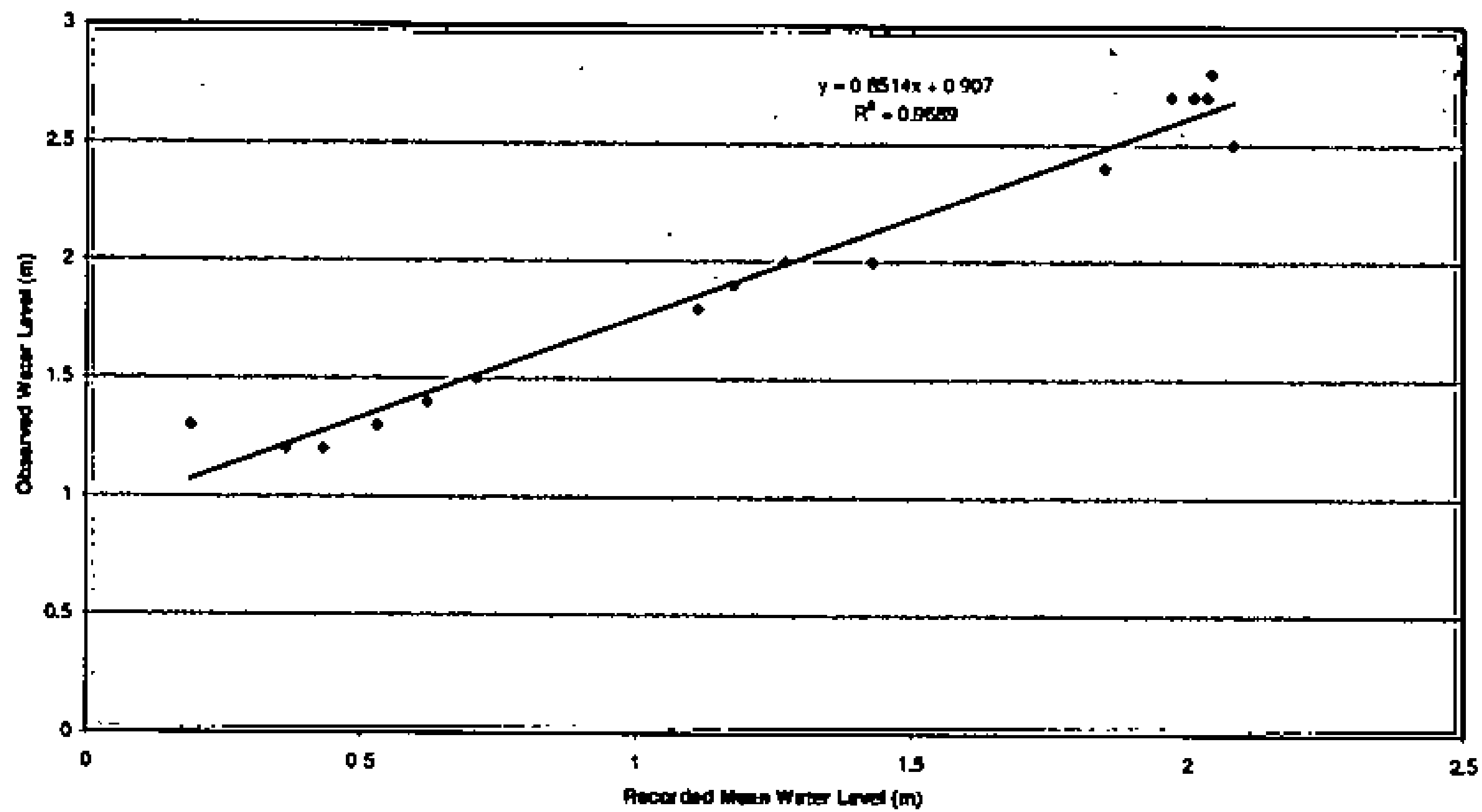


Fig 6: Trend analysis for one vent regulator.

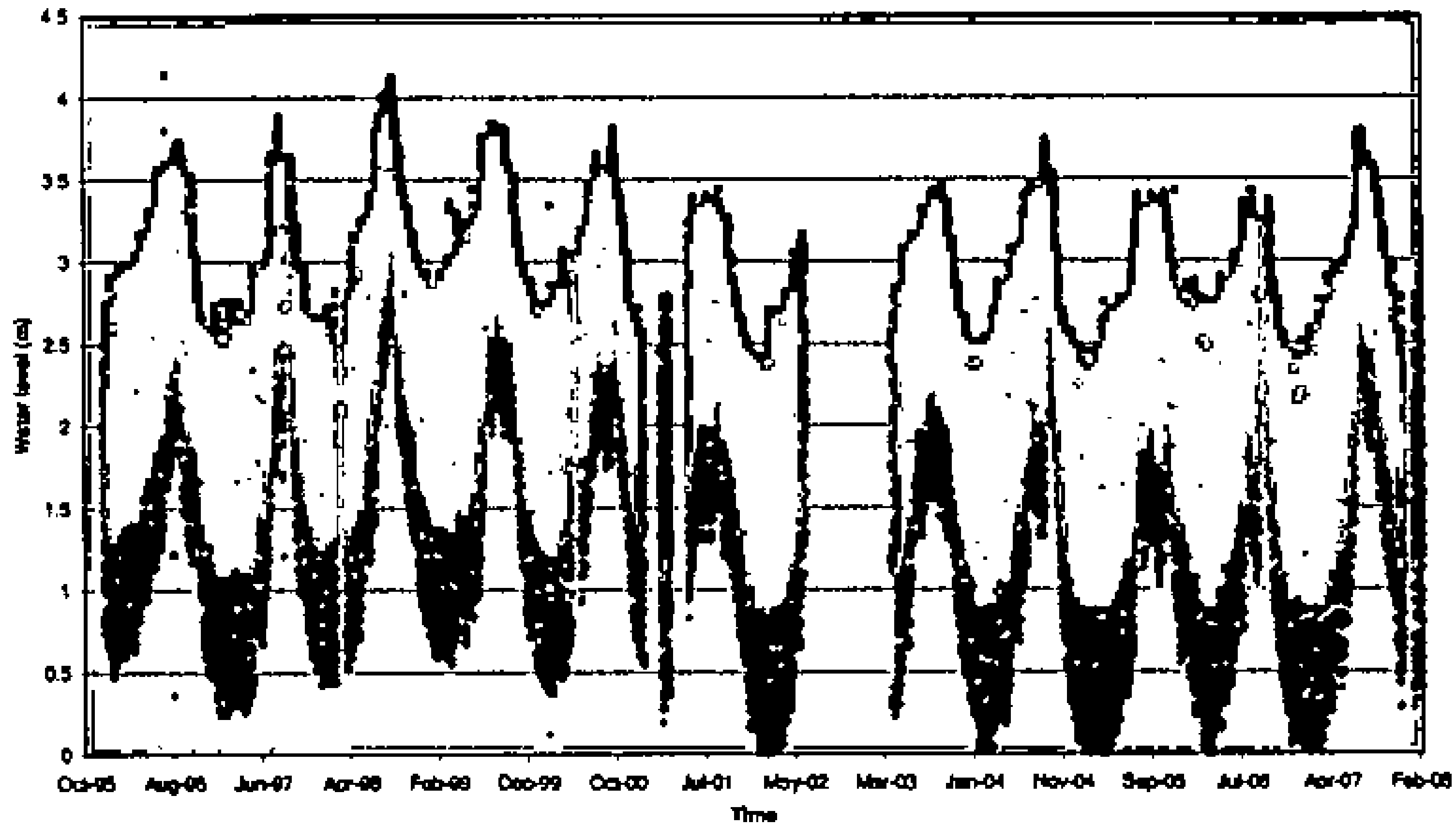


Fig 7: Comparison of raw and calculated water level for one vent regulator.

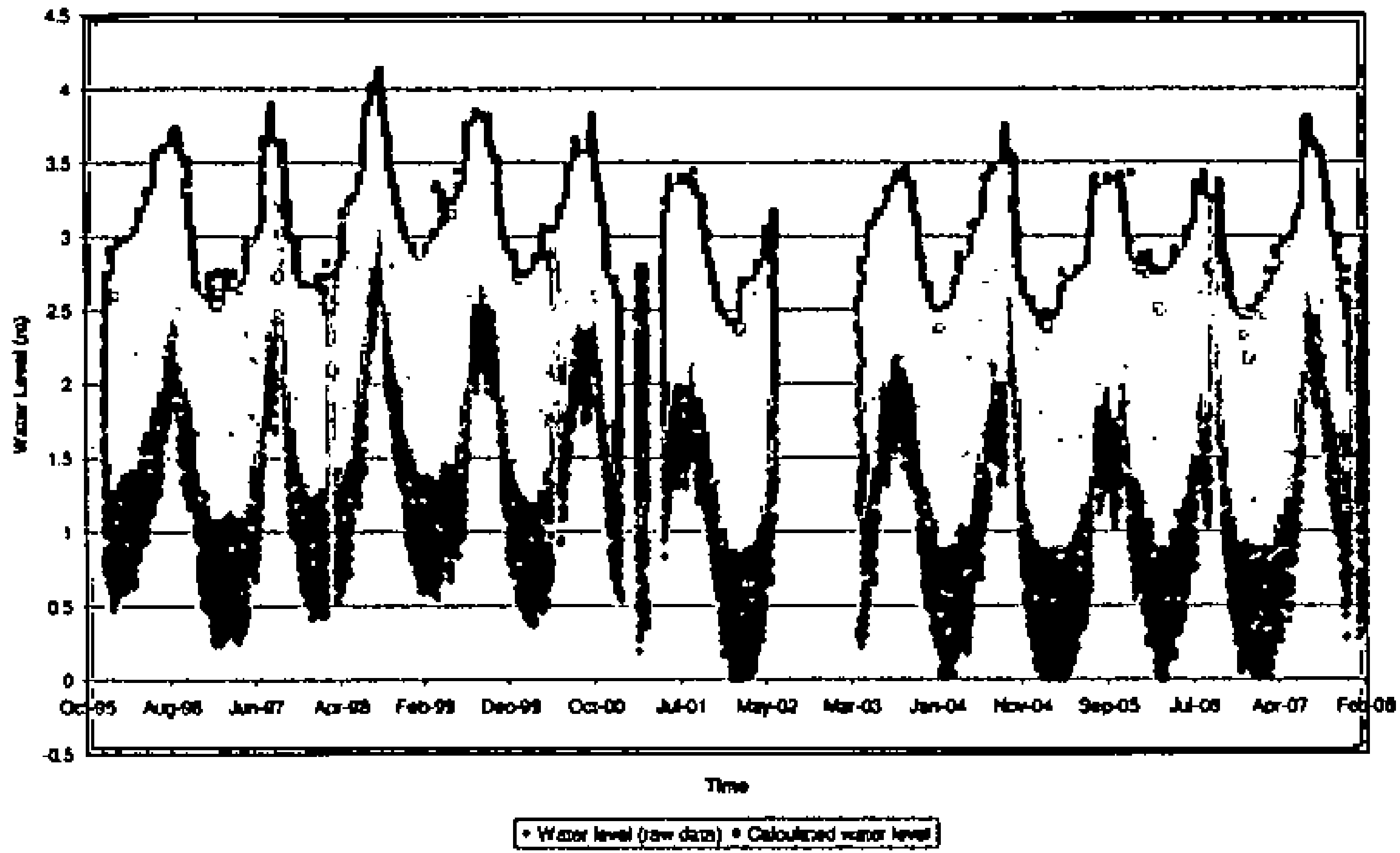


Fig 8: Comparison of Raw and Corrected Calculated Water Level for One Vent Regulator

Field Data for Two Vent Regulator and Observed Data at Afraghat

Time	Recorded Data																					Observed Data
	Mar-96	Mar-96	Mar-97	Mar-97	Mar-99	Mar-99	Mar-00	Mar-00	Mar-01	Mar-01	Mar-02	Mar-02	Mar-04	Mar-04	Mar-05	Mar-05	Mar-06	Mar-06	Mar-07	Mar-07	Mean	
0																						
1																						
2																						
3																						
4																						
5																						
6	2.10	2.35	2.17	1.83	2.08	2.44	1.91	2.19	1.97	2.19		1.69	1.83	2	1.83	1.62	1.99	1.52	1.71	2.03	1.97	2.80
7													1.85								1.85	2.50
8																						2.30
9	1.34	1.49	1.34	1.03	1.38	1.57	1.47	1.38	1.24	1.23		0.88	1.03	1.19	1.19	0.88	1.09	0.76	0.8	1.08	1.18	2.10
10																						1.90
11																						1.80
12	0.86	0.98	0.79	0.53	0.95	1.01	0.81	0.87	0.74	0.79		0.35	0.4	0.64	0.32	0.36	0.5	0.22	0.21	0.48	0.62	1.80
13	0.65	0.77		0.39		0.73												0.11			0.53	1.80
14			0.43		0.7			0.64	0.37	0.52		0.14	0.23	0.43	0.1	0.22	0.22				0.36	1.70
15	1.56	1.94	1.25	1.3	1.48	1.68	1.57	1.36	1.33	1.37		0.97	0.99	1.63	1.63	1.36	1.67	1.29	1.01	1.77	1.43	2.20
16																						2.50
17																						2.70
18	2.10	2.37	2.13	1.89	2.2	2.48	2.11	2.26	2.17	2.19		1.58	1.8	2.07	1.71	2.03	2.1	1.65	1.67	2.18	2.04	2.80
19																						2.60
20																						2.30
21																						2.10
22																						
23																						
24																						
25																						
26																						
27																						
28																						

29																					
30	2.14	2.44	2.03	1.93	2.27	2.45	2.25	2.23	2.21	2.17	1.92	1.65	1.9	2.06	1.73	1.84	2.18	1.75	1.66	2.07	2.04	2.90
31	2.16		2.07		2.29	2.49				2.21		1.67		2.07	1.79	2					2.08	2.70
32																						2.40
33	1.41	1.54	1.43	1.14	1.49	1.68	1.49	1.45	1.43	1.43	1.16	0.87	1.52	1.25	0.98	0.99	1.22	0.89	0.88	1.17	1.27	2.20
34																						2.00
35																						1.90
36	0.92	1.04	0.83	0.67	0.98	1.08	1.11	1.01	0.84	0.82	0.58	0.34	0.79	0.65	0.39	0.456	0.52	0.31	0.3	0.6	0.71	1.80
37																		0.19			0.19	1.80
38	0.67	0.78		0.37	0.74	0.59	0.6	0.64	0.43	0.47	0.23	0.13	0.22	0.47	0.11	0.22	0.22				0.43	1.80
39	1.32	1.67	0.44	1.24	1.37	1.28	1.41	1.01	0.87	1.16	1.21	0.81	0.93	1	1	1.25	1.12	1.14	0.87	1.17	1.11	2.10
40																						2.40
41																						2.70
42	2.14	2.38	1.97	1.83	2.14	2.46	2.21	2.03	2.13	2.13	2.02	1.61	1.86	2.07	1.7	1.98	2.09	1.74	1.66	2.07	2.01	2.90
43																						2.80
44																						2.50
45																						2.40
46																						
47																						
48																						

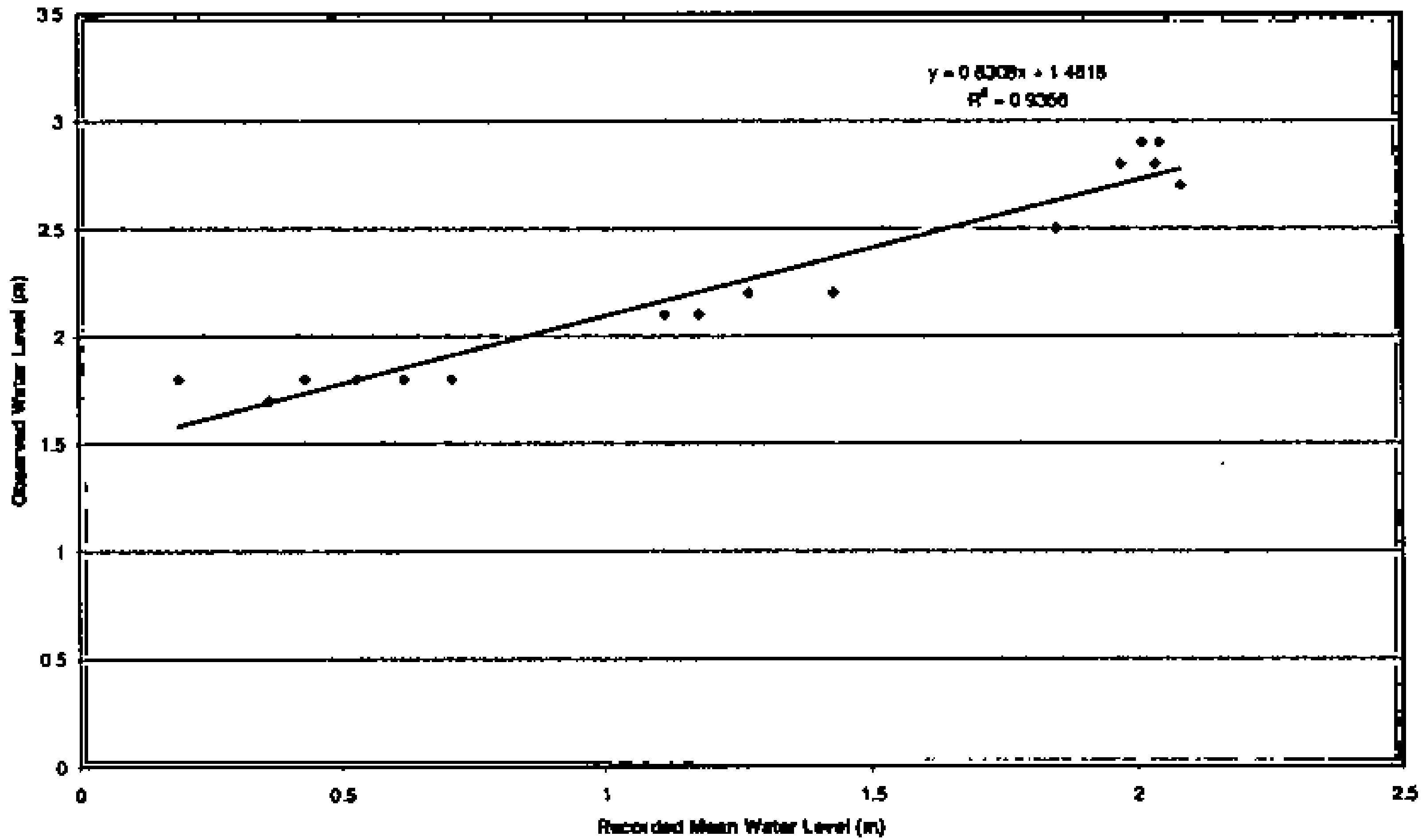


Fig 9: Trend analysis for two vent regulator.

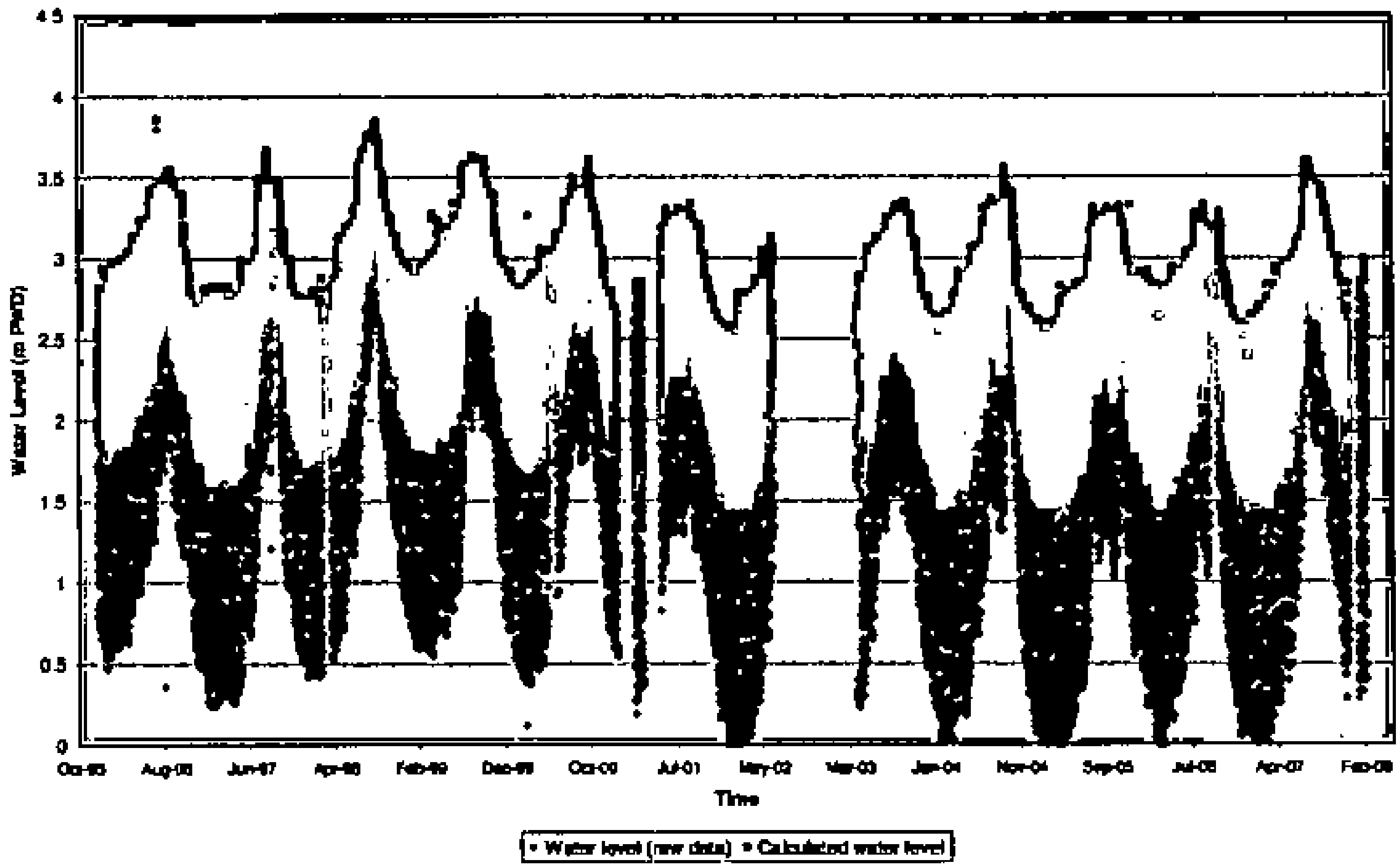


Fig 10: Comparison between recorded and calculated water level for two vent regulator.

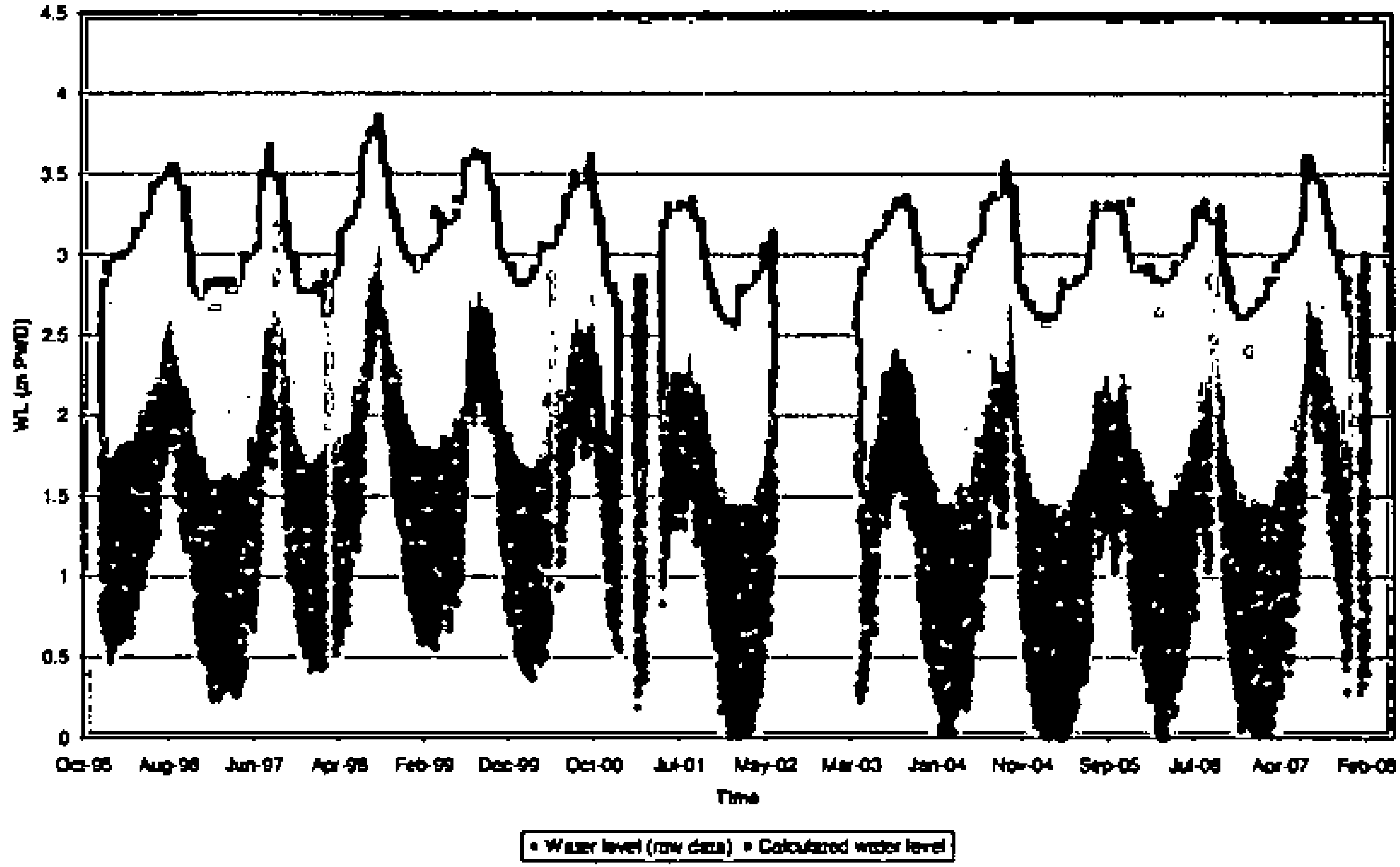


Fig 11: Comparison between raw and corrected calculated water level for two vent regulator.

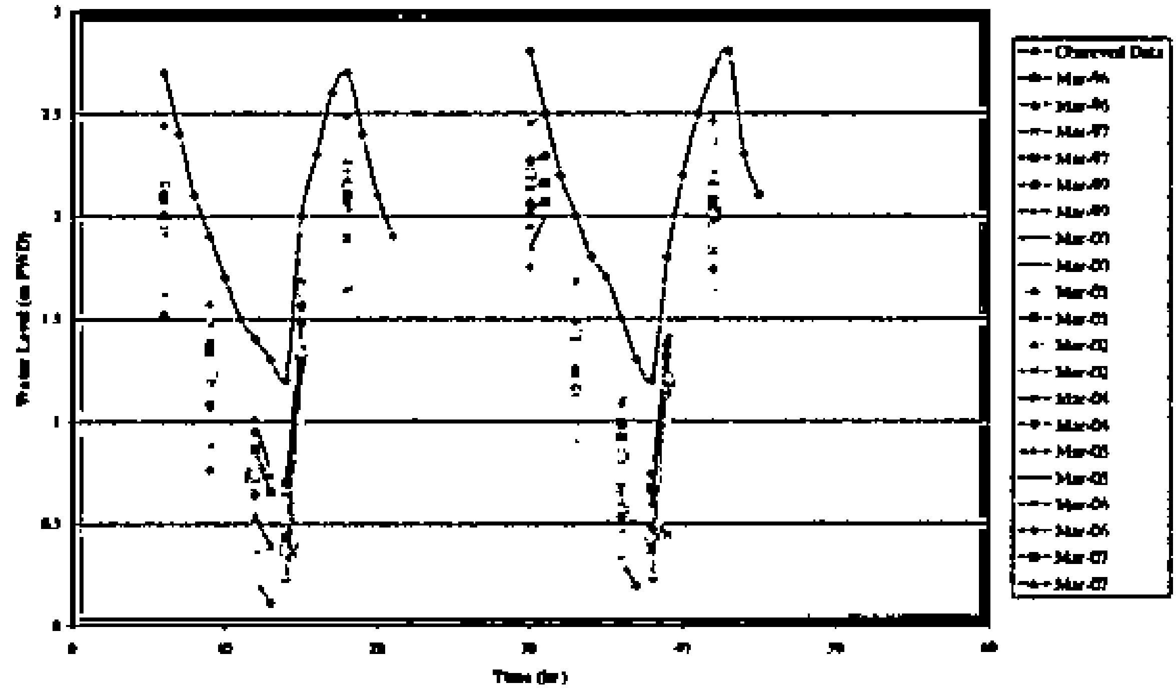


Fig 12: Water level analysis for one vent regulator.

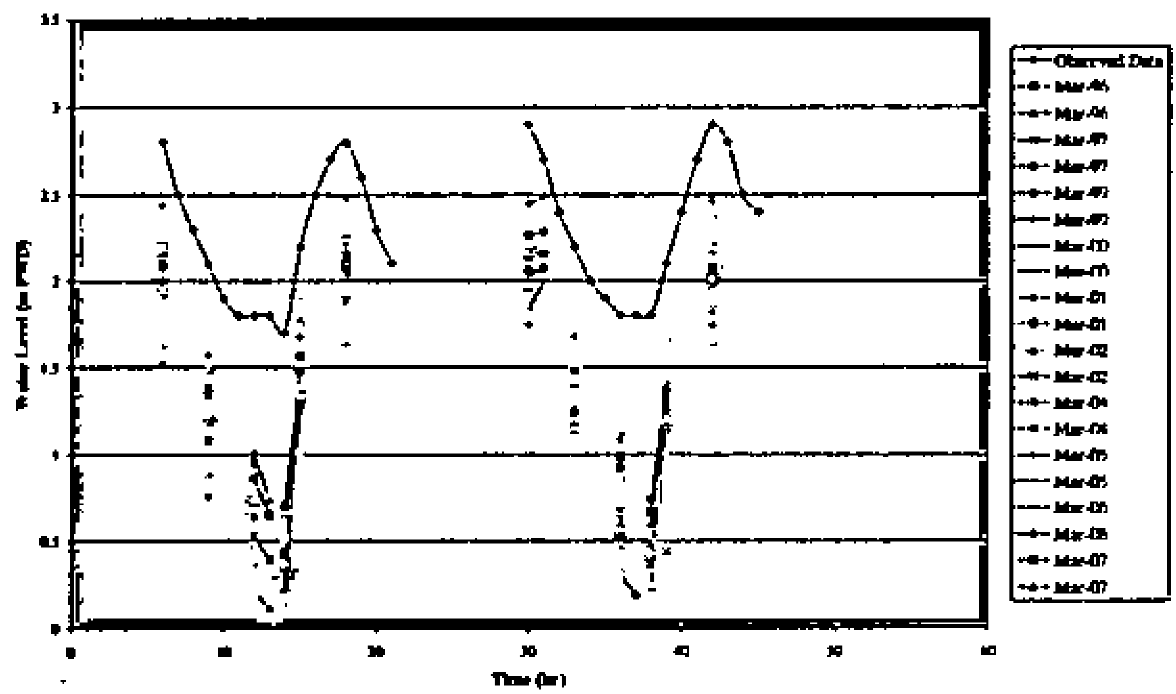


Fig 13: Water level analysis for two vent regulator.

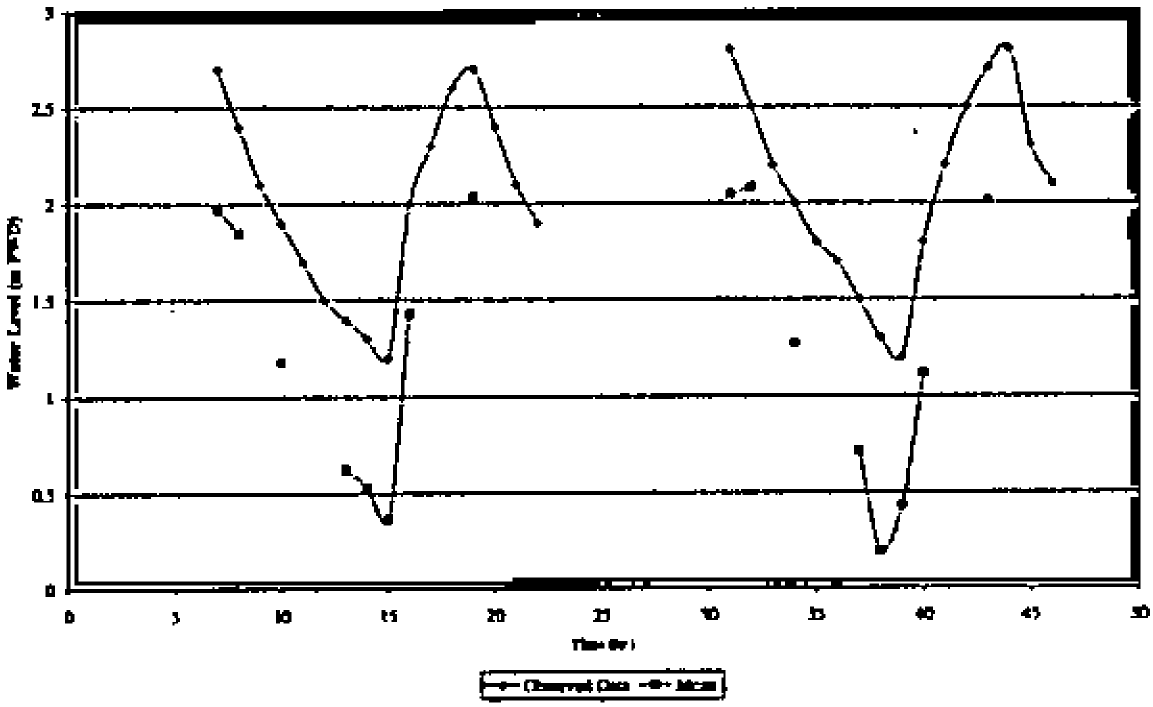


Fig 14: Comparison between observed and mean recorded water level. (One vent regulator)

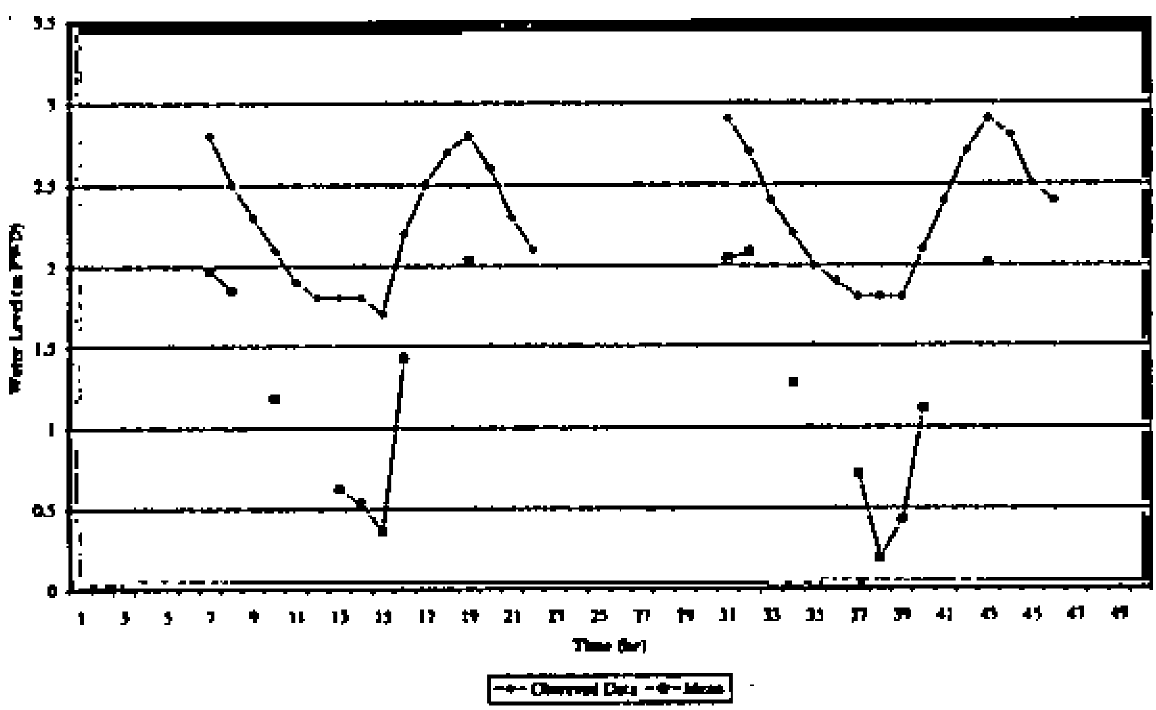


Fig 15: Comparison between observed and mean recorded water level. (Two vent regulator)

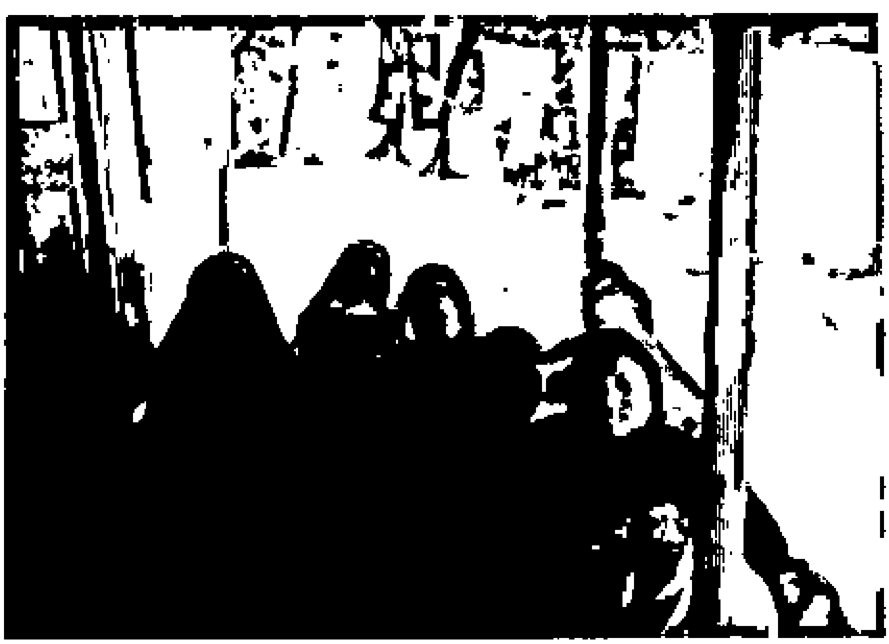
Appendix C

Photographs

Photograph 1: FGD at Slapagla subproject area with WMCA members.

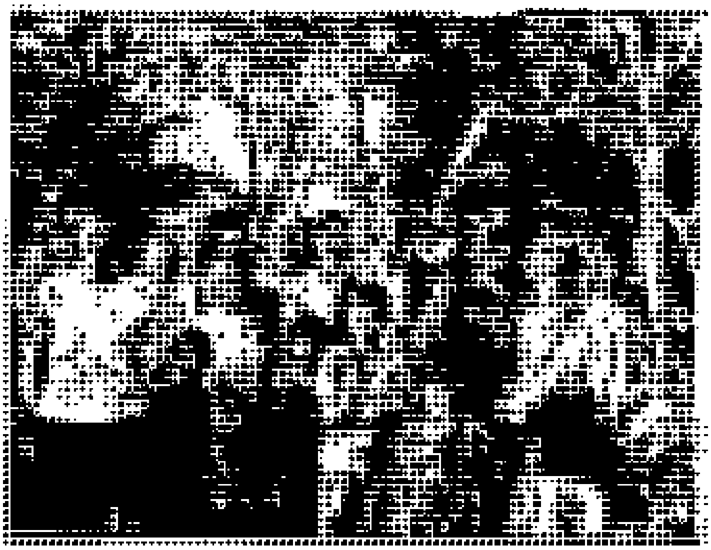
Photograph 2: FGD at Khatnur Beel with WMCA members.

Photograph 3: Siapagla FCD structure.



Photograph 4: FGD with a women group.

Photograph 5: FGD with farmers.

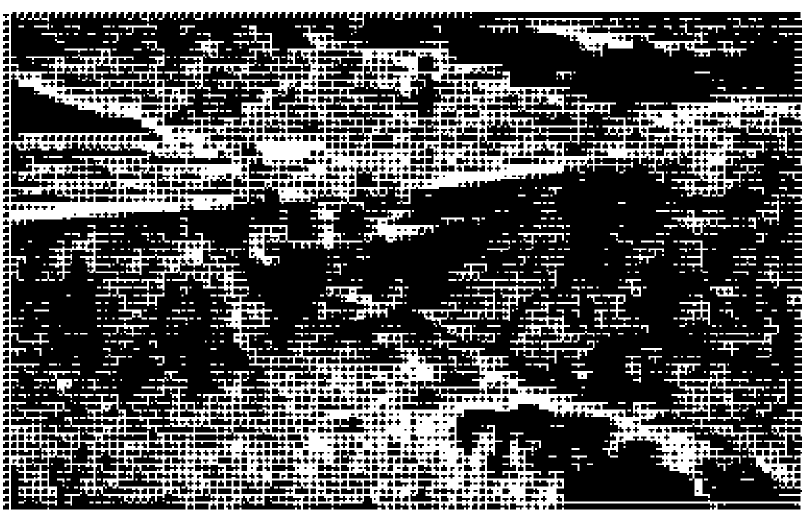


Photograph 6: FGD with Fishermen.

Photograph 7: Stakeholder workshop at local level.

Photograph 8: Stakeholder workshop at administrative level.

Photograph 9: Local people catching fish in the Siapagla Khal.



Photograph 10: The concrete cement barrier at the khamar khal obstructing fish migration.