Two studies on the Impact of Meghna-Dhonagoda Flood Control, Drainage and Irrigation project

I. An impact evaluation of the Meghna-Dhonagoda Embankment
II. An impact on environmental changes and people's perception of the Meghna-Dhonagoda Embankment

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FOREWORD

Empirical evidence point to a causal relationship between the socioeconomic status of individuals and communities and their health. Indeed improvement in health is expected to follow socioeconomic development. Yet this hypothesis has rarely been tested; at least it has not undergone the scrutiny of scientific inquiry. Even less understood are the processes and mechanisms by which the changes are brought about.

The Rural Development Programme (RDP) of BRAC is a multisectoral integrated programme for poverty alleviation directed at women and the landless poor. It consists of mobilization of the poor, provision of non-formal education, skill training and income generation opportunities and credit facilities. The programme is the result of 20 years of experience through trial and error. However evaluation of its impact on human well-being including health has not been convincingly undertaken.

The Matlab field station of ICDDR,B is an area with a population of 200,000, half of whom are recipients of an intensive maternal and child health and family planning services. The entire population is part of the Center's demographic surveillance system where health and occasionally socioeconomic indicators have been collected prospectively since 1966.

A unique opportunity arose when BRAC decided to extent its field operations (RDP) to Matlab. ICDDR,B and BRAC joined hands to seize this golden occasion. A joint research project was designed to study the impact of BRAC's socioeconomic interventions on the well-being of the rural poor, especially of women and children, and to study the mechanism through which this impact is mediated.

In order to share the progress of the project and its early results, a working paper series has been initiated. This paper is an important addition in this endeavour. The project staff will appreciate critical comments from the readers.

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AN IMPACT EVALUATION OF THE MEGHNA-DHONAGODA EMBANKMENT

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SUMMARY

The Meghna-Dhonagoda Embankment (MDE) is an example of a flood control scheme which also regulates irrigation and drainage of the area inside it. This intervention in the natural functioning of the environment - intended to reduce the often catastrophic impacts of flooding on mankind - itself may have substantial impacts on the environment and humans in the short and long run. These impacts are not well understood and thus are not fully taken into consideration at the time of inception of the project.

This study assesses the relatively short-run environmental impacts of the MDE using a statistical analysis. The data used in the study are cross sectional and are taken from a survey conducted in 1992, about 4 years after completion of the embankment. Bivariate and multivariate analysis of direct and indirect indicators were used to analyse the effects of the embankment on agricultural yields, nutrition levels, and wealth. The inferences drawn acknowledge the fact that many factors besides the embankment operate on these indicators and that isolating the effects of the embankment is difficult.

The results of this analysis indicate that the MDE is associated with both positive and negative impacts on the population inside the embankment relative to those outside, and it is difficult to generalise about the overall impact of the embankment on welfare. The most beneficial impacts correlated with the embankment are a higher level of agricultural yields and economic prosperity among the households inside relative to the households outside. On the other hand, fish catch and intake of fruits and vegetables are both found to be lower inside the embankment. One possible cause of virtually all of these impacts is the shifting of land use to HYV rice cultivation within the embankment area. However, due to the cross-sectional nature of this study, any causality implied by these correlations must be considered with caution: some differences between conditions in the areas which are now inside and outside the embankment may have been present before the embankment was built.

Only time will tell the full extent of the impacts of the MDE - beneficial as well as adverse - as these impacts evolve and a new equilibrium is reached. Whether the higher levels of rice production and wealth inside the embankment, found four years after its completion, can be sustained in the long run remains a vital question that will need to be revisited regularly for several more decades.

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ACRONYMS

ADB	Asian Development Bank
BRAC	Bangladesh Rural Advancement Committee
BWDB	Bangladesh Water Development Board
DSS	Demographic Surveillance System
FAP	Flood Action Plan
FCD/I	Flood Control, Drainage and Irrigation
HH	Household
HYV	High Yield Variety
ICDDR,B	International Centre for Diarrhoeal Diseases Research, Bangladesh
ISPAN	Irrigation Support Project for Asia and the Near East
MCH-FP	Mother, Child Health and Family Planning
MDE	Meghna-Dhonagoda Embankment
MUAC	Mid-upper arm circumference
RDP	Rural Development Programme
TG	Target Group

CHAPTER 1: INTRODUCTION

1.1 Background

Bangladesh is a riverine country with a history of experiencing annual floods, and occasionally, catastrophic floods. In many respects, these floods are beneficial; however, in some cases, the detrimental effects are believed to outweigh the benefits. Some floods have had devastating impacts on both infrastructure and human lives. Therefore several flood control schemes in the form of embankments and related water control measures, collectively known as "Flood Control, Drainage and Irrigation" (FCD/I) projects, have been developed under the Bangladesh Flood Action Plan (FAP). Roughly about one third of the net cultivated area in Bangladesh is included in FCD/I projects (ISPAN FAP 16, 1992 a). Among them, the Meghna-Dhonagoda Embankment (MDE), completed in 1988, is classified as a medium sized embankment (BRAC-ICDDR,B 1994).

FCD/I projects aim to protect crops from flood damage and river erosion, as well as to limit disruption of communication and damage to infrastructure (Hunting Technical Services Limited, 1991). In this process, however, they are often responsible for major ecological and environmental changes. These changes are usually not readily discernible immediately after the project's completion since their processes are gradual and take time to become fully evident.

Furthermore, the beneficial impacts of any embankment are not necessarily distributed evenly across the population. They may exacerbate the already wide disparities in wealth and income between the classes of people living in the affected area (ISPAN FAP 16, 1992 b).

With this in mind, this study was undertaken to assess the relatively short run impacts of the MDE on the lives of the people living in that area. The study analyses data collected in 1992, four years after the completion of the project. A follow-up study using later data to compare with this study would provide a valuable longitudinal perspective on the on-going changes brought about by the embankment, including how the benefits and costs appear to be changing through time.

1.2 Objectives

The objectives of this study are:

- to examine whether the MDE has left any impact on the people living inside the embankment four years after its completion.

- to determine which population (on either side of the MDE) is better off through the indicators selected, and the extent to which this is attributable to the MDE.

1.3 Hypothesis

This study tests the hypothesis that the embankment has provided net benefits to the people living inside it, in terms of agricultural production, nutrition, and income.

1.4 Methodology

This study is a secondary analysis, using data obtained from an existing database named the Joint BRAC-ICDDR,B's Socioeconomic Development and Health: Baseline Survey Matlab, 1992 (as discussed in detail later).

It is difficult to test directly the environmental impacts on human lives. Secondary impacts, on nutrition and standard of living for example, were therefore measured so that inferences could be drawn on the magnitude of environmental effects. As a result, variables were selected based on those indicators chosen to best reflect the environmental impact of the MDE. These indicators are:

- demographic factors
- socioeconomic status
- various ownership patterns
- nutrition
- water and sanitation

Data was primarily divided into two categories, namely:

- inside the embankment (MDE)
- outside the embankment (MDE)

The criteria of BRAC eligibility (or non-eligibility) was used to distinguish between the rich and poor. In some cases, data was further classified into MCH-FP and Comparison areas (discussed in detail later), where it was felt that these health interventions (or non-interventions) had some bearing on the results.

Data analysis was conducted by means of frequency distributions, bivariate cross-tabulations, mean tests and multiple logistic regression. Finally, inferences were drawn from the results.

1.5 Limitations

The limitations of this study are:

- The data used in the study was collected in 1992, only 4 years after completion of the project. At best, this is only enough time to observe short term effects of the embankment. In order to measure long term, "permanent" impacts, a period of 10 years or more would be required.

- Direct indicators, such as soil fertility and water quality, which would have been useful to test the quality of the environment were not available in the database. Therefore, inferences had to be drawn from the `indirect' indicators that were available such as socioeconomic status.

- The study is a case of a `snapshot' in time and as such the changes occurring due to the MDE over time are not reflected. This also makes it difficult to know whether the differences inside and outside the embankment are due to the MDE or if the existing conditions were prevailing regardless of the MDE.

CHAPTER 2: THE ADVANTAGES AND DISADVANTAGES OF EMBANKMENTS

2.1 The environmental impacts of embankments

As with most human interventions in nature, there are both beneficial as well as detrimental effects associated with embankments. Often the benefits are reaped almost immediately while the negative effects take time to eventually become apparent. This applies to the effects of embankments as well as to any other `controlled' environment.

The most obvious advantage of an embankment, in fact its very purpose, is to control floods. This can help save lives (in the event of catastrophic floods) as well as livelihoods and properties. Another distinct benefit is that the embankment can be a source for controlling irrigation and drainage, provided that it is operated and maintained efficiently. This can increase agricultural production as it enables farmers to plant high yield variety (HYV) crops and thereby significantly increase food yields.

Past experience with embankments has shown that they may also cause a number of problems. First, some people living in the area often get displaced and have to relocate because their land is acquired for the construction of the embankment. In addition embankments can be rather expensive to build (Miller, 1993).

In considering the long term impact on the environment, the consequences may have far greater implications. Floods not only flush out floodplains but also replenish soil with vital nutrients that allow it to remain fertile. By cleansing out the area there is less risk of water being contaminated and ultimately fewer waterborne diseases in both humans and animals. Siltation, or the gradual deposition of soil, becomes another major problem on river beds as this is no longer washed away by floods. Furthermore, when the fields aren't drained due to poor design and/or maintenance of the embankment (a common problem in Bangladesh) water logging results, which can salinate soil and rot crops.

With the adoption of HYV rice, there is a greater reliance on inputs such as irrigation and agrochemicals which can ultimately degrade soil - especially if applied in an improper manner. Further, by allowing the practice of monoculture (due to an overwhelming switch to HYV crops) embankments can be associated with an eventual proliferation of pests. Agrochemical runoff from fields into water bodies causes water pollution in both surface and groundwater, and can lead to eutrophication due to low oxygen content in stagnant water. Because the existing environment and ecological balance is altered, losses in wildlife diversity can be expected, especially to fish and other aquatic populations. Embankments also often obstruct the migration and spawning patterns of fish,

further contributing to declining populations. Ultimately, these environmental impacts affect the livelihoods of many humans, as well as reducing the quantity of fish harvests which provide a crucial source of protein (Miller, 1993).

Finally, there is the real threat of the embankment collapsing during the most severe flooding. This has occurred to the MDE twice - in both the disastrous floods in 1987 and 1988.

2.2 The effect of embankments on socioeconomic and health conditions

The most immediate and obvious positive result of embankments is the growth in agricultural production through the use of HYV crops. Not only is this a source of enhanced income for farmers but also for farm labourers. A secondary benefit arising from this is found in the improvement in the health status of the local community from the increased availability of food. The use of HYV's, along with fertilisers, has been responsible for an increase of up to 37% in rice. production, since 1970. However, in recent years it has been observed that average HYV rice yields have remained constant or have even diminished. It has been suggested that water logging of soils, and the accompanying loss of vital compounds through deep percolation as well as the formation of toxic compounds, are key causes of this trend (ISPAN FAP 16, 1992 a).

For economic reasons the use of HYV's encourages the practice of monoculture as well as the use of artificial inputs such as fertilisers and pesticides. Both these agrochemicals pollute surface and groundwater, thereby posing health risks from contamination of both household water sources and food chains. An increase in the incidence of waterborne diseases and fish diseases may be expected.

Another potential impact is that farmers may opt to grow higher profit-earning crops and perhaps neglect growing less profitable but more nutritious crops (such as fruits and vegetables). While this may increase disposable income, the reduced availability of nutritious crops may have adverse repercussions on the health status of the local villagers. A shrinking source of fish protein will only exacerbate this imbalance.

It must be noted that in order to take advantage of the potential to grow HYV crops and to cultivate culture fisheries in this controlled environment, one must be able to afford the necessary input costs. It cannot therefore be assumed that an embankment will automatically enhance the standard of living of all affected people (even though averages may improve, at least in the near term). Improvements will accrue primarily to those who have the means to purchase the required inputs to shift to HYV production. Those who are unable to do so may in fact

be rendered worse off as they are deprived of the annual replenishment of soil nutrients and common fish stocks through natural flooding. This category of people are usually the traditional farmers and fishermen (Hunting Technical Services, 1991).

Embankments can have mixed effects on employment. Construction of the embankment and the labour activities associated with it are a source of employment for the local communities (ISPAN FAP 16, 1992 a) but this generally ends with the completion of the project. As previously mentioned, increased crop production can lead to higher employment in that sector. On the other hand, it can reasonably be expected that there will be a decline in employment for fishermen inside the embankment because of the shrinkage in fish population; and also in boatmen because travelling by boat is no longer the only mode of travel, the embankment itself is now a road, and furthermore, the area is now drier or more "water-free" (see Table 14). However, a decline in open water fishing may be offset to some extent by a growth in pond fish culture.

The ultimate value of embankments, a reduction in the risk of flooding to households and property, including crop damage, is very difficult to measure against these long-term negative impacts. Certainly, one cannot be certain how many major catastrophes have been avoided, although it may be possible to guess based on the frequency of such events before construction of the embankment.

2.3 A review of past FCD/I projects in Bangladesh

FCD/I projects are nothing new in Bangladesh. Indeed they have been around for decades. In the 1960's polders and embankments were constructed in 400,000 acres of coastal land under US AID's Coastal Embankment Project (Rahman, 1995). Moreover, it has been projected that by the year 2005, 3.14 million hectares will be brought under FCD and FCD/I projects. This amounts to an elimination of virtually one third of Bangladesh's open floodplain, an astonishing change for the country. (ISPAN FAP 16, 1995).

In most cases, embankments have initially aided in improving agricultural production. The degree of improvement has varied widely, for instance, in the Zilkar Haor Project, located in Sylhet, north-east Bangladesh, yields inside the project area have reportedly been double those in the control area (Hunting Technical Services Limited, 1992 b); whereas in the case of the Kurigram South Project, situated in Kurigram and Lalmonirhat, north-west Bangladesh, "agricultural performance was mediocre" (Hunting Technical Services Limited, 1992 a). But in the example of the Konapara Embankment Project, located in Mymensingh, north-east Bangladesh, the planners, namely Bangladesh Water Development Board (BWDB), failed to anticipate that

farmers were rapidly getting access to irrigation quite independently of the project and thus the significant improvement in agricultural production ultimately has been largely attributable to factors other than the project itself (Hunting Technical Services Limited, 1991).

FCD/I projects have been found to inadequately take into account their impact on fisheries and fish stocks (Hunting Technical Services Limited, 1992 b; ISPAN FAP 16, 1995). In fact, 90% of fish consumption by the rural people is from capture fisheries. Furthermore, nearly all of the subsistence fishery catch comes from *"beels*, floodplains and canals", the sources which require annual inundation for restocking and therefore, also the most adversely affected by FCD/I projects (ISPAN FAP 16, 1995).

The reduction in production from capture fisheries due to embankment projects has been attributed primarily to the disruption in fish spawning and migration patterns. Such disruption was found even in the case of the Zilkar Haor Project, which was a submersible type of embankment and which allowed delayed flooding rather than preventing it. While capture fishery production fell by 70-75% in the Konapara Embankment Project, the project did manage to achieve a measure of success in developing culture fisheries, despite the poor conditions of the embankment (Hunting Technical Services Limited, 1991).

Impacts of FCD/I projects on livestock are often overlooked, even though they play an important role in the rural economy, as a source of draught power, milk, and as a principal form of savings (Hunting Technical Services Limited, 1992 b; 1991). Livestock populations were found to be declining in all three projects. The principal reason for this decline appears to be dwindling grazing lands due both to direct displacement by the embankments themselves and by the conversion of pastures to agricultural land, which the embankments facilitate. It was also seen that feed quality had deteriorated while fodder costs were rising. In the case of the Zilkar Haor Project, not only has net income from livestock fallen, but cattle health has also deteriorated.

Some FCD/I projects have failed to prepare for their potential environmental consequences (Hunting Technical Services, 1991). In particular, the Kurigram South Project and the Konapara Embankment Project have experienced severe problems. Among these are drainage congestion, water logging, sand deposition, embankment erosion (due to poor design and consfruction, as well as cuts made by the public) and declining soil fertility and moisture. The Zilkar Haor Project has claimed that it has caused only minor environmental impacts and has attributed current environmental problems in the area almost entirely to increased population pressure rather than the project.

Some of these FCD/I projects have given rise to social unrest and public reaction. In extreme cases even death has resulted. A tragic case of failure of an FCD/I project is documented in *Beel Dakatia* (Rahman, 1995). This area *(Beel Dakatia)* was a part of the US AID's Coastal Embankment Project (mentioned above) and is located in polder 25 near Khulna, a deltaic plain in southern Bangladesh. The project's aim was to protect the area from daily tidal saline waters and from seasonal floods. Although it did initially help to raise agricultural production, the pitfall of this project was poor operation and maintenance resulting in siltation problems and severe drainage congestion, and ultimately waterlogging and salinization - drastic consequences of which began to show up within a decade in the form of "profound changes in the socioeconomic situation and structure..... serious damages to agriculture, forestry, fisheries, livestock" and where "social infrastructure, including educational and health facilities completely broke down" (Rahman, 1995).

In an attempt to ameliorate the situation, in 1985, the Asian Development Bank (at the request of the Government of Bangladesh) appraised and approved its Khulna Coastal Embankment Rehabilitation Project (KCERP-II) and in 1989, its Coastal Embankment Rehabilitation Project (CERP-II). It planned to rehabilitate a total of 460,000 hectares of land which had been originally enclosed by coastal embankments. By this time the affected people of that area had lost faith in "agencies involved in maintaining the coastal embankment" and feared that irreversible changes had affected the environment. So they took matters into their own hands. They organized themselves and making numerous public cuts in the embankment to allow "tidal circulation" in the hope of improving water quality. Unfortunately this made matters worse. However the government then reacted by implementing an emergency action plan which helped remove some of the congestion of water. This action plan is yet to be fully executed (Rahman 1995).

Because of poor planning and designing of the Konapara Embankment Project, the people living in adjacent areas were negatively affected. They also reacted by making public cuts in the embankment. Although hoping to improve their lot, they unfortunately ended up damaging crops inside the project area. Consequently conflicts arose between the two areas ending in two people being killed (Hunting Technical Services Limited, 1991).

There has also been documented dissatisfaction among people whose land was acquired for projects but who were not properly compensated. They had either not yet been compensated; had been compensated only at a lower than market price; or had only been compensated after paying bribes. Another cause of friction was the further widening gap of income status among the project affected people. Indeed, despite the fact that "the overall living condition of the people within the project area has improved income inequalities appear to have been exacerbated", and "inequality is still extreme (per capita incomes of large landholders are 5.8 times those

of the landless)", are examples of some instances (Hunting Technical Services Limited, 1991; 1992 a). It is generally agreed that large landholders were the greatest beneficiaries of these FCD/I projects and this fact gives rise to social tension between farmers and fishermen and boatmen - in essence, between those who gained and those who lost as a result of the project (Hunting Technical Services Limited, 1992 b).

Obviously not all FCD/I projects are, or have been, failures. Indeed these projects have contributed towards a rise in employment even in non-farm activities (Zilkar Haor Project) within the project areas and housing conditions have improved. Income and nutritional status have improved and there are now better communication links. The Konapara Embankment Project allowed economically useful trees such as mango, coconut, jackfruit and betel nut to be introduced and planted on the embankment itself (as well as other now flood-free areas). In some cases population out-migration had been reduced.

2.4 A review of past studies of the Meghna-Dhonagoda Embankment (MDE)

Several studies have been undertaken to evaluate the MDE. Among the most recent was "The Impact of Environmental Changes and People's Perceptions of the Meghna-Dhonagoda Flood Control, Drainage and Irrigation Project" by Vaughan (1996). This study was based on qualitative methods which attempted to draw out the opinions and views of the impact of the MDE from the local villagers living around the area. It included key informant interviews, focus group discussions (FGD) and participatory rural appraisal techniques (PRA). Thirteen out of the fifteen FGD's were conducted inside the embankment. PRA techniques comprised of seasonal calendars, agro-ecosystem mapping exercises, and a time line exercise. However, it was not clear how the sample was selected.

The study concluded that, overall, the negative effects of the embankment far outweighed the beneficial impacts in terms of environmental factors. The only environmentally positive outcome found was that more trees were being planted now, especially on the embankment. Adverse impacts were found in fisheries, livestock health and soil structure. Furthermore, nutritional deficiencies were found in the diet of the villagers inside the embankment due to declining fish populations. Indeed, according to a study called "Potential Impacts of Flood Control on the Biological Diversity and Nutritional Value of Subsistence Fisheries in Bangladesh" (ISPAN FAP 16, 1995), which surveyed selected households in three different cycles (periods) of 17 weeks each, throughout one entire year, found that fish consumption was overall lower by 43% inside the MDE compared to the outside (see Table

1 below). The three cycles were split according to the following time periods:

- Cycle 1: 15th December – 15th April
- Cycle 2: 16th April – 15th August
- Cycle 3: 16th August – 14th December

Table 1. Fish consumption (g/person/day)

Area	Cycle 1	Cycle 2	Cycle 3	Full year
Inside MDE	19	20	36	24
Outside MDE	43	30	56	42
Average	30	24	45	32

Source: ISPAN FAP 16, 1995

Another study called "The Demographic, Health and Nutritional Impact of the Meghna-Dhonagoda Embankment", (ISPAN FAP 16, 1992 b) focused on health rather than environmental factors. It found that, on the whole, the MDE virtually had no "major negative impact, to date, on the health or nutritional status of people living in areas inside the embankment". The indicators used in this study were diarrhoea morbidity, nutritional status, mortality among children and out-migration patterns. The study states that these indicators show that the catastrophic flooding in 1987 and 1988 had more or less the same impacts on the populations living inside and outside the embankment (the MDE broke during both those floods). But it seems as if the people living inside needed a longer time to recover.

An interesting issue arising from a comparison of these studies is that Vaughan discovered that the richer people living inside the embankment had benefited more from the MDE compared to the poorer people, whereas ISPAN FAP 16 (1992 b) found no significant distinctions in the impacts on the different classes of people.

It is obvious that there is not yet a consensus regarding the net impacts of the MDE. This may be in part due to the different time frames and different research methodologies used in the two studies. Very little time had elapsed since construction of the embankment when the ISPAN FAP 16's (1992 b) analysis was undertaken; a substantial amount of data used in this study is from before the embankment was fully completed (construction finished in 1988, although data was used from throughout that decade). Therefore even the short-term effects of the MDE were probably not fully incorporated into the study findings.

CHAPTER 3: THE STUDY AREA

3.1 Matlab Thana

The MDE is situated in Matlab Thana, which is located 55 km south-east of Dhaka, the capital of Bangladesh. Matlab Thana falls under Chandpur district and the area is intersected by many canals and tributaries of the Meghna and Gumti rivers. The staple food in Matlab is rice, which is grown in two seasons. Agriculture is the main source of employment where the local people are either "owner-operators, sharecroppers, labourers, or a mixture of these". Fishing is also an important source of income (BRAC-ICDDR,B, 1994).

Matlab Thana headquarters are located in Matlab Bazaar, the town which is the centre of regional government, and has a police station, a court, schools, health facilities, a post office, banks, markets, and crop storage facilities. Matlab Bazaar is linked to the district capital Chandpur by a motorable road. Communication between villages is only possible by foot or non-motorized boats and various small towns along the rivers are connected to Matlab Bazaar by scheduled riverboats (BRAC-ICDDR,B, 1994).

3.2 The Meghna-Dhonagoda Embankment (MDE)

The MDE is a typical FCD/I project with the principal goal of boosting agricultural production by enabling farmers in adopting HYV of crops in a secure and flood-free environment (Vaughan, 1996).

The MDE was constructed from 1982 to 1988 and was mainly funded by the Asian Development Bank (ADB). The embankment is 60 km long and totally encircles the project area (see maps at end of chapter). The enclosed area makes up a total of 17,584 hectares (Vaughan, 1996) and irrigates 13,800 hectares (ISPAN FAP 16, 1992 b). The embankment itself is surrounded by the Meghna and Dhonagoda rivers, and hence, its name (Vaughan, 1996).

3.3 Joint BRAC-ICDDR,B Project

Matlab has been the International Centre for Diarrhoeal Disease Research, Bangladesh's (ICDDR,B) major station for field activity since 1966. Among conducting extensive research on "diarrhoea and related fields of fertility and nutrition", it maintains records and monitors demographic factors of 142 villages through its Demographic Surveillance System (DSS). ICDDR,B's Mother, Child Health and Family Planning (MCH-FP)

programme, which provides health services, is conducted in nearly half of the DSS villages. The remaining half is known as the Comparison area (BRAC-ICDDR,B, 1994).

BRAC's activities are centred on the upliftment of socioeconomic conditions rather than in health interventions. Its two major goals are:

- the alleviation of poverty; and
- the empowerment of the (landless) rural poor

The major programme BRAC operates is known as the Rural Development Programme (RDP). Only those who own 0.5 acre, (50 decimals) of land or less, and also have to engage at least 100 days (annually) in manual labour to earn their livelihoods are eligible to be BRAC members and are known BRAC's target group (TG). By no means are all BRAC eligible individuals members of BRAC as some of them do not choose to become members of BRAC.

BRAC's activities range from providing primary education to extending credit, and from providing skill and human development training to legal literacy, that is, raising awareness and consciousness among the members, usually female, about "their civic and legal rights" (BRAC-ICDDR,B, 1994).

In 1992, BRAC decided to extend its RDP to Matlab Thana. Given the many potential benefits arising from combining the activities of both BRAC and ICDDR,B the two organizations decided to 'join forces' in the area.'

Ultimately, to measure the on-going impacts of RDP in Matlab Thana, it was decided to conduct a baseline survey (discussed in the next section) in order to create a yard stick for future comparisons. Hence, the existence of the Baseline Survey database - the database used in this study (BRAC-ICDDR,B, 1994).

3.4 Baseline Survey: Sample selection and distribution

The total number of villages selected was sixty. Households (HI-I) were categorized into a total of eight "cells":

BRAC Eligible (TG)

1. MCH-FP area, inside embankment
2. MCH-FP area, outside embankment
3. Comparison area, inside embankment
4. Comparison area, outside embankment

BRAC Ineligible (Non-TG)

1. MCH-FP area, inside embankment
2. MCH-FP area, outside embankment
3. Comparison area, inside embankment
4. Comparison area, outside embankment

One thousand HH's were randomly selected from each village using 1982 DSS records. However, all BRAC TG HH's were selected and every second BRAC Non-TG HH was covered in the baseline survey (BRAC-ICDDR,B, 1994).

3.5 Survey instrument and response

A total of seven questionnaires were designed in Bengali in order to collect information on the HH, individual, female, male, immunization and village characteristics, as well as the basic learning of children. Fieldwork was conducted for three months, during which 11,343 HH's out of 11,961-targeted HH's were successfully interviewed. BRAC TG comprised 50.1% of the successfully interviewed respondents.

Table 2. Distribution of targeted and interviewed respondents by BRAC eligibility (n & %)

	BRAC Eligible		BRAC Ineligible		Total	
	targeted	interviewed	targeted	interviewed	targeted	interviewed
Currently married women	6834	6244	4086	3610	10920	9854
(< 50 yrs)	(100)	(91.36)	(100)	(88.35)	(100)	(100)
Husbands of above women	6063	4204	3231	2140	9294	6344
	(100)	(69.33)	(100)	(66.23)	(100)	(100)
Children (<6 yrs)	7529	7065	3667	3530	10926	10595
	(100)	(97.32)	(100)	(96.26)	(100)	(100)

Source: BRAC-ICDDR,B, 1994

3.6 Population distribution

The sample was selected with an effort to achieve uniformity in terms of the number of HM's in each cell; there were however some variations when it came to the total population in each cell.

Table 3. Population distribution by MDE

Groups	n	%
Inside MDE	27,172	43.7
Outside MDE	35,012	56.3
Total	**62,184**	**100.0**

Table 4. Population distribution by BRAC Eligibility and MDE

	BRAC Eligible		BRAC Ineligible	
	Inside MDE	Outside MDE	Inside MDE	Outside MDE
n	16,777	21,256	10,395	13,756
%	44.1	55.9	43.0	57.0

Table 5. Population distribution by BRAC Eligibility, MDE and MCH-FP areas

	BRAC Eligible				BRAC Ineligible			
	Inside MDE		Outside MDE		Inside MDE		Outside MDE	
	MCH-FP	Comparison	MCH-FP	Comparison	MCH-FP	Comparison	MCH-FP	Comparison
n	2,221	14,556	13,246	8,010	1,824	8,571	8,412	5,344
%	13.2	86.8	62.3	37.7	17.5	82.5	61.2	38.8

CHAPTER 4: THE STUDY FINDINGS

4.1 Demographic factors

According to ISPAN FAP 16 (1992 b), there were no significant dissimilarities in the age and sex-structure of the 1982 population, relative to inside and outside the MDE. Ten years later (1992), sex structure had more or less remained the same, that is, an equal distribution across gender as well as embankment.

The population age structure inside and outside the embankment in 1992 was similarly distributed (see Table 6), although the population inside the embankment was marginally younger. With regard to age relative to economic status, it can be seen that the BRAC eligible group had both a slightly larger working population (15-64 years) and a smaller younger population (under 5 years) than the BRAC ineligible, across the embankment.

Table 6. Age structure

Years	BRAC Eligible (%)		BRAC Ineligible (%)	
	Inside MDE (n = 16,777)	Outside MDE (n = 21,256)	Inside MDE (n = 10,395)	Outside MDE (n = 13,756)
Under 5	14.1	13.1	11.6	10.1
5 – 14	28.3	27.1	25.9	25.2
15 – 64	54.5	56.7	57.4	60.1
65 +	3.1	3.1	5.1	4.6

x^2 – test (significance level < .001)

Family sizes were significantly larger inside the embankment regardless of BRAC eligibility. This may reflect the need for increased manpower, probably for working in the fields. Indeed. agricultural labourers provided a considerable share in one of the many sources of income.

4.2 Socioeconomic status

The following indicators of socioeconomic status are discussed in the following section:

- education
- occupation
- income

4.2.1 Education

Generally, it was seen that the people living outside the embankment had higher education levels relative to those living inside. This may be related to easier access to local schools in Matlab Bazaar for the population living on the outside.

4.2.2 Occupation

Occupation was calculated based on the working age of Bangladesh (BBS, 1995). The most common form of occupation across **all** cells was `housework' (about 50%). This includes all unpaid activities done by parents and children around the *bari* (a HH unit consisting of a few houses), or out in the fields (see Table 7 below).

Agriculture related occupations fell to second place within the embankment for both BRAC TG and Non-TG groups, but in varying proportions.

Interestingly, service-based jobs (salaried jobs) represented a higher percentage inside the embankment than outside. This is somewhat surprising considering the relatively greater distance to Matlab Bazaar from inside than outside. However, more HH's outside the embankment were involved in business or trade and there were slightly more professionals (for example, doctors and engineers) living there too. Not surprisingly there were more HH's involved in fishing outside the embankment than inside.

It should also be noted that agricultural based occupations constituted a significant proportion (nearly 12%) of income for the BRAC Non-TG group outside the embankment.

Table 7. Occupation of working population

Occupation	BRAC Eligible (%)		BRAC Ineligible (%)	
	Inside MDE (n = 8,350)	Outside MDE (n = 10,950)	Inside MDE (n = 4,766)	Outside MDE (n = 6,446)
Housework	49.7	48.4	52.4	49.9
Farmer	14.2	5.7	21.2	11.9
Farm labourer	10.6	7.9	2.7	2.2
Day labourer	4.3	6.7	1.0	2.0
Salaried job	6.2	4.8	12.0	10.5
Business/trade	5.6	7.6	5.5	11.4
Fishing	2.7	3.9	0.4	1.3
Self-employed	2.4	7.1	1.2	3.6
Professional	0.1	0.4	0.1	0.6
Others	4.3	7.6	3.6	6.7

x^2 – test (significance level < .001)

4.2.3 Income

The major sources of income for HH's inside the embankment were from agricultural based activities, salaried jobs and livestock (see Table 8). For those HH's outside the embankment, it was from business or trade, and also from agricultural land. The highest source of income for those living inside was from agriculture (as expected), and for those living outside was from service based jobs.

Table 8. HH sources of income

Sources of income	BRAC Eligible (%)				BRAC Ineligible (%)			
	Inside MDE		Outside MDE		Inside MDE		Outside MDE	
	(n = 3196)	t	(n = 4050)	t	(n = 1741)	t	(n = 2356)	t
Agricultural land	57.0	***	41.2	***	87.0	***	72.8	***
Farm labouring	48.9	***	38.5	***	22.2	*	19.2	*
Day labouring	22.8	***	28.6	***	6.8	***	10.7	***
Business/trade	19.0	***	22.5	***	19.9	***	33.1	***
Fishing	7.9	***	13.1	***	3.3	***	6.2	***
Salaried jobs	21.2	***	14.7	***	43.8	***	37.1	***
Poultry	12.4	**	14.8	**	12.2	*	15.2	*
Livestock	21.7	***	9.8	***	33.1	***	14.9	***
Cottage industry	1.7	***	3.5	***	0.5	***	1.6	***

x^2 – test (significance level < .001)

It was observed that regardless of BRAC eligibility, HH's living inside the embankment were somewhat better off economically and experienced fewer deficits (see Table 9). This was further verified when a logistic regression analysis was conducted (see Table 10), although the significance was not as strong. In this particular analysis economic status was recoded into a binary variable categorized into those HH's which faced deficits and those which did not.

The effect of agricultural yields was found to be the strongest predictor of economic status out of the independent variables selected. Those whose agricultural harvests lasted from 6-12 months were financially better off. Sources of income from agricultural land, poultry and businesses had similar levels of effect on the economic status of HH's and all were statistically significant.

Table 9 Economic status of HH's

	BRAC Eligible (%)		BRAC Ineligible (%)	
	Inside MDE (n = 3196)	**Outside MDE (n = 4050)**	**Inside MDE (n = 1741)**	**Outside MDE (n = 2356)**
Always deficit	16.2	19.6	4.5	7.8
Sometimes deficit	46.2	47.0	29.8	32.7
Balance	34.7	30.4	49.0	43.1
Surplus	2.9	2.9	16.7	16.4

x^2 – test (significance level < .001)

Table 10. Effect of different sources of income an agricultural yields on HH economic status

Independent Variable	Coefficient (B)	Significance	Odds of avoiding economic deficit
MDE			
Inside	0.1014	0.0177	1.1067
Outside	-	-	1.0000
BRAC Eligibility			
Eligible (TG)	-0.5445	0.0000	0.5801
Non-eligible (Non-TG)	-	-	1.0000
Agricultural yields last for:			
0-6 months	-	-	1.0000
6-12 months	1.2216	0.0000	3.3928
Income from agricultural land			
Yes	0.2965	0.0000	1.3451
No	-	-	1.0000
Income from agricultural labouring			
Yes	-0.6465	0.0000	0.5239
No	-	-	1.0000
Income from business			
Yes	0.3038	0.0000	1.3549
No	-	-	1.0000
Income from poultry			
Yes	0.3201	0.0000	1.3773
No	-	-	1.0000
Income from selling vegetables			
Yes	-0.4332	0.0003	0.6484
No	-	-	1.0000
Income as day labourer			
Yes	-0.4178	0.0000	0.6585
No	-	-	1.0000

Constant	:	-.1472
Model Chi-square	:	1951.85
Degrees of freedom	:	9
Significance level	:	0.00

4.3 Ownership patterns

Ownership of material possessions is an alternative to income as a measure of wealth.

4.3.1 Ownership of land

When it came to ownership of land, average holdings were larger inside the embankment than outside, and there were far more people landless on the outside (Table 11). Mean **cultivable land** inside the embankment was 70.0 decimals per household, while outside it was 50.4 decimals (Table 12). But the difference in mean ownership of land between the poor and the rich both inside and outside the embankment is especially startling: the BRAC Non-TG owned over 4 times more land than the BRAC TG in both locations (Table 11).

Table 11. Mean ownership patterns of land

	Inside MDE			Outside MDE		
	n	**% of HH's**	**decimals of land**	**n**	**% of HH's**	**decimals of land**
BRAC TG	3196	44.1	26.7	4050	55.9	22.8
BRAC Non-TG	1741	42.5	127.0	2356	57.5	104.9

x^2 – test (significance level < .001)

Table 12. Mean ownership patterns of cultivable land

	Inside MDE			Outside MDE		
	n	**% of HH's**	**decimals of land**	**n**	**% of HH's**	**decimals of land**
BRAC TG	3196	44.1	18.9	4050	55.9	13.8
BRAC Non-TG	1741	42.5	110.1	2356	57.5	84.7

x^2 – test (significance level < .001)

4.3.2 Ownership of poultry and livestock

Although the mean number of **chickens** per HH inside the embankment was higher than outside, it was surprising to see that a greater number of HH's outside the embankment had earned a larger proportion of

income from poultry. This may be due to a greater reliance on poultry for family food supply than for income inside the embankment. It may also have been due in part to a higher mean number of **ducks** owned outside the embankment, although the chicken population was over double the size of the duck population.

There may be an assumption that if the HH's inside the embankment can afford to raise nearly twice as many chickens, surely the proportion of ducks should be higher too (relative to the outside). But the actual situation is in keeping with the controlled environment: ducks need a semi-aquatic environment to survive and the lower presence of water inside the embankment necessarily means that a lesser number of ducks can be raised inside as compared to the outside where the conditions are naturally more favourable.

There was little variation in the ownership pattern of **goats** between the BRAC TG and Non-TG populations across the embankment. However, about 1/4 of the population inside the embankment owned at least one goat compared to less than 17% for those living outside. It was interesting to see that while there was a significant difference in the number of **cows** owned between the BRAC TG and Non-TG outside the embankment, the ownership pattern was similar for BRAC Non-TG outside the embankment and BRAC TG inside the embankment (see Table 13). Furthermore while cattle was a source of income for 14.9% of the population in the BRAC Non-TG outside the embankment, it constituted 21.7% for the BRAC TG inside the embankment, thereby indicating that cows were not only used for the increased agricultural activity, but also, to a large extent, for other commercial purposes. In addition the reduced risk of losing livestock due to flooding may have contributed to a willingness to hold a larger population of cows.

Table 13. Ownership patterns of cows

Number of cows	BRAC Eligible (%)		BRAC Ineligible (%)	
	Inside MDE (n = 3196)	Outside MDE (n = 4050)	Inside MDE (n = 1741)	Outside MDE (n = 2356)
0 cows	68.7	81.5	53.9	67.6
1 cows	14.4	10.8	14.5	15.3
2 cows	10.5	5.1	15.9	10.0
3 + cows	6.4	2.6	15.7	7.1

x^2 – test (significance level < .001)

4.3.3 Ownership of possessions

ISPAN FAP 16 (1992 b) stated that, in 1982, HH's inside and outside the MDE had "virtually the same ownership patterns for consumer durables ..... and HH's inside the embankment (area) owned a significantly greater number of boats". Not much difference was found in the ownership patterns of possessions in this study. While in some cases HH's inside the embankment area may have owned a larger share of a particular possession, for example beds *(khats)*, in other cases this may have been offset in different areas where the reverse was true. But when it came to boats, there was a wide disparity in the number owned. In contrast with the ISPAN FAP 16 (1992 b) figures, the HH's outside the embankment now owned a statistically significantly greater number of boats - even up to five times more (see Table 14). Not only was there a lesser reliance on boats as a mode of transport inside the embankment, but fishing as a means of livelihood appears to have declined. The fact that fishing was a source of income for nearly twice as many HH's outside the embankment as compared to those inside is consistent with the complaints of the villagers inside the embankment about the scarcity of fish in their diets, cited in Vaughan's study (1996).

Table 14. Ownership patterns of possessions

Possessions	BRAC Eligible (%)				BRAC Ineligible (%)			
	Inside MDE		Outside MDE		Inside MDE		Outside MDE	
	(n = 3196)	t	(n = 4050)	t	(n = 1741)	t	(n = 2356)	t
Radio	13.2	*	11.4	*	27.2		29.5	
Bed *(khat)*	70.9	*	68.4	*	92.6		92.3	
Mosquito net	73.2		74.4		90.1		91.3	
Cycle	1.1		1.4		2.7	***	5.8	***
Boat	7.9	***	30.2	***	4.8	***	31.7	***
Chair	24.9	**	27.9	**	63.3	***	69.3	***
Table	23.4		23.4		64.0		66.7	*

x^2 – test (significance level < .001)

4.3.4 Ownership and construction material of houses

A typical *bari* consists of 1- 4 houses. However not all families own more than one house. In general it was found that HH's inside the embankment had a slightly higher ratio of ownership of up to four houses. Living conditions seemed to be better as well because a smaller proportion of HH's defined their house(s) as squatters

inside that embankment than outside. The use pattern of houses inside a *bari* were similar across all cells. The first and second houses were mostly used as bedroom-cum-living rooms. The third house was generally used as a kitchen, with the fourth being utilized as a cow shed.

The principal materials used for the **construction of walls** were tin, bamboo, jutesticks and *gol pata* (leaves) - the relative worth of each material declining in that order. Generally, tin or bamboo was used for the first house across all cells. The BRAC-eligible population generally utilized jutesticks and bamboo for the remaining houses while the wealthier BRAC-ineligible typically used jutesticks and *gol pata*. While this held true across the embankment, the ratio of use of the `better' material was slightly higher outside the embankment than inside. It was also observed that there was a lower ratio of jute use inside the embankment, regardless of BRAC eligibility. This fact may indicate that jute was not as readily available inside the embankment, which in turn may be due to farmers shifting from jute harvesting to HYV rice. This may also account for the more intensive use of *gol pata* inside the embankment despite the overall improved economic status (inside the embankment).

The predominant materials used for the **construction of roofs** was tin and *gol pata*. Tin was more commonly used by the BRAC-ineligible while the BRAC-eligible utilized *gol pata*. Nevertheless, tin was used for the first house by the majority of HH's across all cells. In contrast to the **`construction materials of walls'** (excepting house number 2), nearly all HH's inside the embankment had a statistically significantly higher ratio of tin use than did the HH's outside the embankment, regardless of BRAC eligibility.

4.4 Nutrition

To examine nutrition levels, the following variables were examined:

- Nutrition content in diet
- Agricultural yields
- MUAC (mid upper arm circumference)

4.4.1 Nutrition content in diet

It was observed that more fruits and vegetables were eaten outside the embankment than inside. Again this may be because farmers opted to utilize the maximum amount of land in growing HYV rice because it fetches larger incomes, rather than grow fruits and vegetables.

The same held true for consumption of fish. As mentioned before, this was probably due to declining fish populations, regardless of the fact that some of the villagers had started commercial fish culturing in ponds (Vaughan, 1996).

4.4.2 Agricultural yields

The proportion of agricultural yields that lasted for up to one year for the BRAC eligible inside the embankment was nearly twice as much as the BRAC eligible outside the embankment. Furthermore, nearly 1/2 of the BRAC ineligible inside the embankment were able to survive on their agricultural harvests for up to one year as compared to only one third of the BRAC ineligible outside the embankment (see Table 15).

Table 15. Number of months agricultural yields lasted in the previous year

No. of months	BRAC Eligible (%)		BRAC Ineligible (%)	
	Inside MDE (n = 3196)	Outside MDE (n = 4050)	Inside MDE (n = 1741)	Outside MDE (n = 2356)
0-6 months	84.0	91.7	48.3	66.6
6-12 months	16.0	8.3	51.7	33.4

x^2 – test (significance level < .001)

4.4.3 MUAC

MUAC is a "sensitive indicator of the nutritional status of young children" (ISPAN FAP 16, 1992 b). In this case MUAC is applicable to children up to the age of 6 years. MUAC was classified into:

- MUAC < 125 mm (under nourished children)
- MUAC > 125 (properly nourished children)

Mixed results were obtained when MUAC was categorized into each of the eight cells (see Table 16). It was surprising to see the difference between the various cells inside the embankment. There was a notably higher prevalence of nourished children in the Mother, Child Health and Family Planning (MCH-FP) area as compared to the Comparison area (which was expected) for the BRAC TG, but the opposite was true for the BRAC Non-TG, that is, the children from wealthier families in the Comparison area, were healthier as opposed to those in the MCH-FP areas. But then again, the ratio of undernourished children in the Comparison area outside the embankment for the BRAC Non-TG was higher than that in the respective MCH-FP area. However, these differences were not found to be statistically significant.

Table 16. Ratio of nourished versus under-nourished children under 6 years

	BRAC Eligible (%)				**BRAC Ineligible (%)**			
	MCH-FP (n = 392)		**Comparison (n = 216)**		**MCH-FP (n = 392)**		**Comparison (n = 216)**	
	Inside MDE	**Outside MDE**	**Inside MDE**	**Outside MDE**	**Inside MDE**	**Outside MDE**	**Inside MDE**	**Outside MDE**
Under-nourished	18.4	27.1	29.3	25.3	20.9	19.2	13.4	23.2
Nourished	81.6	72.9	70.7	74.7	79.1	80.8	86.6	76.8

A logistic regression analysis showed that out of the independent variables selected, sex was the most significant independent variable (see Table 17) in predicting undernourishment. Boys were found to be 58% times more nourished than girls. The embankment again didn't seem to have any significant impact on MUAC. The analysis indicated that MCH-FP interventions had no significant impact on MUAC even though it indicated that there were more nourished children in those areas.

Table 17. Effect of intervention programmes and sex on MUAC

Independent Variable	Coefficient (B)	Significance	Odds Ratio
MDE			
Inside	0.14	0.30	0.95
Outside	-	-	1.00
BRAC Eligibility			
Eligible (TG)	-0.33	0.02	0.72
Non-eligible (Non-TG)	-	-	1.00
MCH-FP			
MCH-FP area	0.15	0.27	1.16
Comparison area	-	-	1.00
Sex			
Male	0.46	0.00	1.58
Female	-	-	1.00

Constant	:	1.05
Model Chi-square	:	19.72
Degrees of freedom	:	4
Significance level	:	0.00

Nevertheless mean MUAC showed that the average child was nourished. However, one may have expected that mean MUAC should have been higher inside the embankment because of the overall better economic conditions as well as the larger population of cows there.

4.5 Water and Sanitation

Water source, use as well as sanitation will be discussed in this section.

4.5.1 Water sources and uses

The majority of HH's inside the embankment used tubewells as their drinking water source, during both the monsoon and dry periods. Outside the embankment, ponds and rivers constituted a significant share in the drinking water sources. This difference may reflect the relatively elevated economic status of the HH's inside the embankment which allowed them to get access to a sufficient number of tubewells. On the other hand the use of tubewells may simply reflect a lack of convenient alternative sources of drinking water inside the embankment.

It was also observed that the major source of water used, for purposes other than drinking, inside the embankment was ponds rather than rivers. Furthermore, water sources and uses remained more or less constant inside the embankment during both the monsoon and dry periods. Outside the embankment the use of ponds and rivers as water sources was more or less evenly distributed among the various uses.

4.5.2 Water purification methods

It was seen that the use of alum was significantly higher inside the embankment. However, boiling of water and the use of water purifying tablets was approximately equal on both sides of the embankment.

4.5.3 Sanitation

On both sides of the embankment a very negligible proportion of the total population used sanitary latrines. Although there is no data to support conclusions in this area, the combination of agrochemical use and poor water circulation inside the embankment could exacerbate the problems associated with this sanitation issue.

CHAPTER 5: DISCUSSION AND CONCLUSIONS

At first glance these results indicate that the embankment has indeed had a significant positive impact on the people living within the embankment area. By 1992, the embankment area had already achieved substantially higher agricultural yields than the outside area. Furthermore, a greater proportion of land inside the embankment had been utilized for agricultural production than outside.

Even among the BRAC eligible population, those inside the embankment appear to have faced fewer food shortages. Furthermore, various indicators (such as the greater population of cows and relatively larger number of houses owned) also indicate a higher standard of living among HH's inside the embankment.

Nevertheless, a number of factors emerge that signal potential problems associated with the embankment. Some of these may not be due directly to the embankment, but could be connected with practices that the embankment makes possible, like growing HYV rice. The use of HYV rice certainly tends to significantly increase harvests, but the practice of monoculture, which is usually an outcome of this form of cultivation, can have negative impacts on the environment as well as on human health. One manifestation of this is a decline in the availability of other important foodstuffs. It appears that a number of items of important nutritional value are being given low priority within the embankment and are being replaced by those which contribute towards increasing earnings, regardless of health implications. Not only did the villagers inside the embankment suffer a decline of fish in their diets, but they also experienced deficiencies in nutritional value from lack of fruits and vegetables. Another possible indicator of the impacts of a focus in HYV production was the higher prevalence of *gol pata* use as opposed to jutesticks in the construction materials used for walls.

The question of whether the MDE has had a significant impact on the environment has to be dealt with caution. Virtually all interventions with the environment are bound to have some adverse impacts. Because the environment could not be directly assessed in this study, and due to the lack of data from a period before the embankment was built, it is difficult to discern whether any particular difference inside versus outside the embankment is in fact due to the embankment, or is actually a relic from before the embankment was constructed. Further, as mentioned, the embankment is at an early stage in its "life" and the health and environmental impacts (both positive and negative) will continue to change through time. Nevertheless, significant differences do exist between the inside and outside, and many of these are consistent with theory and previous empirical analyses of embankment projects.

In order to begin to gauge the longer term effects of the MDE, it will be necessary to conduct a follow-up analysis using data from 1995 or later and revisiting the issues outlined here. Such a study will allow a tracing to begin of changes that are occurring in the area. This is the only way in which the dynamics of embankment impacts through time can begin to be assessed.

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AN IMPACT ON ENVIRONMENTAL CHANGES AND PEOPLE'S PERCEPTIONS OF THE MEGHNA-DHONAGODA EMBANKMENT

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CONTENTS

SUMMARY

Bangladesh is a poor and densely populated country situated in a large alluvial delta formed by the confluence of the Ganges, Brahmaputra and Meghna rivers, which cause widespread annual flooding. Due to the limited options for improved water management and increasing agricultural production, many large scale flood control schemes have been implemented that now enclose a total of 3.5 million hectares. The Meghna Dhonagoda (MD) Embankment Project, south of Dhaka city, is a well known example which was completed in 1986. The embankment is 60 Km long and encloses 17,500 hectares, where the water level is closely regulated.

The environmental changes have been marked. Many farmers have adopted the High Yielding Varieties of rice and grow three crops per year, which require high inputs of agro-chemicals. Previous evaluation studies have predominately assessed the Project's impact on agricultural production rather than examining the secondary environmental and socioeconomic effects.

This study aimed to assess the environmental effects and their impact upon livelihoods of people living within the MD Project area, as perceived by the people themselves. Field work took place over eight weeks (June to August 1996) in the monsoon period. The methodology included the use of key informant interviews, Participatory Rural Appraisal techniques and focus group discussions with villagers, both within and outside the MD embankment area.

Policy makers, government officials, farmers and the rural poor all confirmed the marked effect of the MD Project on the environment and increased crop production, particularly for richer farmers. However, less recognition has been given to the negative effects, such as declining crop yields, deteriorating soil quality and loss of water sources. The Project seems to have displaced poor subsistence households, put a greater demand on men and women for agricultural labour and led to greater complaints about ill health. The importance of such findings for the future of the MD Project and similar schemes are discussed.

CHAPTER 1: INTRODUCTION

1.1 Background and rationale for the study.

Surface water is an abundant natural resource in Bangladesh associated with advantages, disadvantages and conflicts. The country is a vast alluvial delta situated at the confluence of three of the worlds major rivers, the Ganges, Brahmaputra and Meghna (Rogers *et al.* 1994). The complex network formed by these rivers drains an area of about 2 million sq km, of which only 8% lies within Bangladesh (World Bank 1992). Bangladesh's physical setting severely constrains the control and management of this water flow, both in the monsoon and dry winter seasons. An abundance of water, especially during the monsoons, causes widespread flooding (Brammer 1990 A).

Some 90% of Bangladesh is cultivated but due to mounting population pressure, drought, fragmented landholdings, severe floods and periodic cyclones, the country has one of the lowest levels of agricultural production in Asia (Huq *et al.* 1990). Bangladesh has limited scope for increasing the cultivatable land area, therefore increases in production must come from higher area yields (Rogers *et al.* 1994). Improved water management in the form of flood control, drainage and irrigation (FCDI) schemes can reduce the constraints of drought and flood damage, whilst facilitating an environment suitable for the adoption of high yielding input packages (Rogers *et al.* 1994; Hughes *et al.* 1995). This strategy has been actively pursued by the Bangladesh Government and has led to the development of many flood control schemes (Hughes *et al.*. 1995).

Through the construction of embankments, such schemes seek to isolate an area from seasonal flooding and provide irrigation in the dry season and drainage in the wet season. Farmers can then maximise their cropping intensity, by growing more crops and by utilising high yielding varieties (HYV) (Rogers *et al.* 1994). The construction of drainage channels, embankments and hydraulic structures has enabled about 3.5 million hectare (ha) of floodplain to be enclosed for all seasons agricultural production (Sadeque 1992). Such major ecological change has meant that farmers within such schemes no longer suffer either the negative or positive effects of annual flooding. However, these farmers have had to rapidly adapt to new environmental conditions. For instance, efforts to develop agriculture have utilised this new FCDI environment to grow HYV rice varieties in association with the necessary technological inputs.

Such major ecological changes brought about by FCDI projects and subsequent agricultural changes have reportedly led to an associated increase in environmental problems (Huq *et al.* 1990; Sadeque 1992; Anwar 1993; Khan *et al.* 1994; Hughes *et al.* 1995). As a result such FCDI schemes have been the centre of contentious debates within development circles in Bangladesh. Opponents of FCDI schemes argue that the high associated costs and major ecological effects have been detrimental to the greater good of society and the ecological environment, while those in

favour argue that the positive effects on such hydrologically controlled environments, which supposedly are thus safe from flooding, have increased agricultural production and raised socioeconomic status (Huq *et al*.. 1990).

The Meghna Dhonagoda (MD) Flood Control, Drainage and Irrigation Embankment Project is located 60 km from the capital city of Dhaka and was finally completely embanked in 1988. The Project was funded by the Asian Development Bank and its primary objective was to provide a hydrologically controlled and flood free environment which would enable farmers to maximise their agricultural output. No environmental impact studies were undertaken of the project, either prior to the project implementation or after completion and as yet, the projects associated environmental effects remain unclear and debatable.

1.2 Study Objectives.

The Study aimed to identify the general environmental effects of Meghna Dhonagoda Project upon natural resource factors and the subsequent effect of these changes on the lives of people living within the Project area.

The Study Objectives were to:

1. Identify the general environmental effects of the MD Project in relation to Soil, Water, Fisheries and Farming systems.
2. Determine the perceived impact of these effects upon peoples livelihoods within the project area.

This study comprised of an investigation into the reported environmental effects of the MD Project and its subsequent effects upon the natural and human environment. The study also focused predominantly upon natural resources namely, hydrological change, agriculture and fisheries. The Study used qualitative and participatory research techniques, particularly for exploring and investigating peoples perceptions and understanding. The Study design included a variety of different participants.

1.3 Outline of the Report.

Chapter 2 provides a background to the relevant natural resources in Bangladesh and Chapter 3 reviews the literature and information available on flood control and irrigation policies. The Meghna Dhonagoda Project is then reviewed. Chapter 4 presents the study's design and methodology and the study results are presented in the Chapter 5. These are subsequently discussed in Chapter 6, whilst Chapter 7 outlines the study conclusions and makes recommendations for further research and the application of the findings for future policies.

CHAPTER 2: BACKGROUND ON BANGLADESH

2.1 People and the Environment

Bangladesh lies north of the Tropic of Cancer and in the north-east corner of the Indian subcontinent, in a crescent directly above the Bay of Bengal. It was previously part of Bengal under British rule. At partition in 1947 it became East Pakistan and then an independent nation in December 1971, after a bloody ten month war of liberation with West Pakistan.

Bangladesh is economically poor, one of the most densely populated countries in the world, and a predominantly agrarian society thus highly dependant upon its natural resources (World Bank 1994).

Bangladesh's 110 million people live in an area of 144, 000 sq km (Koht 1990). Population estimates predict 140-45 million persons by the year 2000 and a total 340 million persons before the population growth stabilises (Koht 1990). The density is now over 11 persons per ha of arable land and is predicted to rise to an estimated 38 when the population stabilises. Some 85% of Bangladesh's population live in rural areas, with the majority living in conditions below the poverty level (Koht 1990). Most households are directly dependent upon the continued productivity of soil, water, fisheries, forests and all other available biomass. Their environmental concerns are less aesthetic, relating more to the immediate issues of daily subsistence.

2.2 Climate and Hydrology

Bangladesh has a warm, humid climate with three main seasons: a hot summer with high humidity from March to June; a hot and humid monsoon with heavy rainfall from June to October; and a cooler and drier winter from November to March. Rainfall ranges from 3500 mm to 14000 mm annually. Rain is a critical factor in agricultural production. A lack of rain can limit rice production whilst excess may exacerbate annual flooding.

The Himalayas to the north and the funnel shaped coastline of the Bay of Bengal to the south, produce the life giving monsoons as well as catastrophic cyclones, thunderstorms and floods. Natural disasters often lead to great loss of life and damage to the economy, infrastructure and environment. In the past over 60% of the cultivable area (98 000 sq km) has flooded and caused widespread disruption (World Bank 1992).

The topography of the area is very flat, with land not rising more than 35m above mean sea level, except for the Chittagong Hill Tracts which are in the south east corner adjacent to Myanmar. This flatness is a feature of the delta of

the Ganges, Brahmaputra and Meghna rivers. The flat topography, minimal height above sea level and the large volume of water in the network of rivers means that the country is highly susceptible to annual flooding (Brammer 1990 B).

Efforts to develop water resources for crop cultivation have concentrated on flood control and drainage schemes, combined with irrigation using surface and water pumps to tap shallow aquifers. At present, 30% of the cultivated area is irrigated compared to 14% only a decade ago (World Bank 1992).

2.3 Soils

Bangladesh's soils are predominantly alluvial and highly variable. This factor, together with hydrological interactions, dictates the diversity of agricultural practises. The soils can be divided into three broad physiographic divisions (FAO 1988; Rahman *et al.*. 1994; Brammer 1996).

There are the hill soils composed of tertiary rocks and unconsolidated tertiary sediments, which are predominantly acidic with pH values of 5.2 to 5.6. Then there are the old alluvial soils, formed on the alluvium of the Pleistocene period. These are found high above flooding level and belong to the latosol group of generic soils. They are clayey in texture, reddish to yellowish in colour, contain numerous ferrous concretions and are rich in iron and aluminium. They are also highly aggregated and have a high phosphate fixing capacity with a pH from 5.2 to 5.6 (FAO 1988; Brammer 1996).

Then there are the more recent alluvial soils, found in the Gangetic alluvium, Testa silt, Brahmaputra alluvium and coastal saline tracts. These areas are flooded yearly and replenished by fresh deposits. Rich in calcium, magnesium and potassium, with free calcium carbonate, they are deficient in nitrogen and phosphate and have a pH ranging from 5.5 to 8.5 (FAO 1988; Brammer 1996).

2.4 Farming Systems

Agriculture has a 47% share in Bangladesh's Gross Domestic Product (GDP) and it employs approximately 71% of the labour force, with some 80 million people being dependant upon it for their livelihood (BBS 1995). Land area intensively cultivated is some 60% of the country total, one of the highest in Asia (Sadeque 1992). Rice is the main crop, accounting for 78% of the cropped area, and the other main crops are jute 5%, and wheat 4% (BBS 1995). Numerous other minor crops are also grown, such as cereals, fibre crops, fruit, vegetables, spices and pulses.

Rice is traditionally of three types, each of which may be characterized by the season in which it is grown. These are Aus or early wet season rice grown April to July; Aman or late wet season rice grown August to November; And Boro or dry season rice grown December to March. HYV varieties of Aman and Boro have been available since the 1960s, whilst HYV Aus is relatively new. Traditional varieties are predominantly broadcast, whilst HYV varieties are transplanted. The year round season offers potential for increased multiple cropping if resources can be made available. However, the introduction of HYV technology crops, together with monocropping, has led to a decline in soil fertility and resulted in a rapid increase in nitrogen and pesticide use. This has in turn led to water eutrophication and other high input related problems (Huq *et al.*. 1990; Rahman *et al.*. 1990).

Existing technology is traditional with most of the land cultivated by bullock power, with output highly dependant on the weather and climatic conditions (Rogers *et al.* 1994). Livestock and poultry are economically important resources in Bangladesh. Cattle provide the main source of draught power whilst also providing milk and cow dung for fuel and fertiliser. Animals are genetically poor and suffer dietary deficiencies and parasitic infestations (Rahman *et al.* 1994). Poultry are important for protein and for income generation.

Agriculture is characterized by small scale farms with an average size of 2.2 acres and with 70% of farms being below 2.5 acres (Sadeque 1992). Although 60% of rural households are without sufficient land to produce food for their families, some 10% of the population control over half of the land (Rahman *et al.* 1994). The majority of this land is cultivated under the "ADHI" share cropping system (Rahman *et al.* 1994). Under this system the landowner gets a half of the crop without contributing anything to the input costs. In addition, the owner can redistribute the land to a new tenant each year. With the introduction of HYV crop technology, the sharecropper's inputs are much higher than those needed for local varieties and after deduction for expenditure, the farmers are contributing their labour almost free. The structure of land tenure is a critical factor in agricultural production but the adoption of new technologies, as well as holding size, farmers status and financial resources, can all influence production (Rogers *et al.*. 1994).

2.5 Fisheries

Bangladesh has traditionally been rich in fish stocks, which account for 3% of GDP on average (World Bank 1992). Over 500 native fish species have been documented and fishery exports have consistently remained within the top three items, after garments and jute, as a source of foreign exchange (World Bank 1992). Fisheries have traditionally produced 70-80% of the protein consumed by the population and have provided seasonal employment for millions of households (Sadeque 1992). Consequently, demands on fish resources have grown with the increase in population. However, in recent years the catch of inland fisheries has declined by 20%, reportedly due to river siltation, pollution, overfishing and flood control schemes (Sadeque 1992).

The irrigation based growth of food grain production has led to the reclamation of floodplains and a reduction in fish movement and habitat, whilst rapid increases in fertilizer and pesticide use have caused environmental problems such as eutrophication and pollution of water resources (ISPAN FAP 16 1995).

2.6 Forestry

Over the past few decades forest cover in Bangladesh has declined from about 15% of the total land area to just 5% (MEF 1991). Deforestation is partly caused by population pressure, greater demand for forest products (especially by the urban and commercial sectors) and land conversion for industrial and agricultural purposes. There exists an acute shortage of fuel wood and timber. In 1986, the per capita annual consumption of fuel wood and timber was 2.7 and 0.3 cubic foot respectively (Sadeque 1992). These are among the lowest wood consumption rates in the world. However, it has been estimated that by the year 2010 AD the available supplies in Bangladesh will meet only one sixth and one fourth of the projected demands for fuel wood and timber respectively (Cool 1979). Some 78% of fuel wood now consumed comes from homestead forests, inspite of their accounting for only 15% of the forested area (Sadeque 1992). Despite the importance of these homestead forests as a source of income and savings for rural households, they are being overcut and depleted. In the absence of fuelwood supplies people use manure and crop residues for fuel, which limits the available organic matter for recycling in the soil, thus lowering soil fertility.

2.7 Conclusions

Bangladesh is a densely populated country, rich in natural resources. However, the environmental pressures coming from the growing population threatens the sustainability of these resources. These factors, together with soil and water interactions and marked seasonal changes, largely determine agricultural practices. Development policies to boost agricultural production have tended to favour large scale infrastructural flood control schemes. Such schemes usually have a major impact on the local environment and consequently the livelihoods of local people. The long term consequences of such environmental changes on the availability, sustainability and use of natural resources appears to have been largely ignored in the policy making processes.

CHAPTER 3: FLOOD CONTROL AND IRRIGATION POLICIES

3.1 Introduction

Flood waters annually cover between one third to one half of Bangladesh during the monsoon period and over many years they have enabled the fundamental processes of land formation (Brammer 1990 B). Floods bring many benefits that underpin the agro-ecology and economy of Bangladesh. The normal annual floods are generally beneficial, although abnormal major floods, such as those in 1987 and 1988 do occur, resulting in substantial loss of life, disruption to the economy and damage to infrastructure and crops (Brammer 1990 A).

The contentious nature of the annual floods in Bangladesh, together with the political history of the Flood Action Plan and the strength of the NGO development community, has meant that there is a diversity of secondary data available on Flood Control Drainage and Irrigation (FCDI) schemes in Bangladesh.

This section presents an assessment of the status of FCDI schemes, based on secondary sources and by providing background information on the floods, flood control schemes and environmental change within Bangladesh. This information provides the context within which the Meghna Dhonagoda Project (a large FCDI scheme) is then discussed in order to highlight areas relevant to the objectives of this research study.

3.2 Flood Control and Irrigation Projects

The inhabitants of the flood plains are accustomed to dealing with floods and have been managing their water resources for many centuries with indigenous techniques (Paul 1995). However, during British colonial rule (1757-1947) traditional forms of management were neglected, dismantled or left to decay (Hughes *et al.* 1995). In 1957 a UN commission investigated water management options for dealing with floods and its recommendations gave rise to the formation of the first large major water control body, the East Pakistan Water Power and Development Authority (EPWAPDA). The Authority undertook work on a 20 year master plan for flood control, drainage and irrigation works, all aimed at increasing agricultural output (Adnan 1990). The Plan involved the construction of thousands of miles of embankments, nearly one hundred polders and numerous water control structures (Hughes *et al.* 1995). The portfolio of the master plan contained 58 separate FCDI projects, involving a total cost of US$ 2.1 billion at 1964 prices (Thompson 1990). The large scale investment was justified on the benefits that were to be obtained from increased crop production.

Following the independence of Bangladesh, EPWAPDA became the Bangladesh Water Development Board (BWDB) which continued with the development of the large scale projects whilst also seeking to implement smaller localised projects. However, the implementation of large scale projects often did not take into account many cross-sectoral issues and externalities, such as potential impacts on the environment, social conditions, fisheries, homestead gardens, forests and biodiversity (Adnan 1990; Thompson 1990; Hunting FAP 12 1992; Haggart *et al.*. 1994; Hughes *et al.*. 1995; Paul 1995).

3.3 Flood Control and Environmental Effects

Recent evaluations of FCDI schemes have shown that in many areas the projected increases in crop production have not materialised and, in general, most of the negative impacts have been borne by the majority of poor people living in the project impact areas (Adnan 1990; Thompson 1990; Sultana *et al.* 1994; Hughes *et al.* 1995; ADB-CAD 1995). The FCDI projects are a contentious issue in Bangladesh and irrigated agriculture has had many reportedly adverse effects on the human and natural environment (Adnan 1990; Thompson 1990; Hunting FAP 12, 1992; Haggart *et al.* 1995; Hughes *et al.* 1995; ADB-CAD 1995).

In some project areas land remains water logged all year, which often degrades soil, leads to low soil oxygen availability, causes chemical changes, loss of soil nutrients and the formation of compounds toxic to plants (Brammer 1996). The construction of drainage channels, embankments and hydraulic structures has brought about the conversion of 3.5 million ha of floodplain to agricultural production (Sadeque 1992). These have obstructed fish movement and migration, resulting in fewer fish and degraded fish habitats and reduced wet land sites for flora and fauna (Khan *et al.* 1994; ISPAN FAP 16 1995). Widespread fertiliser and pesticide use has resulted in high concentration levels in still water areas and is supposedly leading to environmental problems (Adnan 1990; Rahman *et al.* 1994, Hoque *et al.* 1995).

The social consequences, particularly the negative ones, of the FCDI schemes have been highly debated by NGOs. In general NGOs have argued that large scale, expensive and technical solutions to flooding and improving agricultural production do not work (Paul 1995). They cite the cutting of embankments by dissatisfied villagers who are unable to drain waterlogged land inside the embankments, the loss of livelihoods for boat and fishing people and the marginalisation of smaller farmers by larger farmers more able to take account of the new agricultural packages and techniques (Haggart *et al.* 1994; Anwar 1993; khan *et al.* 1994; Hughes *et al.* 1995; Paul 1995).

The diversity of negative social and environmental effects has lead to changes in flood control policy. The BWDB has started to refocus its efforts on smaller less expensive projects with more awareness of the complexities of cross cutting

issues. However, for the majority of outstanding completed projects the money and infrastructure have already been put into place, with the BWDB now committed to maintaining the infrastructure. One such project is the Meghna Dhonagoda Project in Matlab Thana.

3.4 Meghna Dhonagoda Embankment Project

The primary aim of this Meghna Dhonagoda (MD) Project is to boost agricultural production by providing a secure environment which is safe from flooding and that has sufficient drainage and irrigation facilities to enable the adoption of HYV crops. In areas where the project is functioning successfully up to three crops a year of HYV paddy can be grown. Details of the Project are summarised in Appendix One.

The embankment project is situated in Matlab Thana, Chandpur District, which is 55 km south east of Dhaka city (See Map 1 below). The Thana has a population of about 400,000 people. The area is a riverine delta that is intersected by two major rivers, the Meghna and Gumti. The MD Project was started in 1982 and completed in 1988. The embankment is 60 km long and during the monsoon the majority of the surrounding land is flooded (See Map 2 below). The encircled area is now 17,584 ha and is surrounded by the Meghna and Dhonagoda rivers. The area inside is completely enclosed by the embankment, with the water level being controlled through a system of canals, sluice gates and two pumping stations to the north and south. These stations pump water out for drainage or in for irrigation, depending on seasonal demands.

There are now no large internal open water areas within the embankment, but the area is intersected by a network of canals that prior to the project were fresh water and tidal. These canals, together with those constructed by the project, provide irrigation water in the dry season and drainage during the wet season. The topography is undulating ridge and trough patterns throughout the area.

The area no longer floods although the embankment broke and caused widespread flooding in 1987 and 1988. The lack of seasonal flood waters combined with the controlled environment has a caused major ecological change, with resulting changes in farming systems which have affected the livelihoods of the people inside and, to a lesser extent, outside of the project area (Hunting FAP 12 1992).

3.5 Evaluations of the Meghna Dhonagoda Project

The Meghna Dhonagoda (MD) FCDI Project remains one of the better known FCDI schemes in Bangladesh and it has been the subject of several evaluation studies. Previous studies of the MD Project mainly used quantitative Rapid Rural Appraisal (RRA) techniques and were commissioned by the Asian Development Bank (ADB), the main project funder. Reliance on quantitative techniques appears not to have revealed the diversity of opinions that exist about the impact of the project. With this in mind, the present study concentrated on using more qualitative methods so as to draw on peoples perceptions as the key to assessing the Project's impact. However, the political and contentious nature of FCDI projects in Bangladesh, together with the fact that two of the most thorough and recent evaluation studies were commissioned by the ADB, makes their findings more suspect.

The two most relevant and recent studies of the MD Project were commissioned by ADB. The most thorough is that known as the Flood Action Plan (FAP) 12, which was undertaken by Hunting Technical Services (UK) in 1992. The second study was undertaken in 1994 as a joint project between the Bangladesh Centre for Advanced Studies (BCAS) and Bangladesh Engineering and Technical Services (BETS).

Two other studies include evaluations done by Thompson (1990), called: "Impact of Flood Control on Agriculture and Rural Development in Bangladesh: Post Evaluation of the Chandpur Project". This used the MD Project as a control and comparison area in the evaluation of another FCDI project. The second evaluation was by Sultana, Thompson and Daplyn (1995), called: "Rapid Rural Appraisal: Impact of Surface Water Management Projects on Agriculture in Bangladesh". This reviewed 17 different flood protection projects, of which the MD Project was one.

These MD Project evaluations varied greatly in their format, coverage and methodology, using predominantly quantitative techniques with sample surveys and structured questionnaires. The reports focus mainly on hydrological, agricultural and economic impacts, and thus appear to ignore the complex sociological and environmental impacts. Most evaluations used extensive household surveys that did not appear to follow rigorous designs or explain the procedures for sample selection nor the methodologies used. They also ignored various parameters associated with such FCDI projects. Evaluations were also performed too soon after project completion to allow for possible impacts to become apparent. Some critics of FCDI projects have argued that even a ten year period is far too shorter a time in ecological terms to recognise the full effects of such projects (Khan *et al.* 1994, Hughes *et al.* 1995). Unfortunately, none of the above evaluations considered the subsequent long term project impacts, including those upon the environment and population living within the area.

The above evaluations found the MD Project had a significant impact upon agriculture and cited the growth in HYV paddy production as a direct result of improvements in drainage and irrigation facilities. Sultana, *et al.* (1995) found that the MD Project had a higher cropping dominance for paddy, with 89% in the MD area compared to 67% within the control area. Huntings FAP 12 (1992) found: "A large growth in paddy output, estimated at some 74,000 mt annually, transforming the area from a grain deficit to grain surplus". However, it also concluded that: "Impressive though the agricultural impact is.... studies appear to have overestimated, producing spuriously high estimates of potential benefits" (Hunting FAP 12 1992).

Sultana *et al.* (1994) also recognised that the growth in paddy cultivation had come at the expense of other crops, such as wheat and pulses, and this had consequences for human and livestock nutrition and other factors. These authors also found that fanners in the MID area used twice as much agrochemicals compared to farmers in the control area, thus requiring a high investment of working capital.

In addition, the MD Project was found to have had a devastating effect on those households that had relied on floodplain subsistence living and fishing (Huntings FAP 12 1992). However, the same report noted: "Since 1988 the MD project has had a major impact on flood conditions in the area....65% of the land is no longer flooded in the monsoon season" (Huntings FAP 12 1992) and Sultana *et al.* (1995) wrote: "MD shows dramatic benefits as 80% of the cultivable lands are virtually free from flooding due to the embankment and pumped drainage". However, the use of such statistical values may hide other effects, such as the reality that water logging is also a serious problem in the Project area. In addition, Huntings FAP 12 (1992) found the system to be "highly successful", whilst the BETS (1994) evaluation found the system to be "operating well below capacity".

These reports suggest that the impact of the MD Project on socioeconomic conditions has been less successful. For instance: "Despite only being completed for a short period, the project does not appear to have had important socioeconomic impacts.... However, there have been important adverse impacts on minority occupations and employment" (Hunting FAP 12 1992). Such contradictory statements, taken from two of the most thorough evaluation studies, appears to mask the large effects of the hydrological changes on socioeconomic conditions within the MD Project area.

CHAPTER 4: STUDY POPULATION AND RESEARCH METHODS

4.1 Introduction

The study was conducted in Bangladesh over a period of 8 weeks from late June to August 1996. An initial period of four weeks was spent in Dhaka interviewing key informants and collecting secondary data. This was followed by four weeks living in Matlab Bazaar and working in villages both inside and outside the Meghna Dhonagoda Embankment Project.

In Dhaka meetings were held with a selected number of well informed individuals within the Government of Bangladesh, NGOs and private Organizations. The interviews aimed at providing an overview of the history and current status of FCDI schemes in Bangladesh, based on a set of prepared questions. These questions addressed matters of general policy relevance rather than those relating specifically to the MD Project. Interviews were extremely useful in identifying topics for the field research, as well as for useful contacts and other sources of secondary data.

On completion of the research in Dhaka, four weeks were spent undertaking fieldwork in the MD Project area in Matlab Thana, using Rapid Rural Appraisal (RRA) and Participatory Rural Appraisal (PRA) qualitative research techniques (Casley and Kumar 1988; Moris and Copestake 1993). The field work was conducted during the monsoon period and was undertaken by two co-field workers and the author. Since the field work was undertaken in Bengali, one of the co-workers was an interpreter.

4.2 Study Population in Matlab Thana

About 85% of the Matlab population is Muslim with the remainder being mostly Hindu (BRAC 1994). There are on average 5 to 6 people in a household and each family typically owns a one or two roomed house. A number of households, usually those that are patrileneally related to each other, live around a common courtyard unit called a "*Bari*". Several *baris* form a village. The average village has grown in size from 1200 people in 1963 to over 1,400 in 1990, although villages range in size from a few hundred people to several thousand (BRAC 1994). The staple food in Matlab is rice supplemented with vegetables and pulses.

Matlab bazaar is the town containing the Thana headquarters. It has mains electricity although supply is erratic. It is the centre of local government and contains a police station, court, schools, health facilities, post office, banks, markets and crop storage facilities, including three cold storage units. Matlab bazaar is connected to the district capital of Chandpur by a motorable road. Several smaller towns along the rivers are linked to Matlab bazaar by river boats and ferries.

4.3 Key informant interviews

Interviews were conducted with key informants in both Dhaka and Matlab. The informants were selected depending on the nature of their relationship to flood control projects and in particular to the Meghna Dhonagoda Project, while other informants were contacted after they had been recommended during previous interviews. A variety of informants were interviewed in order to draw on a diversity of different perspectives, including individuals from the Bangladesh Water Development Board (BWDB), World Bank, universities, non-government Organizations and private consultancy firms. Some had particular knowledge of the MD Project. In general, interviews lasted 30 minutes and concentrated on macro issues dealing with FCDI schemes rather than on the MD Project. The Asian Development Bank funded the MD Project, but unfortunately the individual responsible for FCDI projects declined to be interviewed.

4.4 Participatory Rapid Appraisal (PRA)

Participatory Rural Appraisal has grown out of the widespread usage of Rapid Rural Appraisal (RRA) which seeks to collect qualitative and selected quantitative information by utilising a variety of research techniques, including informally sampled interviews and direct observations. This is usually done during a relatively short visit by a multi-disciplinary team of experienced specialists who can make informed judgements rapidly whilst still in the field (Howes 1991, Sultana *et al.* 1995).

PRA uses a variety of RRA techniques but in addition it also aims to involve respondents directly in the data collection and evaluation process (Moris and Copestake 1993). Participants are encouraged to play an active role in the research, by such means as drawing village maps, transects, seasonal calendars and other diagrams.

Five **PRA Exercises** were undertaken, three inside and two outside the embankment area, using Seasonal Calendars, Agro-ecosystem Mapping and Time Line Exercises (McCracken 1989; Lightfoot *et al.* 1991). These were undertaken at the outset of the research for training purposes and to enable the researchers to obtain a better understanding of the physical and social environments. Exercises were conducted using two researchers, one who facilitated the research and the other who recorded and transcribed the findings. Researchers were members of BRAC's Rural Development Research Programme and already had substantial RRA and PRA training and field experience.

Respondents were selected from BRAC village member Organizations as men were found to be less available at the homestead due to seasonal labour demands for harvesting. In addition, BRAC members were available and willing to participate. However, available men were strongly encouraged to participate and were requested not to dominate the

sessions. Between 4 and 8 women respondents participated during the four different exercises. The PRAs were conducted in the open air in the central area of the Bari.

Two **Seasonal Calendars** were undertaken, one within and the other outside the embankment. The respondents were asked to draw a timeline on the ground and to mark of the 12 calendar months plus an additional 4 months at the end of the year, thus totalling a 16 month calendar. This allowed for tasks from all the farming system seasons to be accounted for. Respondents were then asked to identify particular tasks associated with their farming systems and then to mark off the start and finish dates associated with that particular task. For example, respondents identified the calendar months associated with the production of paddy, including ploughing, planting, weeding and harvesting. Examples of calendars from outside and inside the embankment are shown in Appendix Two.

Agro-ecosystem Mapping Exercises were performed, one inside and another outside of the MD Project area. For this exercise four individual farmers were selected and asked to draw a map of their farming system on the ground. This was undertaken with the support and prompting of the researchers who helped respondents throughout the process. Various objects took on symbolic characteristics to resemble certain factors within the system, for example rice grains were used to symbolise the rice paddy fields and a chicken feather to represent poultry. A checklist was used to prompt respondents with questions so as to encourage them to elaborate on their agro-ecosystem. Finally, the researchers drew a copy of the participant's map and checked its accuracy with the villagers.

One **Time Line Exercise** was conducted inside the MD project. Respondents were asked to draw a line on the ground and to mark off the last 15 years. They were then encouraged to mark on the date line when significant events relating to the embankment and flooding had occurred. For example, respondents marked off the construction of the embankment, the floods in 1987 and 88, and the introduction of HYV rice varieties into the area. This exercise was not as useful as the other PRAs for identifying farming systems, but it did enable the researchers to understand the time frame and processes of change brought about by the construction of the embankment.

All the above exercises were tape recorded and the conversations were transcribed. Throughout these exercises the respondents remained focused by the subtle use of probing questions and by allowing discussion. A debriefing on the exercises and on the performance of the research team were undertaken upon completion of the fieldwork at the BRAC headquarters.

All the PRA exercises provided useful information about farming systems both inside and outside of the embankment. They also enabled training of the research team and the identification of the key topics to be investigated in the focus group discussions.

4.5 Focus Group Discussions.

A total of 13 sites were visited and 15 focus group discussions (FGDs) were conducted, with 11 of the sites and 13 discussion groups being conducted inside the embankment and the remaining being outside in villages subject to seasonal flooding. The FGDs were tape recorded with consent and then transcribed and fully translated from Bengali to English. During the FGD sessions one researcher would provoke, focus and steer the discussion whilst another would record the discussion.

The semi-structured checklist of questions used in the FGDs was developed from issues identified during from the secondary data review, key informant interviews and PRA exercises. A preliminary checklist was developed and then pretested for meaning, clarity and the time taken to administer it. The final version, which was derived after three further revisions, had thus been tested for its relevance to the aims and objectives of the MD Project. The process was done in conjunction with the pilot focus group discussions, which provided the research team with a means of evaluating its own work and effectiveness. After completing each FGD session, the researchers met to discuss and evaluate the research findings.

The FGD checklist questionnaire contained sections on Water, Soils, Farming Systems, Health, Socioeconomic status and other general factors. A full copy of the checklist can be found in Appendix 3.

The 13 different *bari* sites were selected for the FGDs on the basis of variability, accessibility and availability of respondents. Within the MD Project there are differences in topography, population, infrastructure and soils. Sites were selected that represented the diversity in the area, including differing soils, irrigation, drainage facilities and topography. These sites are shown on Map 3 below. Unfortunately, due to the monsoon rains access was difficult to the villages farthest from the roads. In the majority of villages only women respondents were available for discussion, which was due mainly to the high seasonal nature of the demand for labour. Five FGDs were conducted with women only, five with men only and five were mixed. The respondents were selected on basis that they were at least 15 years old when the embankment construction started in 1982 and had subsequently lived permanently within the MD Project area. For the women and men only groups an attempt was made to collect together those respondents with similar backgrounds, such as landholding farmers, sharecroppers, agricultural labourers, or small businessmen, including rickshaw pullers and shopkeepers. Attempts were also made to get women respondents of similar socioeconomic status.

The mixed discussion groups included men and women of different socioeconomic backgrounds to see if their answers were different.

CHAPTER 5: STUDY RESULTS AND FINDINGS

5.1 Key informant interviews

Key Informant respondents agreed that there had been profound environmental changes as a result of the construction of the embankment, which in turn had led to impacts upon peoples livelihoods. However, in relation to the subsequent effects of these environmental changes, two clear schools of thought emerged.

Firstly, individuals from the World Bank and the BWDB and other government bodies believed that, although there had been profound changes, these had been for the better. Respondents argued that although some project people had lost their livelihoods, many had found alternative means of income and were now better off Respondents also argued that since the main Project structures were now in place, any remaining problems consisted mainly of infrastructural issues such as irrigation canal maintenance, rather than any subsequent socioeconomic effects relating to the environmental changes. These respondents were positive about the Project, although admitting that it had not lived up to expectations. However, they still believed that the embankment was for the best and that any remaining problems could be solved by structural and institutional responses. The concept remained the best means of boosting agricultural production and safeguarding the area against floods.

The second set of opinions were predominantly aired by the NGO community and by select individuals working, living or owning land within the project area. These informants also agreed that there had been profound environmental changes as a result of the embankment, but argued that the subsequent detrimental environmental effects and their subsequent impact upon people within the Project, outweighed the benefits as well as discounted the longer term environmental effects.

Both schools of thought admitted, however, that the financial cost of the project was too high. Given the diversity of arguments for and against the Project, as presented by the different groups, it became clear that due to the variety of different effects, both points of view could be argued and justified.

5.2 Participatory Rural Appraisal (PRA)

For the initial fieldwork in Matlab five PRA exercises were conducted. These helped with the training of the researchers and provided a better understanding of the environment inside and outside of the embankment. The exercises also helped to develop the main themes for inclusion in the FGD semi structured checklist.

The PRA exercises included seasonal calendars, agro-ecosystem analysis and timelines. The information gathered by these exercises was predominantly of a descriptive nature and provided an overview of the different farming systems both inside and outside of the MD embankment.

The most significant result was clearly in relation to flooding. Inside the embankment there was no flooding but there was some water logging, whilst outside the embankment the farmers still followed the natural flooding cycle. The results showed differences in cropping times and variety, which directly related to the onset and duration of the floods. Outside the embankment farmers retained their diverse cropping systems with the cultivation of paddy, jute and mustard being the norm, whereas inside the embankment farmers concentrated on growing three crops of paddy per year. Differences were found in the role of open water and culture fisheries within the different household systems. These played a major role in the ecosystem outside the embankment whereas inside fisheries had a more limited role.

5.3 Focus Group Discussions (FGDs)

The FGDs formed the core part of the field research. A total of 13 different sites were visited and 15 focus group discussions conducted. The FGDs were undertaken in a semi-structured manner that enabled a diversity of opinions to be expressed on a range of different topics concerned with the project. This section presents the findings from the FGDs and the main themes that were discussed.

All respondents agreed that there had clearly been profound changes in the environment inside the embankment, related particularly to the lack of seasonal flooding since the embankment was finally completed in 1986. The following summarises the replies given by the participants.

For **'Water'** all respondents stated that the MD Project had a major effect on the hydrology of the area, which was no longer subject to flooding, although the embankment had broken and caused flooding in 1987 and 1988. All respondents were worried that the embankment would break again in the future and that they would loose everything, as they did in 1987 and 1988.

For **'Water Drainage and Irrigation Services',** respondents felt that they were at the mercy of the BWDB. If they had a problem they would report it, but nothing ever seemed to happen. Farmers said that if they could afford it they would use power pumps rented from one of the local contractors for drainage and irrigation. However, in some areas this was not feasible due to the consistent water logging or limited availability of water for irrigation. Many farmers complained about water logging, saying that if the situation continued they would consider cutting the embankment to let out the water. Farmers also stated that those villagers who lived near the pump house and main canals had adequate drainage and irrigation, whilst those further away suffered many problems.

As a consequence of the lack of annual flooding, respondents stated that their access to **'Water Sources'** had been reduced, particularly for household and irrigation purposes, due to the reduction of smaller seasonally flooded water bodies, such as *beels* and *khals.* Water sources were now more limited to canals, ponds, rain collection and tubewells. Even during the monsoon season access to still water bodies was now severely reduced.

All respondents said that **'Water Quality and Quantity'** for agricultural and household use had declined. Respondents said that the floods were beneficial in "washing away all the dirty things" and replenishing water bodies. The low level of water in still water bodies led to stagnant situations and associated problems. For instance, respondents said that water stagnation led to increased mosquito populations, high levels of agro-chemicals and more ill health, including skin diseases and stomach disorders. Water for bathing, clothes washing and other household needs was also limited by the reduction in water quality. Only one respondent specifically cited problems of water contamination by human faeces. For domestic purposes respondents said that they frequently had to use pond water as tubewell water was not easily available, even though they were aware of the potential health problems associated with pond water.

In relation to **'Soil and Land'** all respondents agreed that there were now problems with the soil fertility and structure, which was not present when there was flooding. Some said that during the dry season the soil was like stone, lacking structure and that it had a reduced ability to hold water. Farmers stated that prior to the embankment the floods would bring nutrients and goodness to the soil, thus helping the soil fertility and water retention. Now that soil fertility was depleted and fanners needed more fertiliser every year. One elderly male farmer said: " The soil is like a corrupt government official, it will not produce unless it is bribed". When farmers were asked if they were able to use organic manures, they stated that these were not powerful enough and that, in any case, manure was needed for other things such as fuel. Some farmers, however, did use rotted water hyacinth as a manure. When asked if farmers could change their cropping patterns from mono-crop rice to a pattern with a break or green manure crop, they stated that they would like to do this and knew how beneficial it would be for their soils. However, they could not do this now for financial reasons, such as indebtedness, and thus rarely did so.

With regard to **'Land Availability'** farmers also reported losses due to construction of the embankment, canals and roads. They stated that although they were reimbursed most had to pay a bribe to receive their compensation and even then there was no alternative land available to be bought.

It was agreed that land prices had substantially increased and in prime areas that could grow three crops a year prices were five times that for areas outside the embankment. However, big variations were found in the quoted prices, which ranged from Taka 2000 to 6000 per decimal of land. During four different discussions respondents said they had sold land to outsiders to finance sending one of their male family members overseas for employment. Respondents also stated that rich people had migrated into the area, as only they could afford to buy the good land.

With regard to **'Fisheries'** all respondents stated that there had been major changes in the fisheries as a result of the embankment and that this had a profound impact upon their households and livelihoods. Prior to the embankment the fisheries had followed the natural cycle, with people catching fish everywhere and the floods bringing fish into the seasonal water catchments areas, such as ponds and canals. It was said that many poorer people made a direct living from fishing, whilst others supplemented their household income and food sources with fishing and wild shrimp catching. However, consumption of fish was now deemed only possible by the wealthy and by people who had access rights to ponds and fishing areas.

As a result of the embankment all respondents agreed that fishing was now almost totally restricted to waters outside the project area and only in a limited number of internal canals and ponds by people fortunate enough to have access. Poor people had been particularly adversely affected as they now had little opportunity of catching or cultivating fish. The respondents attributed this directly to the reduction in wild fish stocks due to the lack of annual flooding. However, those owning ponds saw this as a benefit, as now fish cultivation was possible all year round, as stocks were not washed out by floods. Cultured ponds fish are fed with urea, lime, oilseed cake, potash, vegetative matter and dead animals. A pesticide called "*nagus*" was also used before stocking the ponds to kill off the predator fish. The common use of such feeds in ponds, together with the use of pesticides and stagnation of water were all believed to have had an effect on the health of the villagers.

Respondents stated that the lack of fish in their diet meant their health was declining. Wild fish were said to be more tasty and healthier, unlike cultured pond fish which often diseased, due to their concentration and the stagnation of water. Advice had been provided to farmers on fish cultivation by BRAC and Government extension agents. Fish pond culture was either undertaken by the pond owners themselves or the ponds were leased to farmers who cultivated fish to sell to other villagers. Howe[v]er, fish cultivators now preferred to use exotic species, such as silver carp and tilapia, to the indigenous varieties.

This section on **'Farming Systems'** presents findings related to changes in cropping patterns, livestock, homestead vegetation and forestry resources. The farming systems in the area are typified by small field sizes, paddy cultivation and a mixture of crop and livestock interactions. The major importance of fisheries has already been considered above.

Prior to the embankment being completed farmers stated that they were only able to grow one HYV paddy crop a year, whereas now some were able to grow up to three HYV paddy crops a year by utilising the HYV IRRI 8 for the *Aus*, *Aman* and *Boro* seasons. However, the respondents stated that the ability to undertake this was highly dependant on the drainage and irrigation facilities in their area. Some farmers were fortunate to have good facilities whilst others argued that their land was too low lying and thus suffered from waterlogging in the wet season or that the ground was too high to be irrigated due to the difference in water and ground levels. It is clear that such topographical and infrastructural differences between farms has had a profound effect on the abilities of farmers to adapt their cropping systems to the new environment. Thus some less fortunate farmers were only able to grow one or two HYV paddy crops a year and others said that they had to continue farming as before, but now they did not have the advantages brought by flooding.

Farmers reported a decline in the growing of jute, as paddy was more profitable and there were now fewer open water areas to wash and process the jute crop. The growing of HYV paddy was said to be more profitable since it resulted in substantially higher yields, but farmers were increasingly having to use more fertilizer to maintain soil fertility and pesticides to control other pests. Farmers said soil fertility and pesticide problems had definitely increased. One respondent said that farmers were now part of a cash economy and that they had to spend more on inputs to get the higher yields.

With regard to **'Extension Services'** farmers said they received little advice on timing and quantity of agro-chemical applications and that their main source of advice was from the chemical suppliers themselves. Farmers stated that they received minimal help from the government extension agencies and that some had never even met the agent for their area. They also received advice from BRAC on seed and agro-chemicals from suppliers and other farmers.

Farmers reported that their **'Main Crop'** choice was still rice but other crop varieties had remained the same, except for the use of the new HYV paddy varieties. The cultivation of HYV rice was liked for its profitability but on the whole the new IRRI rice did not store well and was believed to be less tasty and less nutritious. However, substantial increases in yield were commonly remarked upon and one respondent said: We produce more rice, nobody dies now for lack of rice food after the embankment, but before the embankment it did happen". IRRI rice was said to yield more, but farmers said yields were declining and more and more fertilizer was needed to maintain the soil fertility. This factor, together with the rise in the cost of agro-chemicals meant that the profit margins were being reduced and, therefore, farmers were having to work harder to pay for inputs, despite the lower yields. Villagers also stated that IRRI rice posed health problems due to the different taste, lack of nutritional value and problems associated with the increased use of agro-chemicals.

Farmers also grow a variety of other field crops, including wheat, sesame, jute, sugar cane, mustard, chilly, field peas, pulses and potatoes. Respondents, especially the women, stated that they had not changed their homestead vegetable and fruit crops and that they still grew chilies, lemons, radish, tomatoes, gourds, cucumbers, ochra, pumpkins, papaya and mango. However, some respondents stated that their homestead garden production had declined due to increased labour demands for working in the fields, combined with the declining soil fertility.

'Increased Work Loads' were noted by both men and women, due to increases in cropping intensity and the additional demands of planting and harvesting. The production of IRRI rice and increased yields was said to be a major factor. The increase to three crops per year meant that there was no longer a break in the season where farmers, labourers and draught livestock could rest.

'Tree Planting' was reported to have increased, both around the homesteads and in field areas, as a result of the lack of flooding which previously used to threaten tree survival. Planted trees included such varieties as mango, coconut, jackfruit, banana, plum and palm. The tree fruits were kept for the homestead, given to friends or sold for additional income. In two cases farmers had planted tree plantations for fuel, which would be sold in later years. They said they were now able to do this, as they did not fear losing the young saplings due to flooding. Respondents stated that the 1987 and 1988 floods had killed many of the smaller trees and saplings.

Respondents also said trees were available for sale from the government, BRAC and in the local markets. The BWDB had planted trees on the embankment and roadside verges. Virtually all interviewees stated that the trees belonged to the BWDB and that the villagers were unable to avail themselves of these byproducts. However, the one exception was in a village close to the embankment edge where the management of the trees was controlled by a local village group and the by-products would be made available to the management committee. Fuel sources were said to be less now as farmers grew less jute and "*Daincha*" (a tall fuel crop grown on barren land or as a break crop) because the cultivation of paddy had increased. In addition, prior to the embankment, farmers grew long grain rice straw, which provided fodder and fuel.

The keeping of **'Livestock',** such as goats, cattle, ducks and poultry was said to have increased, although farmers faced a fodder shortage in the dry season as they had changed from the long-straw indigenous rice to the shorter-straw HYV rice. There had been an increase in the keeping of livestock due directly to the lack of flooding, since farmers no longer feared for the loss of their animals due to flooding. Four women members of two FGDs said that diseases had increased amongst their livestock as a result of the increase in numbers and the poor water quality. However, respondents said that the construction of embankments, roads and canals had also given them greater access to grazing on the verges during all seasons. The management of the grazing on these common property resources was unclear and respondents cited that they could just graze where they wanted as long as their neighbours did not mind.

Farmers stated that if they had the money available they would hire a power tiller instead of using draught oxen, as this enabled them to plant earlier and at the beginning of the monsoon season when draught animals were not yet in a fit enough condition to plough. It was also easier to use a power tiller than oxen in waterlogged areas.

Some notable **'Gender issues'** were high-lighted in the FGDs. For instance, one woman respondent said that the embankment was a good thing because: "It encourages roads and now in the flood season if a man beats his wife, she can walk to her parents house and get away". However, several women participants said that poor women were now worse off as they had less access to fishing, water and fuel sources. Women were also said to have increased workloads for the processing of crops and more women could now be seen working in the fields, particularly during the harvest. This practice had changed the role of women, as previously they were not allowed to work outside of the Bari.

With regard to **'Infrastructure'** the increase in roads and canals had meant better access during the wet season and had substantially improved the transport and sales of products to other villages and at local bazaars, such as Matlab. There was also now an increase in the number of hawkers and peddlers, as they were able to travel around the area in all seasons. Villagers reported that the government had acquired land to build the embankment, canals and roads and that owners were reimbursed only after paying a bribe. Respondents complained that nobody was responsible for the maintenance of the canals and that some canals were falling into disrepair. Also the increased quality of access around the site meant that villagers were able to move around more, visit relatives and avail themselves of more services. Respondents also stated that as a result of the good access they received more visits from local government officials and NGOs, such as BRAC. It was also stated by one FGD that as a result of better access, thefts and robbery had also increased.

In terms of **'Socioeconomic Status'** respondents said that more homes were being built. The reduction in flooding had enabled them to extend their homestead *Baris* to accommodate more family members, as they could now build on areas that had previously been flooded. Consequently many new homes had been built on low lying land, thus enabling poorer family members to be accommodated at the homestead. However, respondents said they worried about the embankment breaking and again flooding their homes.

Due to the change in cropping intensity, household income had increased but as there were diminishing agricultural returns and declining soil fertility, economic status was said to be growing closer to the situation prior to the embankments construction. However, respondents also stated that they now had more money to spend on ill health if necessary. All respondents said they took loans or borrowed money from family members to buy inputs at the beginning of the agricultural season. These loans were then paid off after harvest time. Two FGDs stated that they took loans from BRAC members, although they knew that this was not what the BRAC money was intended for. All respondents said

that the rich had benefited more than the poor from the embankment scheme, primarily because they could afford the high costs of the agricultural inputs.

The increase in work loads was reported to have provided more employment opportunities for the poor people in the area. All respondents said that wage rates for a days labour were now higher inside the embankment and wage rates varied from 25 to 60 Taka for a 8 am till 1 pm working day, according to the season, task and employer. Respondents said that the displaced people, such as those who lost their land or means of income (eg. fisherfolk and boat people) were now able to find work as rickshaw pullers or as day labourers. However, other poor people had been forced to migrate elsewhere in search of work. Some respondents stated that some in-migration had occurred as a result of the demand for day labourers. They also noted that some of the poorer people had been forced to squat on the embankment itself and that those whose houses were on the outside edge of the embankment still faced the threat of flooding.

One group of FGD respondents said that as they now had more income: "People want more luxuries, clothes, make up and radios". This together with the greater use of transport was changing their society as people became more ‘western’. Others stated that education and literacy was now directly relevant to their management of the environment and that educated people were the ones who knew best how to look after their environment.

5.4 Conclusions

In answer to the final FGD question: **"Are you now better or worse of after the embankment?”** there were clearly two main responses. Individuals who owned land said that they were better off whilst poorer people stated that they were worse off. This clearly demonstrates the dilemma that faces many development projects, which is how to achieve a balance in the distribution of the economic benefits. In this respect the MD Project needs to pay greater attention to equity in future planning.

In general, the results and findings of this qualitative research study appear to confirm previous evaluations that assessed the impact of the MD Project. As this was a qualitative study and the evaluations mainly used quantative approaches, it is not possible to statistically compare the results. However, with regard to the environmental effects of the Project on the availability and sustainability of natural resources and the subsequent effects on people, the negative impact appears to be more complex and far greater than those found in the more recent evaluation studies.

CHAPTER 6: DISCUSSION ON STUDY RESULTS AND FINDINGS

6.1Methodological problems encountered

During the field research a number of methodological issues arose. Under taking field research during the monsoon season proved problematic, as frequent rains disrupted and delayed the FGDs and hampered access around the research area. Ploughing and rice transplanting, harvesting and processing are all undertaken during the monsoon season, thus labour demands were high, restricting the availability of villagers for research, particularly the poorest.

Seasonality meant that some of the poorer villagers were unable to spare time to participate; unlike wealthier farmers who were not undertaking harvesting tasks and thus had more time available. Women found it difficult to find time for FGDs, since they were often busy processing the harvest and undertaking homestead work. In general, poorer farmers had less time and in some cases they were socially ostracised by wealthier villagers. Field researchers tended to take the easier option of interviewing the more available, and thus wealthier, respondents. Due to the seasonal labour demands it was difficult to settle respondents and the research team had to balance expediency versus the quality and representative ness of the data collection.

The location of research sites affected participants responses. Those closer to roads and the embankment were nearer to such amenities as transport and shops, which appeared to influence their responses. In addition, some research sites had been visited by previous researchers and it seemed as if respondents anticipated questions and discussion. In several cases villagers said they were fed up with being "tested by outsiders as they got little in return" and they demanded something for their participation in the research.

Cultural factors influenced the research and responses. In several instances villagers decided it was inappropriate for women to be interviewed and in other situations they were not relaxed in the presence of men. The field researchers, author included, were clearly of a different social status and in some situations, particularly with women, this led to difficulties in communication and responses. The use of Bengali was a problem as the author relied solely on co-researchers for translation and interpretation of the discussion. This resulted at times in confusion and lack of clarity in posing questions and comprehending responses.

Due to seasonal labour demands the majority of available respondents were women and their responses may well have been different from the men, as would those from fisherfolk or boat peoples be different from small farmers. The selection of research sites concentrated on the south-eastern side of the MD project, primarily due to ease of access and time availability. The above two factors, together with the site differences within MD, which included topography,

infrastructure, soils, hydrology and sociological and economic factors, questions the representativeness and validity of the research findings. Had different sites and participants been sampled, it is possible that different responses would have been received.

The use of qualitative research techniques for this study was a deliberate choice, as the Study aimed to understand the perceptions of the people rather than to confirm those of the researchers. Such approaches are useful when attempting an anthropological evaluation that looks at the issues from the villagers point of view. Indeed, different actors within the research process all have different perceptions and backgrounds that influence their interpretation of the findings. Any one seeking to interpret such information needs to be aware of theses issues when seeking to draw conclusions and make recommendations.

6.2 Discussion of main findings

The primary objective of the Meghna Dhonagoda Project was to improve agricultural output and this has reportedly been achieved, even if this is less than what was envisaged by the project planners. The general aim of this research project was to identify the environmental effects of the Meghna Dhonagoda Project and its probable impact upon natural resource factors and livelihoods of the people living within the embankment.

All respondents agreed that the MD Project had caused very significant environmental changes which had resulted in marked effects on the area's natural resources and people. This conclusion is in keeping with, but is also much stronger, than those available from previous evaluation studies. However, due to the diversity of causal factors and effects, the benefits and negative aspects of the Project are unequally distributed and difficult to disentangle. In this situation arguments can thus be made both in favour and against the impact of the scheme.

By far the biggest environmental change is the reduction of flooding and control of the water within the embankment area. This primary change has clearly been the root cause for other subsequent changes.

The reduction in flooding has enabled all season HYV crops to be grown, but only in areas with sufficient drainage and irrigation. Spatial differences of effects are also evident, as some farmers could grow three crops per year, whereas others continued to farm as they had done before the embankment. Their differences relate to the uneven distribution of drainage and irrigation facilities. Richer farmers in better resourced areas were thus able to maximise the returns on their agriculture within the new environment. Some farmers argued that apart from the change to new HYV of rice, there had been limited other agricultural changes. Although the cultivation of HYV varieties has led to increases in yields it has also led to a heavier work load for both men and women. The change to more HYV of rice has had an effect on fuel and fodder availability and reportedly on the storage and consumption of rice.

The impact on households appears to have been considerable. For example, respondents reported reductions in homestead gardening, changes in income, expenditure and debts, and reported effects on peoples health. In addition, there was now limited access to open water areas and reductions in water quality. These environmental factors have reportedly had serious consequences for water usage for household needs and had an impact on health and sanitation.

With regard to agriculture, the lack of flood waters to replenish soil nutrients, together with the monocropping of HYV rice, has led to reported problems for soil fertility and structure. Farmers stated that the soil was becoming less fertile and required more inputs of fertilizer. This means that farmers need to spend a higher proportion of their working capital on fertilizer and they can thus become further dependant on a fluctuating market economy to meet other subsistence needs.

Substantial changes in the fisheries were found to have occurred and people lamented the demise of their access to open water and seasonal fisheries. The lack of flooding has adversely affected open water fisheries but has enabled pond fisheries to be stocked and operated all year round. Fish form a vital dietary and income component within many households and the reduction in fishing and fish stocks has led to less consumption and the loss of income for many households.

The landless and poor people appear to have gained little from the Project. Many appear to have migrated out of the area and whilst others have found alternative means of work, such as undertaking agricultural labouring and rickshaw pulling. By contrast wealthy landowners appear to have been able to take advantage of the changes through better access to inputs and by diversifying into other profitable occupations. Thus the environmental changes have led to differential benefits by socioeconomic class.

The increase in demand for labour and improved access has had other sociological effects, with people more able to travel freely and work outside of the Homestead. Thus, they can then come into contact with a wider range of people. Another reported effect is the reported increase in mobile traders and a higher crime rate reportedly as a result of increased access and wealth.

In conclusion, the MD Project has resulted in a number of major effects that are derived from the initial environmental control of flooding. Flooding has now been prevented; water levels are hydrologically controlled; HYV crops and cropping intensity has increased; and seasonal fisheries have been drastically reduced. However, the consequent effects on people varied depending on their initial wealth, location, available resources and other factors. There has most probably been an increase in social inequalities between households as a result of the embankment.

6.3 Implications for further Research

The results of the research present a number of implications for further research. The changes resulting from the project are still an ongoing and dynamic process. There are difficulties in quantifying the equality and distribution of the changes and for adequately evaluating the Project benefits.

The undertaking and establishment of an ongoing baseline survey would enable the impact of the project changes and effects to be measured over time. The use of monitoring and evaluation techniques could well allow for more definite conclusions to be made regarding the impact of project effects.

The project has had disparate effects on different socioeconomic classes. Poor people seem to have gained proportionately less than the wealthier farmers, however this is not true in all cases. An ongoing study of the socioeconomic impacts of the project combined with the ongoing baseline survey would prove useful in evaluating the socioeconomic impact upon households and livelihoods and could prove beneficial in determining ways in which this process could be reduced thus providing for more equality in the elevation of poverty.

The Project has reportedly had an impact on people's health within the project area, arising directly from environmental change and also from changes in natural resource management practices. Further studies could be undertaken to consider the health impacts of these changes both in terms of water quality and quantity, and also issues arising from farming systems changes such as increased work loads, increased use of agro-chemicals, changes in fisheries and the nutritional status associated with cropping systems and homestead gardens.

The project has had an impact on the natural resource management practices within the project. Problems with soil fertility are only now becoming readily apparent and are likely to continue to worsen. The continuous cropping of rice has led to an increase in agro-chemical usage. Research could be undertaken to assess the more specific effects of the natural resource management changes and practices then into ways to undertake more sustainable farming systems strategies such as; green manures, intercropping and integrated pest management.

There are disparities of effectiveness relating to the projects infrastructure. Research into the actual effectiveness of the present infrastructural operating system could highlight areas for potential project development. Consideration could then be given to upgrading the effectiveness of the canals infrastructure, operation and maintenance. In highland areas an evaluative study could determine the feasibility of creating a secondary embankment and canals within the main embankment to provide irrigation and drainage facilities to those areas presently without services. The management and responsibility for infrastructural maintenance remains unclear. Respondents felt that they were at the mercy of BWDB

and had little control. Future research could be undertaken to consider the possibility of management committees to be involved in the development and maintenance of the project infrastructure. This would allow local people a greater role in the development of their services and place an emphasis on people for maintenance responsibilities.

If further studies of the project were to be undertaken then the combined use of both qualitative and quantitative research methods would best enable the diversity of effects to be examined. The combination of both techniques would enable areas of relevant research to be highlighted and provide statistical data. This could then enable comparisons of the project effects upon different socioeconomic classes, natural resources and throughout varying agro-ecological zones to be conducted.

The environmental changes resulting from the Project are far reaching and effect a number of secondary areas. Already questions are starting to arise about the sustainability of the project both in ecological and sociological terms. Further research and evaluation is urgently required that examines the diversity of different effects and dynamic interactions. Such research could go a long way to providing solutions to current problems and towards preempting further problematic effects. Research could also prove beneficial in providing answers to the wider debate about the effectiveness of FCDI schemes and for agricultural development policy in Bangladesh.

CHAPTER 7: CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

There is no doubt that the MD Embankment Project with its reduction in seasonal flooding and hydrologically controlled environment, has resulted in a major ecological change. This change appears to have enabled the primary objective of increasing HYV rice production to be achieved. However, this change has also been the primary cause for further environmental, social and economic changes within the Project area. Secondary changes affecting natural resources have occurred in the soil and water regime, farming systems and fisheries and additional effects have also been reported on human health, economic wellbeing and broader sociological issues, such as gender labour divisions.

The environmental sustainability of the Project remains questionable. The effects of intensive rice cultivation are becoming more apparent and are now being reflected within broader environmental and social terms. The people of the Meghna Dhonagoda Embankment Project are now committed to living within the realms of a new artificial environment. The benefits of this environment are now also being readily reflected in the diversity of negative effects resulting from the ecological change.

Although the embankment has not been breached since 1988, all research respondents feared that it may do so in the future. Even during the period of this research, emergency repairs were being carried out on several stretches of the embankment. If the embankment were to breach this would cause serious devastation to households and farming systems. An immediate priority for BWDB is, therefore, a commitment to an ongoing and expensive maintenance programme, for fear of flooding causing a major disaster in the future.

Determining the impact of the embankment and its subsequent full effects is a complicated and difficult task. The changes take time to develop and are the result of a dynamic process that continues to affect a number of different areas. Changes are closely related and no change stands on its own, with all the effects continuing to be interrelated and crosscutting.

The methodology for this present research study provided a suitable forum for the elaboration of the diversity of perceptions on the Project's effects. The use of PRA techniques and FGDs enabled the people to express and explain their perceptions and opinions. However, such qualitative techniques did not allow for any means of quantification of the effects for comparison with previous evaluation studies. Further research into key problematic areas, incorporating both quantitative and qualitative approaches, together with a baseline survey to establish the present situation, should provide essential information for establishing the future effectiveness and equality of Project benefits.

In the past agricultural development was incorporated within FCDI schemes in order to increase area yields and provide direct economic benefits. However, policy planners are now becoming more aware of the diversity of the many negative effects that can result from environmental and agricultural change. Current solutions to agricultural development and food grain sufficiency may only be beneficial in the short term and urgent consideration needs to be given to the long term environmental implications. The short term gains resulting from infrastructural and technological fixes may threaten the sustainability of Bangladesh's environment. A long term perspective is essential if sustainable environmental changes are to be achieved. If agricultural development and water management schemes do not consider the multitude of such diverse effects and interactions associated with Flood Control, Drainage and Irrigation Schemes, then such schemes will still provide disparate socioeconomic benefits and the environment will continue to be degraded by the effects of modem agricultural practices.

7.2 Recommendations for Further Research

1. The undertaking of a baseline socioeconomic and environmental survey to establish the impact of the Project and to provide a benchmark against which the changes and Project effects can be measured in the future.

2. Further research into questions arising from current natural resource management practises and their effects, as an essential contribution to developing techniques and policies for sustainable agricultural production. Such research should use a combination of qualitative and quantitative research techniques.

3. Further research is urgently needed into the current status of the Project's infrastructure and into the means to improve its effectiveness and maintenance.

4. The results and findings from such research need to be incorporated into the BWDB current development programme, so that future policy is strongly embedded in the reality of the present day situation.

5. Far greater reliance on local institutions and people in project research, evaluation and management of current problems.

6. Emphasis should be given to developing closer working relationships between the BWDB and local people, with an emphasis given on local peoples participation in Project maintenance and development of new management practices.

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APPENDIX ONE

MEGHNA DHONAGODA PROJECT.

Project Summary

Project Name	:	Meghna Dhonagoda Irrigation Project
Project Type	:	Flood Control Drainage and Irrigation
Location	:	FAP Region District: South East Chandpur
Area (ha)	:	17,584 ha gross, 14,367 ha cultivable
Funding Agency	:	Asian Development Bank
Implementing Agency	:	Bangladesh Water Development Board
Construction Started	:	1978/79
Scheduled Completion	:	1983/84
Actual Completion	:	1987/1988
Original Cost Estimate	:	Not undertaken
Final Cost Estimate	:	Tk 2418.8 million (1991 prices)
Major Flood Damage	:	1987 and 1988
Rep air\Rehabilitation	:	1989 to present

Summary Overview:

A very high cost project (even as appraised and much more so as built) incorporating pumped drainage and canal irrigation as well as flood control. Construction was protracted due to poor planning and site investigation and the embankment failed twice in the first two years after completion due to poor investigation and the reduction of design standards.

Agricultural performance subsequently has been very good and there are clear indications of increased wellbeing in the project population, but EIRR is only 7 % (including fishery losses, but assuming no further failures) due to the long delay in completion and cost over-runs.

(Source: Bangladesh Flood Action Plan FAP 12/ FCDI Agricultural Study Summaries of PIE Survey Reports, Hunting Technical Services, UK).

APPENDIX TWO

FOCUS GROUP DISCUSSION QUESTIONNAIRE

INTERVIEW FIELD NOTES

These points are here to help you and to help the research process.

When making an introduction, clarify why we are here and what are our objectives. Also we want to hear peoples opinions and this is about focus group discussion, so encourage them to speak freely and discuss.

Remember to listen and think carefully about the questions and the discussion.

The interview form is only a check list, not a questionnaire, use it to generate discussion. If something interesting arises tell me, question it and then bring the discussion onto the subject.

Try to maintain the focus and record everything. Don't record just yes or no but the full answer.

At the end of a particular subject ask if the respondents wish to say anything else that has not been covered.

If you don't get enough time to write notes ask people to repeat.

Clarify peoples status and land use before grouping for interviews.

Try to ask only one question in a sentence otherwise leads to confusion.

Review an introduction for each section and then explain the topic and start a discussion. Don't be to specific, generalise and provoke discussion.

Explain that the discussion will take about 45 minutes and we need them to stay the whole time otherwise it is a problem.

Remember the focus group discussion: Embankment environmental change and the effect on the people.

STRUCTURED CHECKLIST FOR FOCUS GROUP DISCUSSION

INSIDE EMBANKMENT: BEFORE AND AFTER EMBANKMENT

DATE **TIME** **NAME OF VILLAGE**

NUMBER OF RESPONDENTS

SOCIOECONOMIC CLASSIFICATION

SEX AGE RANGE

BRAC MEMBER yes/no Number

ICDDRB MEMBER yes/no Number

DURATION OF DISCUSSION

(General question to start discussion)

1 What changes have there been since the embankment was built?

FISHERIES

1 How has your fish situation changed?

(more or less quantity and variety?)
(effect on health?)
(effect on income or expenditure?)
(access to fishing areas?)
(fish cultivation)
(poisons in fish cultivation)
(use of canals for fishing? who)
(number of fisher people?)

2 What other things can you tell me about fishing?

GENERAL COMMENTS: (ask anything they want to, add information or we have not asked)

AGRICULTURE:

1 Is your agriculture different now than before? if so how?

(production more or less crops, yields higher or lower)
(yields stable, increase or decrease)
(pests and diseases situation in your crops)
(more or less fertilisers and pesticides)
(receive advice on agriculture, fertiliser, pesticide application and usage?) (grow more or less vegetables? field and garden, variety)

2 What is the situation with selling and also eating your crops?

(market more, eat more variety quantity)

3 Do you have more or less work to do for agriculture?

(Who does the work men or women, what is workload split)

4 Has your livestock and poultry situation changed ?

(more, less, variety)
(fodder, variety more less)
(diseases more,less)

5 How is your fuel situation now?

(more or less fuel sources?)
(more less access to trees)
(planting trees, variety)

6 What is the situation with fodder and/or fuel from the embankments?

(How is fodder and fuel from the embankments controlled?)

7 What is the wage rate for a days labour?

(has it changed?? seasonality)

8 What is the situation of the water now?

(problem with waterlogging?)
(irrigation services sufficient?)
(water quality better or worse?)
(how do you know?)
(seasonality)

9 What is the situation of your soil fertility?

(How do you know?)
(how to classify)
(could use different cropping patterns to maintain the quality of the soil? how?)

GENERAL COMMENTS:

(ask anything they want to add or we have not asked)

HEALTH:

1 How has your health situation changed?

(eat more or less, and of what?)

2 How has the embankment effected your health?

(seasonality)
(water quality and sanitation, pit latrine tubewell)

3 Has the effect of the embankment changed the money you spend on health?

GENERAL COMMENTS: (ask anything they want to add or we have not asked)

SOCIOECONOMIC:

1. What happened to the poor people after the embankment was finished? (more or less poor people)

(fisher people and boat people)
(landless people now)
(migration, religion, sex, gender)
(squatters)

2. Are you better or worse off now after the embankment?

(why)
(income and living conditions better or worse?)

3. Has your taking loan situation changed?

(more less seasonality)

4. Do you have any problem with corruption and powerful elites?

5. How has the land tenure situation changed?

(maybe more less land sold?)
(people have bigger smaller farms)
(frequency of land sales?)

GENERAL COMMENTS:

(ask anything they want to add or we have not asked)

GENERAL QUESTIONS:

1. Do you worry about the embankment breaking and flooding again?

(everybody, seasonality)

2. Has your transport situation changed?

(better worse, seasonality)

3. Has the embankment changed the number of visits you receive from government, BRAC, ICDDR,B staff?

(who and how often)

4. What are the good and bad points of the embankment?

GENERAL NOTES:

(list here other points and information raised)

(also anything else they wish to mention)

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3. Unpacking the black box: studying the relationship between socioeconomic development and health -- *Ian Scott, Tim Evans and Richard Cash, 1995*

4. Formation of village organizations: the first three months -- *Manzurul Mannan, Mushtaque Chowdhury, Abbas Bhuiya and Masud Rana, 1995*

5. Participatory methods to assess change in health and women's lives: an exploratory study --*Alayne Adams, Rita Das Roy and Amina Mahbub, 1995*

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