DEPARTMENT FOR INTERNATIONAL DEVELOPMENT

STRATEGY FOR RESEARCH ON RENEWABLE NATURAL RESOURCES

NATURAL RESOURCES SYSTEMS PROGRAMME

FINAL TECHNICAL REPORT

DFID Project Number

R6755

Project title

Sustainable Local Water Resource Management in Bangladesh – Meeting Needs and Resolving Conflicts

Volume I: Main report

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NRSP Production System

High Potential Production Systems

Date

November, 2000

Contents

Acronyms

ASFA	Cambridge Scientific Abstracts
BARC	Bangladesh Agricultural Research Council
BBS	Bangladesh Bureau of Statistics
BCAS	Bangladesh Centre for Advanced Studies
BDK	Bangshi-Dhaleswari-Kaliganga region
BIDS	Bath Information Data Service
BRAC	Bangladesh Rural Advancement Committee
BWDB	Bangladesh Water Development Board
CABI	Commonwealth Agricultural Bureau International
CC	*Chowk* Committees
CPP	Compartmentalisation Pilot Project
CPR	Common Property Resources
CPWR	Common Property Water Resource
CWMC	Compartment Water Management Committees
DC	District Commissioner
DEM	Digital Elevation Model
DFID	Department For International Development
DOF	Department of Forests
DTW	Deep tubewell
EGIS	Environment and GIS Support Project
EU	European Union
FAO	Food and Agricultural Organisation
FAP	Flood Action Plan
FRA	Free Access Resource
FCDI	Flood Control, Drainage and Irrigation
FGD	Focus Group Discussion
FPCO	Flood Plan Coordination Organisation
GOB	Government of Bangladesh
H/H	Household
HP	Handpump
HYV	High Yielding Variety
ICDDRB	International Centre for Diarrhoeal Diseases Research, Bangladesh
IDS	Institute of Development Studies
ITK	Indigenous Technical Knowledge
IWRM	Integrated Water Resources Management
KS	Knowledge Systems
LGED	Local Government Engineering Department
LLP	Low Lift Pump
MFA	Ministry of Foreign Affairs

MoWR	Ministry of Water Resources
NGO	Non-Government Organisation
NEMAP	National Environment Management Plan
NFMP	National Fisheries Management Plan
NWMP	National Water Management Plan
NWP	National Water Policy
O&M	Operation and Maintenance
PRA	Participatory Rural Appraisal
RAS	Research and Advisory Services
RDP	Rural Development Project
RNRRS	Renewable Natural Resources Strategy
RPK	Rural People's Knowledge
RRA	Rapid Rural Appraisal
SCWMC	Sub-Compartment Water Management Committees
SDS	Social Development Society
SRP	Systems Rehabilitation Project
STW	Shallow Tubewell
SWC	Soil and Water Conservation
TNO	Thana Nirbahi Officer
TROPAG	Tropical Agricultural Institute
UN	United Nations
UNDP	United Nations Development Programme
WARPO	Water Resource Planning Organisation
WUG	Water User Group

BANGLA TERMS

Aman	Rice crop own in the monsoon season and maturing after the monsoon
Aus	Early rice season occurring in early summer (pre-monsoon)
Bari	A homestead consisting of one or more households in a compound with an inner courtyard and surrounding houses
Barsha	'Regular' flood
Beel	Natural depression in the floodplain, perennially/seasonally flooded
Bigha	Bengali unit of land measurement
Bonna	'Extreme' flood
Boro	Rice crop sown, transplanted and maturing in the dry season. Requires irrigation, now normally supplied by tubewells
Chawk	The smallest hydrological or physiographic unit which is easily recognisable in the field because of homogeneity
Chula	A stove (usually locally made)
Dhanee	Rich (used in reference to wealth status in this case)
Garib	Poor (used in reference to wealth status in this case)
Gusti	Patrilineage
Hat	Afternoon village market
Jamindar	A person who will guarantee that his client will repay a loan
Katcha	Poorly made, again tends to refer to buildings such as toilets or HPs made of local materials
Khal	A canal
Kharif	Bengali season, encompassing pre-monsoon and monsoon periods
Khas	Untitled land or water bodies owned by the Government of Bangladesh
Khub garib	Poorest of the poor (used in reference to wealth status in this case)
Malik	The household head
Matbar	Head of the *samaj*
Maund	Bengali unit of weight, equivalent to approximately 37 kg
Mouza	Smallest administrative unit, broadly equivalent to a village, though it may cover more than one if the villages are extremely small
Robi	Bengali season, equivalent to winter, that is dry season
Pagar	Human-made feature, similar to a pond but without a rim. As a result, water enters via overland flow during the rainy season
Para	Section of the village frequently based on occupational, religious or geographical groupings
Pucca	Well made or solid, generally refers to buildings such as toilets or HPs that are made of concrete
Purdah	The seclusion of Muslim women from outsiders. Women as confined to the homestead and go veiled when they move outside the compound
Samaj	Muslim congregation, village association
Samity	Group level organization
Shalish	Informal local court, or village arbitration process, formed on request of villagers
Taka	Unit of Bangladesh currency (average in 1997-98 £1 = 76 Taka
Thana	Medium-sized administrative unit, roughly equivalent to a sub-district.
Union	Sub-thana unit of administration
Zamindar	Superior landlord/revenue collector

1. Executive Summary

In Bangladesh, the relationship with water resources is particularly important; the nation's water resources are fundamental to life and are the resource upon which many livelihoods are based. They are the foundation for many traditional livelihood activities including inland and coastal fishing and transportation and water supply also forms the backbone of the country's primary activity, agriculture.

Given the multiple demands on water resources, the dynamism of the hydrology, and the resultant potential threat to the rural livelihoods of people who are already vulnerable, it is essential that in the future Bangladesh develops a flexible, integrated strategy for the management of these resources.

This research aimed to explore and develop an in-depth understanding of how the rural population of Central Bangladesh manage water resources as part of the process of attempting to secure a livelihood. This was undertaken in two, broadly similar research sites, where the key difference was one had flood control infrastructure and the other did not. The research identified priority problems, potential solutions, and arenas of conflict over water resources, with the purpose of developing and promoting appropriate and cost-effective techniques for water distribution, drainage and re-use. The techniques highlighted are both technical solutions, and improvements to the management strategies of the water resources. The research also hoped that agreements between stakeholders would be reached and links into the national planning framework responsible for developing and implementing a water strategy developed.

The research found several limitations of the water resource-based livelihood systems in operation in the two research areas. These were the result of technological, socio-economic and political processes at work in these systems. These limitations occasionally manifest themselves as disputes between the various livelihood groups. The key problem is one of lack of water, rather than excess, both during the dry season and the monsoon season. This leads to direct problems for many livelihood activities such as shortage of water for agricultural operations (irrigation during the dry season, retting of jute during the rainy season) lack of sites for fishing activities – (professional or otherwise), and indirect ones such as difficulties in operating hand pumps which is a consequence of the temporal draw down of the water table due to over extraction.

Other problems include: faecal contamination of water bodies used for human bathing, pollution of water bodies by agricultural inputs, high iron concentrations in groundwater, poor operation of flood control infrastructure and poorly conceived legislation and ineffective and corruption in relation to the management of *khas* lands. There are also clear limitations in terms of the process by which groups able to articulate their needs to the agencies responsible for the various activities associated with management of the resource base.

It is obvious that the community has detailed knowledge of their water resources and the causes of the difficulties they now face. The solutions the various groups highlighted frequently refer to physical infrastructure change and there were frequently references to doing something in order to "make things like they were before". Whilst there is a good understanding of the causes and effects, there seems to be a reluctance to accept that there is a new hydrological regime operating which cannot be reversed. Yet; there are clear, rapid changes taking place in livelihood activities of the population that reflect the new system dynamics.

A number of recommendations are made which are based around the participatory process this research has established. Now the communities are engaged it is important that these entry points be finalised and acted upon and extended. The researchers are actively seeking support to enable this to occur.

2. Background

The livelihood systems of the rural population living on the floodplains of Bangladesh are complex, multiple and inter-linked. Consequently, as one or more parts of the system are stressed, the entire system becomes vulnerable. The management of the water resource base is a critical component of this vulnerability, affecting agricultural productivity, nutrition, health, off-farm income earning opportunities and physical security during annual flooding. Within this integrated livelihood system, a number of water-related development problems have long been apparent, many of which, it is claimed, have developed or at least have been exacerbated by, the water development strategy the country adopted, particularly the Flood Action Plan or FAP (RAS, 1992; Adnan and Sufiyan, 1993; MFA, 1993; Haggart *et al*, 1994; Rahman, 1995; Thompson and Sultana, 1996). Such problems include: scarcity of water for numerous purposes both during the dry season and rainy season (Shamim and Salahuddin,1994), vulnerability to flood and erosion hazards (Mamun, 1996), inadequate quality of water for domestic needs, waste disposal and other purposes (Haggart *et al*, 1994), non-equitable access for small and marginal farmers to the opportunities presented by irrigated dry season agricultural production (Howes, 1985; Wood and Palmer, 1991), deteriorating availability of food (especially fish) and other goods from the commons (Sadeque, 1992; Tsai and Ali, 1997; BCAS, 1997), and due in part to inadequate levels of participation of the rural population in development process, a failure to adequately understand needs and priorities in relation to water resource development, planning and project implementation (Adnan *et al*, 1992; SGK and Unnayan Shamannay, 1997).

The key to effective sustainable development is in understanding the forms of resource use by the various users. These include identifying the conflicts between different sectors of rural society over the management of water resources and responses to water resource hazards, and determining the institutional relationships and activities involved in attempting to resolve those conflicts at the local level.

Whilst several key studies have embarked on examining elements of rural resource use in Bangladesh, few have had the longitudinal basis which provide the long-term understanding required by policy makers, and focus on the interaction of all forms of water resource use. For example, Jansen (1988) undertook one of the few longitudinal pieces of work on competition for scarce resources in rural Bangladesh. However, this seminal work barely touched on the issue of water resources. Similarly Woods and Palmer-Jones (1991) long-term research focussed solely on irrigation markets.

The debate surrounding the Flood Action Plan (FAP) forms the basis of evidence for the need for the research. This has been summarised in numerous policy statements and discussion documents produced by the Government of Bangladesh (GOB), the Bangladeshi NGO and research community, and the donor community. For example, the 1995 Bangladesh Water and Flood Management Strategy produced by the GOB states that the priorities in the next five years (to 2000) should *"broaden the scope of water sector planning to include all sectors"* within a context which recognises that *"Given the large number of often conflicting interests in water and land resources in Bangladesh.....a participatory planning approach which tries to assess and balance different needs and priorities is essential"* (FPCO, 1995).

In relation to the issue of local participation the NGO community has long argued that past approaches to water sector planning have been socially and environmentally damaging and unsustainable and have called for new approaches based on full stakeholder participation. Qazi Faruque, Chairman of Association of Development Agencies (ADAB), the main NGO co-ordination group, has argued for the ending of the *"mismatch of perception between project initiators and stakeholders regarding needs and priorities to be addressed in the project"*.

The joint statement of the Government of Bangladesh and the Development Partners (the donor community) of January 1996 emphasised the importance of integrated approaches based on stakeholder participation and the full accounting of the social and environmental aspects of water sector planning, whilst the *purpose* of the DFID's Bangladesh Natural Resources Strategy is *"to maximise the benefits to poor men and women through the sustainable use of natural resources"* which, in a Bangladeshi context, inevitably means an integrated approach in which water resources are central.

3. Project Purpose

The purpose of the project was to develop and promote appropriate and cost-effective techniques for water distribution, drainage and re-use. The research project addressed the need for an improved understanding of the forms of water use and relationships between the various stakeholder activities on the floodplain as a basis for promoting these appropriate and cost-effective techniques for water distribution, storage, drainage and re-use. It also examined access rights to water resources and the role and form of participation of the rural population in managing water resources. These data allow researchers and policy makers to better plan strategies for managing the water resources in the area.

The research was undertaken in two areas, one inside a large flood management infrastructural project (the Compartmentalisation Pilot Project or CPP) and the other in an area where there had been no major initiatives of this kind. Many major initiatives were undertaken as part of the FAP and the researchers were keen to determine what difference such initiatives had made to resource management strategies of the local population.

The study was conducted in a wholly participatory and action-oriented way through involvement of the various livelihood groups and other stakeholders in the identification of water resources related problems and needs, and the process of solution identification and implementation. This approach has allowed the researchers to gain a thorough understanding of the issues at the local level, and to distinguish between the needs and concerns of the different stakeholder groups found at the local level. The participatory method led to the analysis of the existing water resource management strategies operating at the local level. Equally importantly, the process enabled local people and other stakeholders to gain an understanding of all views of water resource use in the area, to examine the consequences of actions of linked water resource activities and to begin the process of developing a consensus on how to manage their livelihood systems more appropriately in the future. It also initiated the process of developing a micro-action plan (MAP) for the two research sites.

4. Research Activities

The research activities undertaken during the course of the project are shown schematically in Figure 1 and are described from an operational point of view to provide an overall view of interlinked elements of the research system. Table 1 summaries the research elements undertaken to meet the log-frame activities. A more detailed account of each of these activities is provided in the project's final report (Annex 10).

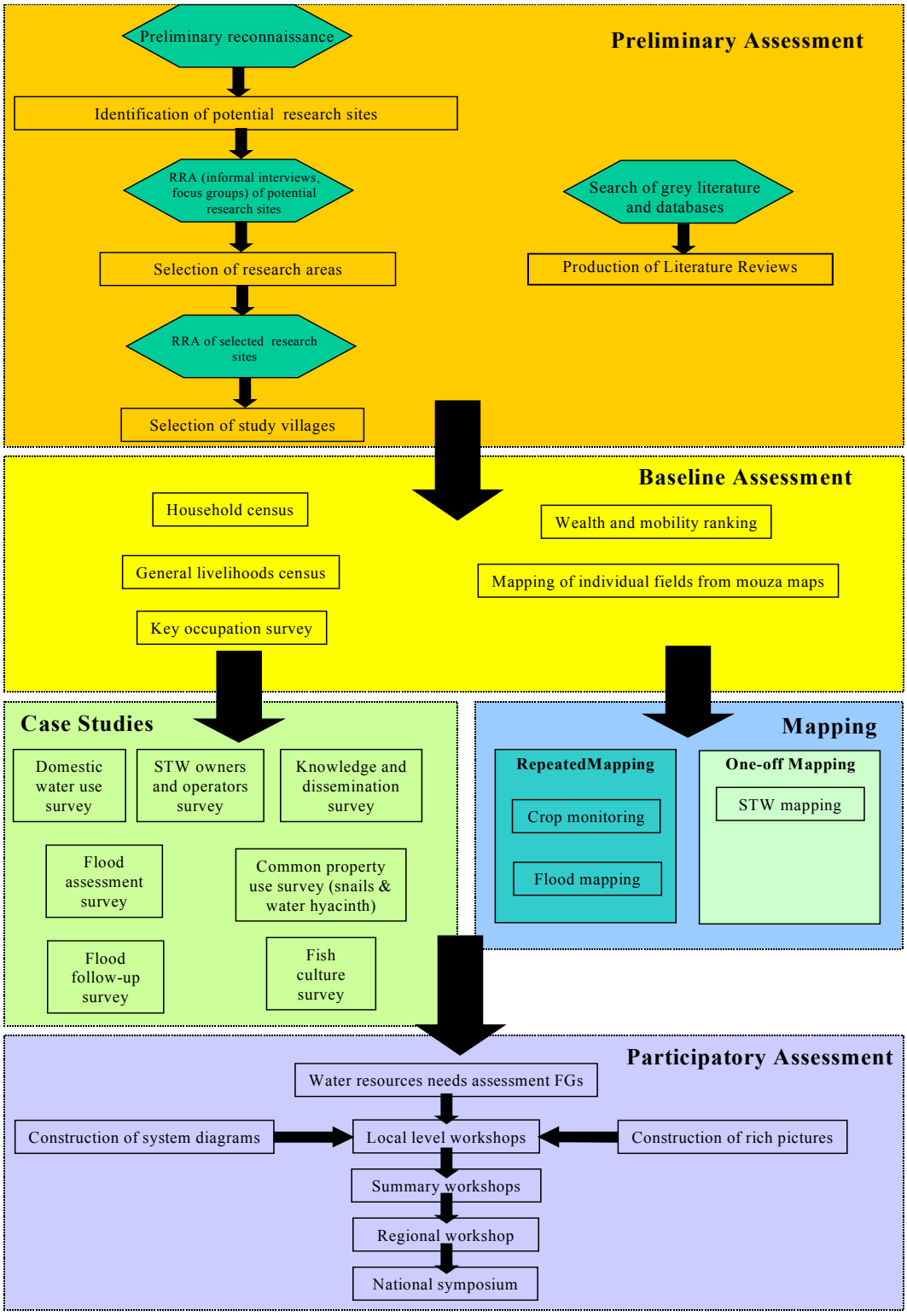


Figure 1: The Elements of the Research System

Table 1: Log-frame Activities and Corresponding Research Elements Undertaken

Log-Frame Activities	Research Element(s) Undertaken to Meet Log-Frame
1.1. Reviews of literature and existing project experience in Bangladesh on Indigenous Technical Knowledge, Rural Development Trends and Water Sector Development Issues.	Three extensive literature reviews (Annexes 2, 3 and 4)
1.2. Rapid Appraisal Research into patterns of land and water resources in Tangail District used to identify study villages.	Preliminary five day reconnaissance visit, Rapid Rural Appraisal exercise of 14 villages, Return field visit to shortlist villages
1.3. Longitudinal research in the social, environmental, institutional and economic context of water resource use in 4 study villages in FAP 20 area and 4 study villages elsewhere in Tangail District.	Fieldwork in the two four-village clusters over three years
2.1. Analysis of limitations of, conflicts arising from and further potential of local water management practices.	Review of: Focus Group Discussions (FGDs), water quality measurements (biological and chemical), flood surveys, rich pictures, respondent interviews, personal observation
2.2. Field verification of the analysis, with attention paid to 'niching' the analysis to local environmental and socio-economic conditions.	Conclusions drawn by reviewing the FGD findings verified during the second phase summary and regional workshops
2.3. Development of GIS and integration of remotely sensed data to structure the analysis of resource/land use data	Development of Microsoft Access database, based on information from several surveys, detailing each households resource use patterns. Also development of GIS datasets of the land use and inundation levels, and of the cropping patterns of all plots of land in the eight study villages. Remote sensing methods not utilised.
3.1. Identification of potential water resource management strategies, based on field research findings.	Original Focus Group Discussions (FGDs) , local level workshops, regional workshops and summary workshops
3.2. Assessment & prioritisation of potential strategies through participatory process of need and priority identification with local actors.	Original FGDs, local level workshops, regional workshops and summary workshops
4.1. Analysis of project reports, case studies and other documents containing details of water resources management in other regions.	Review of National Environmental Management Plan (NEMAP) reports and of Systems Rehabilitation Project (SRP) reports
4.2. Rapid appraisal fieldwork in a number of sites in other regions, including coastal areas and the haor region in the north-east.	Necessity of activity overtaken by the completion of the NEMAP and SRP projects (by John Soussan and the Bangladesh Centre for Advanced Studies (BCAS)
4.3. Consultations with key respondents and workshop to review water management strategies and institutional arrangements in different regions.	No longer necessary in the light of the NEMAP reports which are reviewed in the Final Report
5.1. Assessment of feasibility, including institutional arrangements, of identified strategies through wider discussions and appraisal with NGOs, government agencies, CPP, and other projects.	Undertaken through individual consultations with relevant agencies and as part of the wider summary workshop consultations
5.2 Participatory technology development and sharing through pilot trials in study villages	Identification of possible solutions achieved by the end of the project cycle. Due to financial and time limitations it was clear that the establishment of pilot trials could not be achieved.
6.1. Appraisal of potential success &/or failure of strategies, including assessment likely of social, economic and environmental impacts and identification of indicators for monitoring and evaluation of strategies in the field.	Without establishment of pilot options this could not be achieved.
6.2. Full documentation of research findings prepared in media appropriate for all audiences.	A Final report has been produced along with the production of working papers. During the course of the research, its finding have also been published in NGO newsletters in English and Bangla. Workshop summaries were also published in national newspapers (English and Bangla). The results were presented for discussion in the regional workshops and summary workshop.
6.3. Workshops in Bangladesh and UK and reports disseminated to promote research findings and strategies developed.	A regional project workshop was held in Bangladesh and attended by all key agencies as well as local representatives. A final symposium where element of the research were presented was also held and the proceedings published and distributed in the UK and Bangladesh. The projects working papers were also distributed in the UK and Bangladesh.

Research Area Selection

The team worked from the basis that one research site (a cluster of four villages) would be located inside the command area of the CPP, a large infrastructure project designed to regulate flooding and drainage. The other site would be broadly similar in physical geography and socio-economic character but would not be within the bounds of a large infrastructural project. BCAS conducted a preliminary field visit to identify potential sites inside and outside the CPP area. This five day visit (January 1997) involved discussions with CPP staff, and staff from local government departments and a review of secondary data sources. The team used a number of broad biophysical and socio-economic criteria, which the research site should meet. These were: land of classes F0 to F4[1], presence of a permanent water body (*beel*), access to a main river, a range of socio-economic criteria that are considered "representative" of rural Bangladesh (majority Muslim population, range of livelihood activities, number of households).

[1] Categories F0 - F4 were identified by the Environment and GIS Support project (EGIS).. The category definitions are: F0 (flood free), F1 (1-30cm), F2 (31-90), f3 (91-180cm) and F4 (>180cm)

Based on these discussions 14 potential sites were selected, of which seven were in the CPP. The team visited each of these sites and using rapid rural appraisal (RRA) methods (informal interviews and focus group meetings with village leaders and local elites) gathered information on: the villages adjacent to the *beel* and associated *khal*(s); the main economic activities of the villagers; land tenure; activities associated with the *beel*; agricultural patterns in the surrounding landscape; and hydrological characteristics of the *beel*. Based on these findings a shortlist of sites was drawn up and a further field visit was then undertaken to finalise the study sites. This process of final selection included a detailed appraisal, based primarily on the use of a checklist, for each area. This information was then analysed in conjunction with existing information including the history of infrastructure development by the CPP (areas where infrastructure had been in place for some time were preferred), information on CPP's past, present and future community-based programme and, hydrological and elevation data and led to the selection of the Jugini *beel* area inside the CPP project and the Bartta *beel* area outside (Figure 2).

Statistical data such as number of households, employment and religious profiles were then collected to gain an insight into the socio-economic and demographic characteristics of the villages surrounding the two *beel* areas under consideration, and to check that they were generally "representative" of those for the rest of the region. At the end of the assessment, four villages I each area were selected.

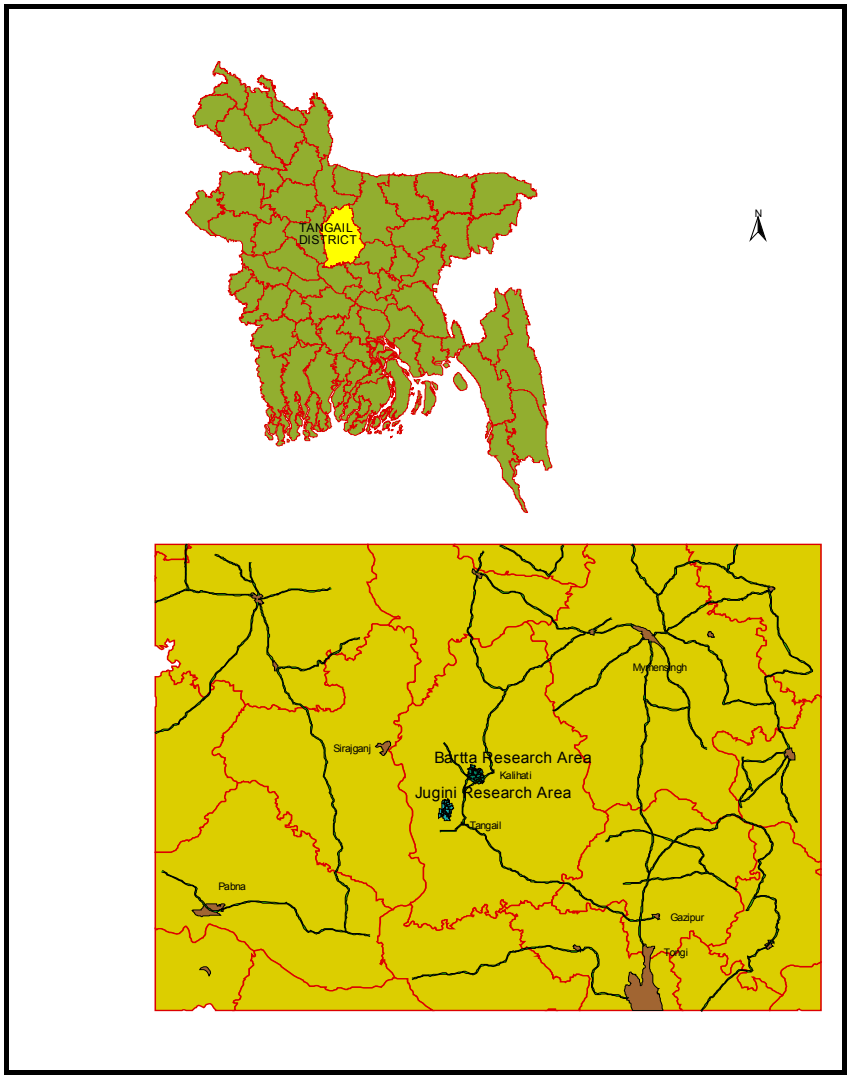


Figure 2: Location of Research Sites

As a means of gaining a rapid insight into the livelihood systems of villagers, and the resource management patterns and practices (land and water) operating in the areas, a preliminary RRA exercise was developed to be undertaken at all of the villages in the selected areas. The appraisal was piloted in three villages, revised and then undertaken in the 10 villages around Jugini and 18 in the Bartta area. The RRA involved the use of a semi-structured questionnaire. Interviews were carried out with key respondents and members of particular target groups such as sharecroppers, fishermen, landless and farmers with landholdings of various sizes. From this list of villages four were chosen in each area for detailed investigation. A detailed description of the site selection process is given in the project Progress Report (Annex 5) and Final Report (Annex 10).

Literature Reviews

Three reviews of the literature were undertaken to determine what other research existed in the white and grey literature. These were reviews of:

- water resource issues in Bangladesh, including a discussion of the development of approaches to water sector planning over the last 10 years, an assessment of hydrological problems and processes at the national level and an analysis of local and regional variations in these problems and processes (Annex 2);

- indigenous technical knowledge (ITK) relating specifically to water management, and to indigenous knowledge generally in Bangladesh (Annex 3); and

- rural social and economic trends and an analysis of past and existing approaches to participatory development in Bangladesh (Annex 4).

The literature reviews were undertaken by visiting all major libraries in Bangladesh and through searches of online and CDROM-based bibliographic resources in the UK including CABI, BIDS, TROPAG/RURAL, ISI, and ASFA databases as well as the University of Leeds library system. Relevant material was summarised and entered in the Idealist textual database.

These three literature reviews represent completion of Activity 1.1 in the log-frame and goes well beyond this for the reasons stated below. Included in each of the literatures reviews, although not specified in the project's log-frame, is a digital annotated bibliography of the literature compiled during the review process. This has been included because it will assist other researchers and practitioners in the field of water resources in Bangladesh.

Baseline Surveys

A series of baseline surveys were then undertaken on the eight study villages against which subsequent changes can be measured. Initially, a household census collected information on 1807 households including: each household's members, (gender, age, education level), the livelihood activities undertaken by household members and land ownership. This census enabled the team to establish the key livelihood groups in the area. It was decided that livelihood groups were more appropriate than stakeholders which invariably are based on landholding classes, as these livelihood activities form the basis of peoples' livelihood systems rather than simply the amount of land they own. Eleven livelihood groups were identified: agricultural labourers, small farmers, medium farmers, large farmers, water sellers,

artisans, entrepreneurs/business people, professional fishermen, other water-based activities (primarily domestic water managers), fish culture practitioners and non-agricultural labourers.

A RRA wealth and mobility ranking exercise was completed for the households in each of the eight villages to gain a rapid insight into locally perceived criteria of wealth and of who is upwardly or downwardly mobile in terms of "wealth".

It was apparent early on that certain livelihood groups were more important in relation to water resource utilisation and management than others. A key occupation survey used to gather information on these groups (fishermen, water sellers, fish culturalists) including who was involved or had been involved in the past and details of the form of involvement in the activity.

A General Livelihood Survey was undertaken and provided detailed information on the main livelihood activities of the 1807 households. A questionnaire formed the basis of this survey. The questionnaire included information on the various aspects of each household's livelihood system. For example, the questionnaire explored the amount, and social and economic arrangements, of the land they farmed, the household's involvement in fishing and with livestock, and their use of common property resources.

All of these data sets are stored in Microsoft Access databases and are coded with the HH code. This enabled these data to be linked to the spatial data on the various fields within the village.

Mapping

The most recent government cadastral *mouza* (village) maps were obtained and digitised. These maps show the exact location (within 20m) of all plots of land in each village. Each plot has a unique plot number. In total there are 8,049 plots. Once this was completed, each plot was visited and the land use recorded (Figure 3).

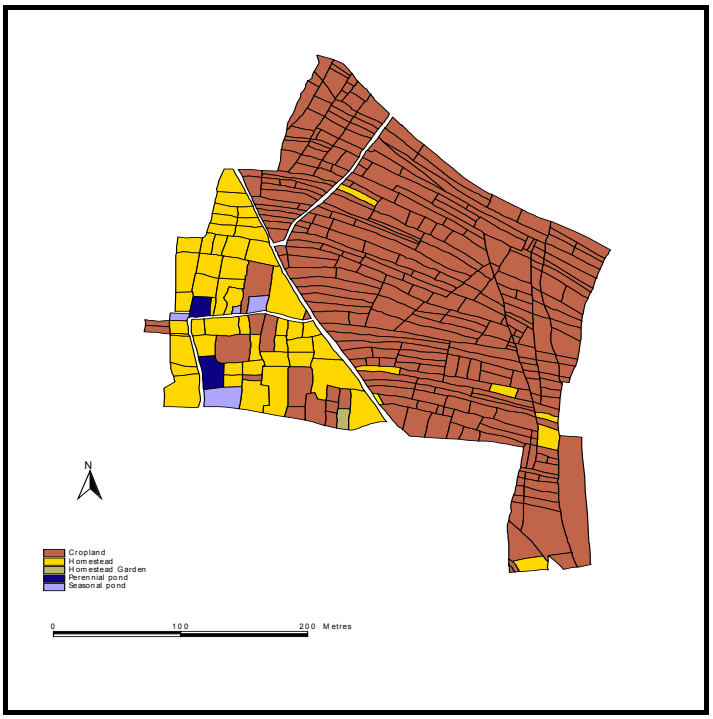


Figure 3: Land Use, Dhitpur Village, Jugini Area

Originally it was also hoped to determine the elevation of the land to ascertain the extent and level of flooding in each area but without undertaking detailed surveying, which was deemed inappropriate use of valuable time, this was not possible. It was decided that a local classification system of the levels of "usual" depth of inundation would act as a measure of elevation. The level of inundation was recorded through discussion with the landowner or the sharecropper who works it.

In order to examine the management of water resources for agriculture, the cropping patterns for the last two and a half years for each of these plots was recorded (Figure 4). The location of STWs and their command areas, in order to determine the level of involvement and form of water markets operating in the two areas was also recorded.

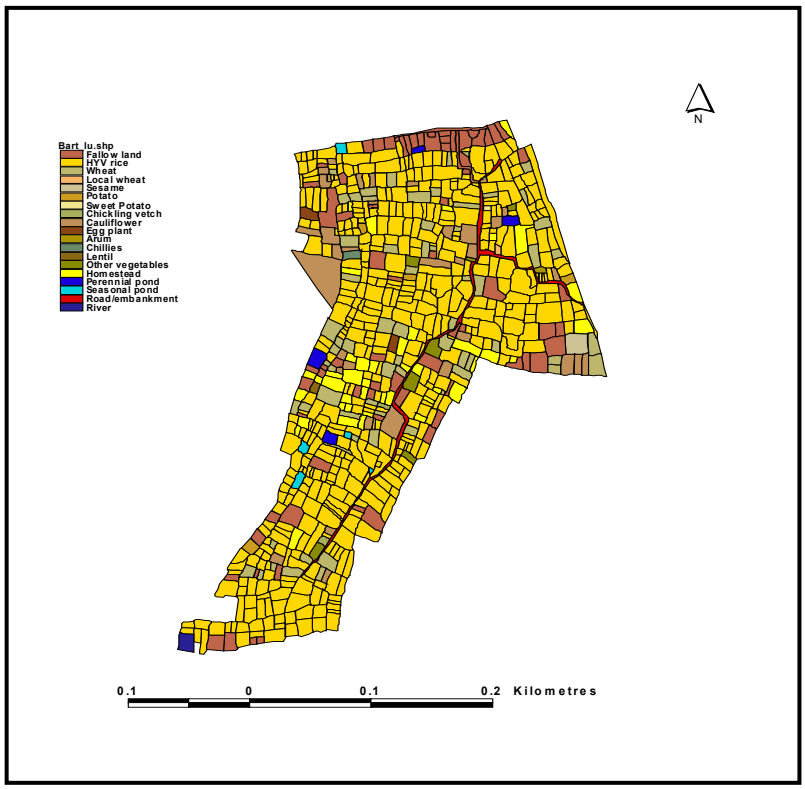


Figure 4: Cropping Pattern, Bartta Village, Bartta Area

Thematic Topics

Domestic Water Supply Survey and Testing

Following the completion of the baseline surveys the team began a series of thematic studies. The first such study focused on domestic water use and sanitation. Domestic water use is a key activity in terms of water resource management in rural areas. The study comprised two key elements, a social survey based around a semi-structured questionnaire and focus group meetings, and a detailed microbiological survey of the main water resource types in the area. The team also sampled and analysed non-biological water quality parameters for the major water resources in the Jugini area during the rainy season and the Bartta area during the dry season.

The microbiological analysis from both studies showed that the drinking water, supplied universally through hand pumps, was of a high quality. There was evidence of low-level post-extraction contamination where water was kept in storage jars. However, many of the

water bodies used for bathing were heavily contaminated and some in the Jugini area exceeded EU Directives for bathing water 30 times, representing a potential health risk. There is a need to look beyond the importance placed on ensuring clean potable water supplies and sanitation that has dominated the last decades of the century and to focus more on education and changes in cultural behaviour. The findings of the Domestic Water Supply Survey and Testing are published as part of a working paper series (Annex 6).

1998 Flood Assessment Study

The floods in the 1998 monsoon season proved to be the worst in living memory. This event provided a unique opportunity to observe the various coping strategies adopted by the various livelihood groups in response to the floods, to assess the success of these and to attempt to determine the overall consequence of such events on the peoples' livelihood systems. Initially, a flood assessment survey was undertaken using a 10 percent stratified sample of the households in the two study areas (95 and 96 households respectively). The assessment was also undertaken with 130 new household that arrived in the Jugini area after their homes and land were lost to riverbank erosion[2]. This information was supported by qualitative information in the form of flood histories from several respondents. The team also recorded the extent of flooding over the monsoon season on a fortnightly basis (Figure 5). Six months after the floodwaters receded, a follow-up survey was undertaken with the same households. This study involved the use of a semi-structured questionnaire.

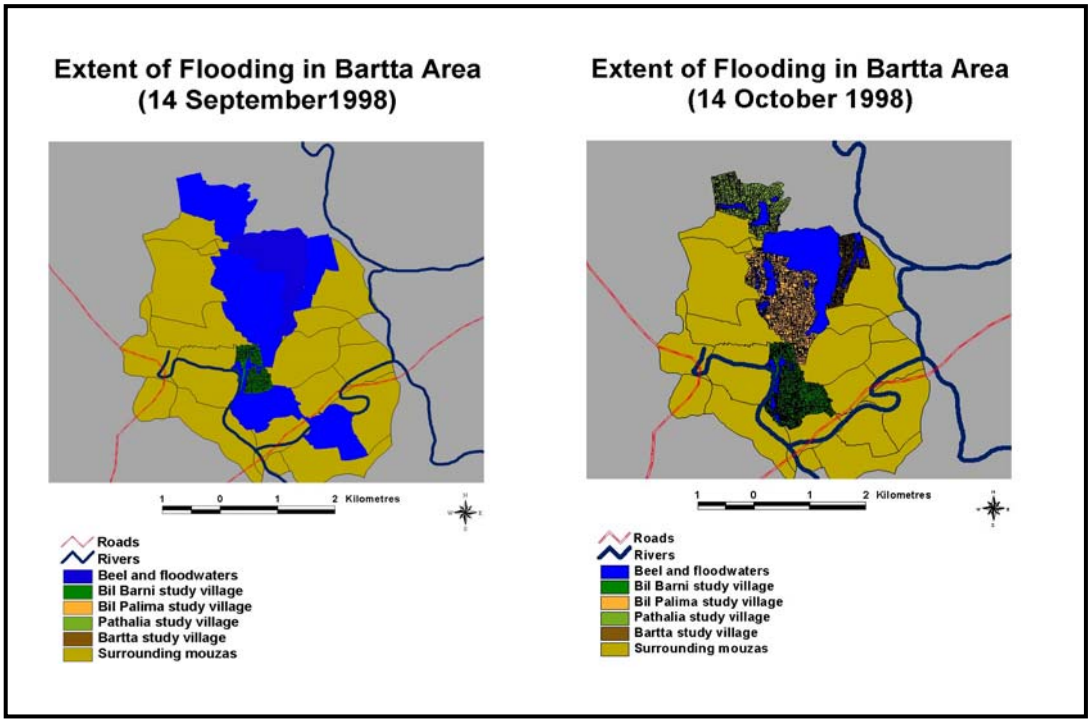


Figure 5: Flood Maps, Bartta Area

Knowledge Study

Another thematic study investigated the types of information uptake pathways for households, how effective these are and how they differ for different groups of the population. The approach adopted was a series of FGDs with livelihood groups and, through the use of a checklist of questions to guide the FGD, determination of where information relating to

[2] A paper has been written for Land Degradation and Development on the plight of the people who lost their land to riverbank erosion (Annex 9).

particular activities is obtained and the quality of this information in terms of its relevance, applicability and accessibility. The questionnaire aimed at establishing what types of information the groups needed.

Workshops and Symposium

The participatory process began by establishing, through focus group meetings with each of the livelihood groups, the water resource utilisation and management problems faced by different sections of the community. These FGDs went on to outline their proposed solutions. The findings of this problem assessment exercise are published as part of a working paper series (Annex 7) and have also been reviewed and summarised in the editorials of several national newspapers in Bangladesh. The FGDs were followed by a series of local workshops with the various livelihood groups involved in the original FGDs and other stakeholders such as local NGOs and government staff in the two research areas to make them aware of the priorities and problems faced by the various water resource users in the area and to try and identify entry points for the various agencies operating in the area. Two summary workshops, attended by representatives from all livelihood groups and the stakeholders were then held at which the research findings were presented and further options as how best to mitigate for these elicited.

Finally, a regional workshop was held at which livelihood representatives and other stakeholders from the two areas were brought together and the possibilities for a micro-action plan for each area discussed. This participatory process is shown in Figure 6.

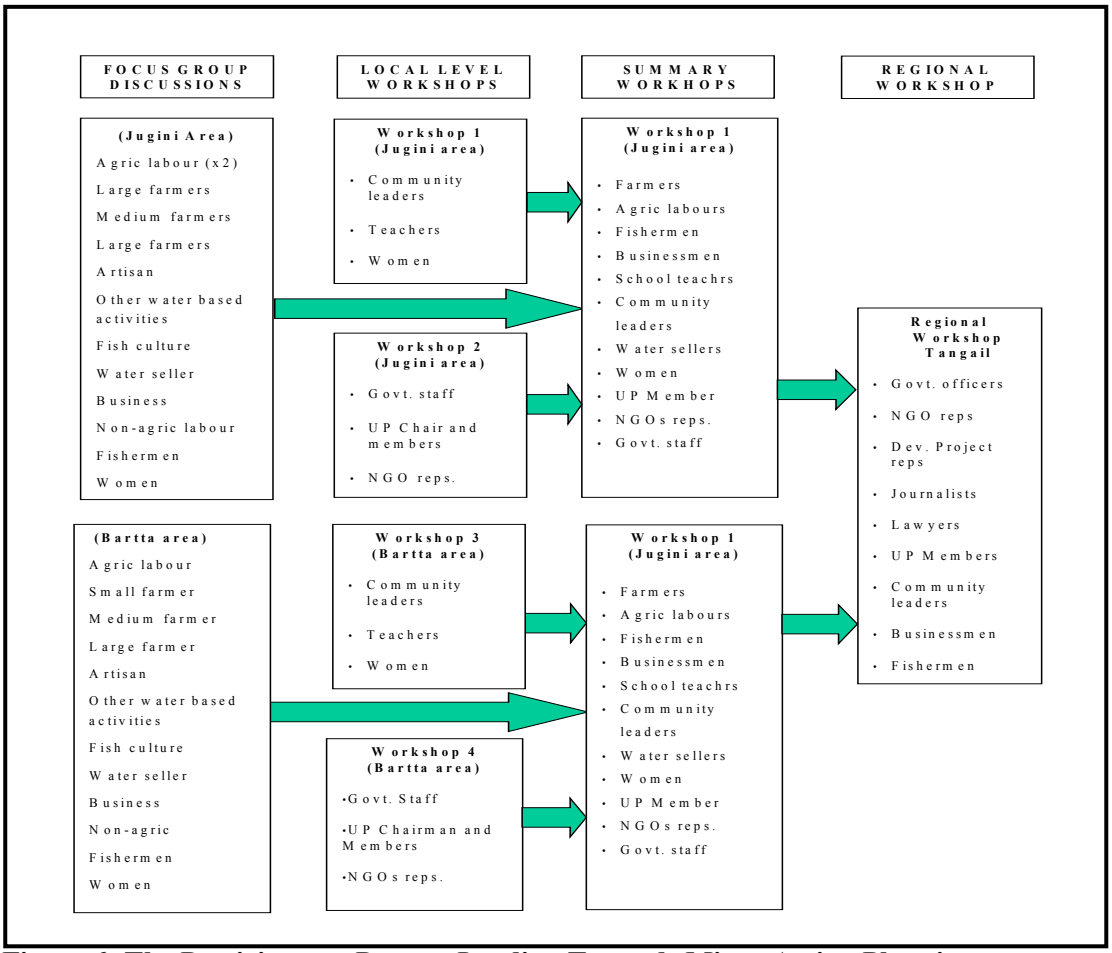


Figure 6: The Participatory Process Leading Towards Micro-Action Planning

A National Symposium was held jointly by the University of Leeds with the University of Newcastle on People's Livelihoods at the Land-Water Interface - Emerging Perspectives on Interactions between People and the Floodplain Environment, at which some of the issues identified through the research projects were highlighted. Papers were also presented by a number of other research and bilateral projects involved in livelihood strategies at the land-water interface. The symposium proceedings have been published (Annex 8).

……5. Outputs

Output 1: Analysis of local water management practices developed and integrated into existing water-based GIS and databases

The identification of livelihood activities and their subsequent investigation has enabled the research to build up a detailed picture of the water resources-based activities in the two areas. These include: agricultural practices, particularly groundwater irrigation, fishing, aquaculture and domestic water supply. From the FGDs it became obvious that these are interlinked not only in terms of use but also in terms of when this becomes limiting for these various elements of the system. Thus the strategies for use of water resources are largely focussed on dealing with limitations of supply (either in terms of quantity or quality), that is the problems that arise in managing its provision and use.

The water resource management system on the floodplain, at its simplest, can be analysed as one whereby choices are made or forced upon stakeholders relating to obtaining an adequate supply of water throughout the year, obtaining water-based products, such as crops and fish, and ensuring access to water for other livelihood activities (such as domestic supply and agricultural processing). The strategies involved in water management are largely concerned with the development of solutions to problems that arise in the course of undertaking water-related livelihood activities

The databases that have been developed provide detailed information of the elements of water-based management practices. In so far as some of these are spatial, for example the location and control areas of shallow tubewells (STWs), this information has been digitised and is stored in ARC/INFO file format.

The key water resource related practice in relation to agricultural production is the utilisation of irrigation derived from groundwater supplies (very few plots of land were found to be irrigated from surface water bodies). The research found that a smaller percentage of households from all wealth groups were involved in groundwater-derived irrigation in the area located within the flood control project (Jugini area) than those outside (Figure 7).

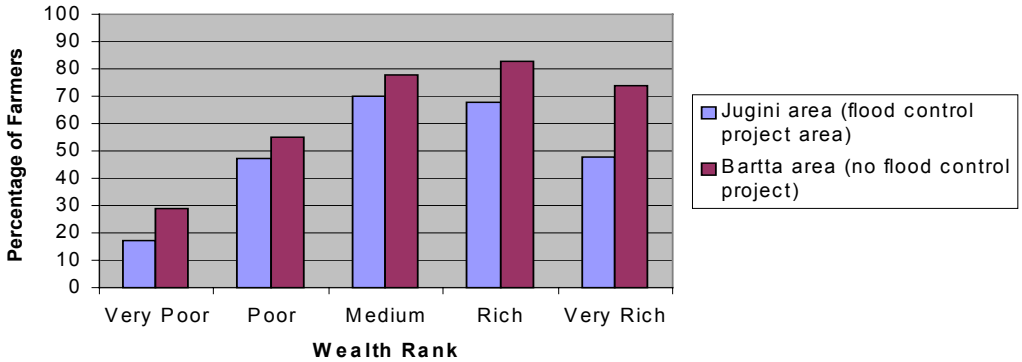


Figure 7: Percentage of households who irrigate their crops (primarily rice) by wealth rank by village

Further disaggregation of these results show that the richer the household the more likely it is to be involved in groundwater irrigation, and that the richer the person the more likely they would provide their own irrigation water and irrigation water to others.

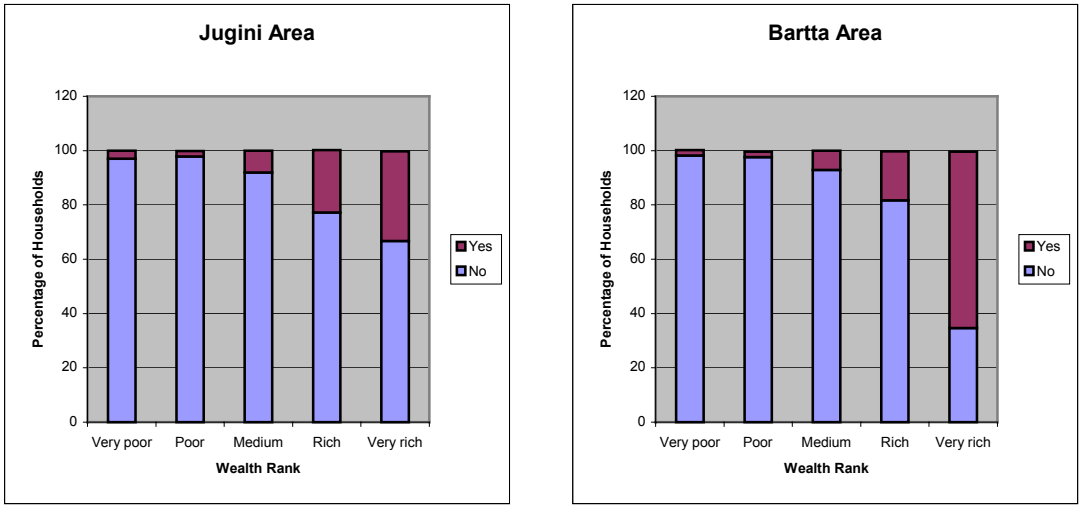


Figure 8: Percentage of households who own irrigation equipment by wealth rank in each area

Of those households who do have STWs, roughly 60 percent said the primary reason they chose to invest in irrigation as a means of supplementing the household's income whilst the remainder said they wished not to rely on others to irrigate their land. Amongst the farmers who do not own the source of their irrigation water a third expressed a desire to do so.

The irrigation water is used primarily for the cultivation of dry season rice. Bangladesh has seen a gradual decline in the dominance of the summer rice crop (*aman* rice) and an ever increasing importance of the winter season, groundwater irrigated rice (*boro* rice). The last published figures (1995) put total area under *aman* rice in Tangail district as 304,780 acres and under *boro* as 219,040 acres (BBS, 1995). Table 2 gives the area of land under *boro* and *aman* production of the years 1998 and 1999). The dominance of *aman* rice shown in the 1995 statistics has, at least in the study areas, been reversed in the last five years.

Table 2: Area planted with *boro* and *aman* rice over the period 1998-99 (m^2)

	***Aman* 1998**		***Aman* 1999**		***Boro* 1998/99**		***Boro* 1999/00**	
	HYV	**Local**	**HYV**	**Local**	**HYV**	**Local**	**HYV**	**Local**
Jugini Area								
Kathua Jugini	3,850	209,633	20,093	172,869	179,642	1,306	186,581	1,170
Dhitpur	17,359	46,065	21,862	22,719	73,231	0	75,570	0
Sapua	74,159	20,720	2,762	89,678	180,788	0	173,309	0
Krishnapur 1	44,861	16,314	9,701	91,597	215,259	0	211,433	0
Krishnapur 2	27,483	112,848	85,249	72,917	204,222	2,545	196,962	4,306
Bartta Area								
Pathalia	0	158,740	0	244,413	361,702	0	550,077	0
Bartta	9,428	7,958	0	200,104	297,310	0	290,656	7,450
Bil Palima	1,358	513,528	0	593,333	801,672	0	993,853	0
Bil Barni	0	0	0	393,473	204,222	0	196,962	0

A key reason for this rise in importance is displayed by the two years of *boro* production: stability. The two years show little variation in the amount of rice grown. However the pattern is complex. The same cannot be said for *aman* production which was greatly affected nationally by the devastating flood of 1998. Here, the benefits of the CPP project can be seen. The CPP area remained largely unaffected by the flood, whereas in the Bartta area, which was severely affected, only the area planted in Bil Palima village remaining similar over the two years. In the village of Pathalia, planting up was reduced as the flood waters rose and in Bartta and Bil Barni, both adjacent to rivers, virtually no planting out of rice ever took place in 1998.

A similarly complex pattern appears in relation to whether farmers use HYV or local varieties of rice. As could be expected, HYV *aman* is used more extensively in the area inside the flood control project (Jugini area). However, the pattern here between the two years is unclear with some increasing their production in the year after the flood whilst in others it decreased. *Aman* production in the Bartta area is dominated by local varieties which are taller and better suited to inundation. Of those villages in the Bartta area that did plant up with HYV *aman* in 1998, none did so in the following year.

A more detailed account of the water management strategies adopted for agricultural production is provided in the final report (Annex 10).

Management of domestic water resources is firmly the domain of women. Survey results showed that all of the households in the two areas derive their water from handpumps (HPs). The issue that is of greatest potential threat to achieving a sustainable livelihood for households relates the primary source for bathing ponds (Figure 9).

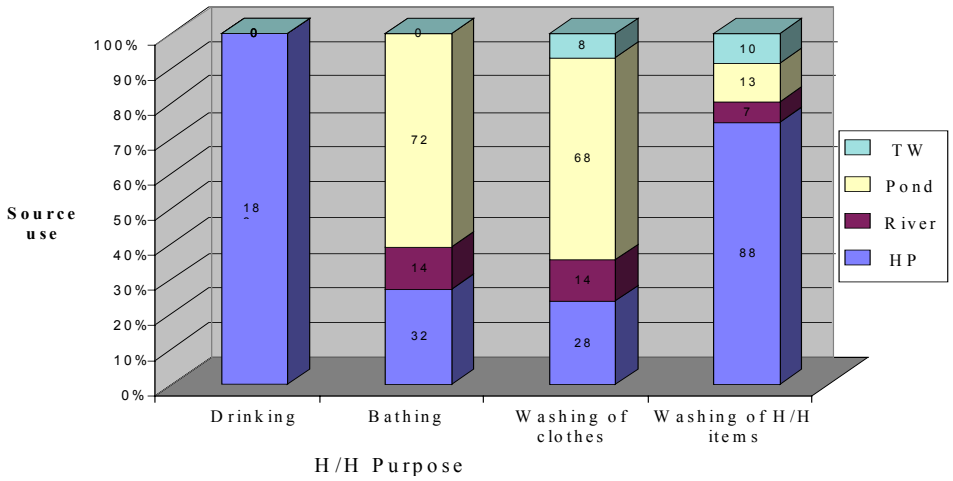


Figure 9: Primary water sources for the main domestic water activities (Jugini area)

Many of these ponds display extremely high levels of faecal contamination, some over thirty time the World Health Organisation's (WHO) standards for bathing water. Direct observation of people rinsing their mouths in such water whilst bathing suggests these sources may be a potential risk to household members. Whilst data were not collected on the number of working days lost to diarrhoea or dysentery, both are endemic to Bangladesh, and represent a cost to households in terms of the number of working days lost and medicinal costs as well as human suffering.

Of the off-farm activities that households are involved in the one of primary importance is fishing. The two areas display different patterns of use. Figure 10 shows the percentage of

households in each wealth group where a family member fishes regularly (at least once a month for the two areas). The pattern is reversed in the two areas with the number increasing with wealth in Jugini and decreasing in Bartta. It is thought this is due to the leasing of Jugini *beel*. As is discussed in the next output relating to problems in water resources management, access to Jugini beel has been restricted since it was leased out. Many people now complain that the surrounding water bodies are overfished. As a result, it appears people feel it is preferable to undertake cash earning activities and purchase fish at the market rather than spend time fishing when they may catch little. Here, it appears fishing is becoming the preserve of the rich. However, in Bartta the "expected" pattern of poorer households undertaking the majority of fishing as a way to supplement their livelihood (principally diet although some sell to gain cash income) does dominate. Whilst the number of households that fish may appear high, the mean percentage that fish across the groups is 42 percent in Jugini and 55 percent in Bartta, calling into question the age old belief that "every man is a fisherman in Bangladesh". A more detailed analysis of the off-farm water management strategies in relation to maintenance of household livelihood is given in the final report (Annex 10).

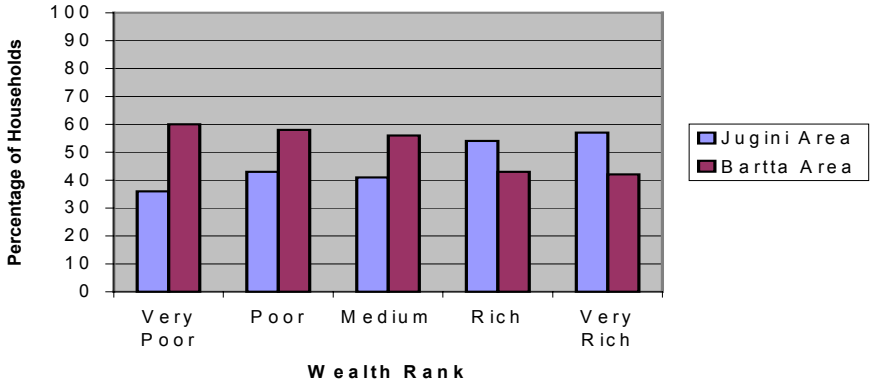


Figure 10: Percentage of households who fish regularly by wealth rank in each area

The GIS data are provided as ARC/INFO coverages which, with a reasonable understanding of GIS and ARCVIEW can be employed. It was never the intention, or ever stated, that the project would provide this information in a "user friendly" format. This is invariably achieved through the development of a graphical user interface (GUI). It is generally acknowledged in GIS that such systems take at least the same amount of time to develop as to construct and input the data. With the provision of sufficient funds such a task could be undertaken.

A similar case is made for the research databases. It was not the intention to develop a format which would necessitate the development of a series of macros to guide the user through the data. As a result an understanding of the dataset requires some knowledge of the aims of the research, the data collection methods and form and of Microsoft Access.

Copies of the Microsoft Access database and the ARC/INFO coverages have been sent to the EGIS project, which is responsible for the maintenance of the national water resources database in Bangladesh. The researchers will also pass copies of the databases to DFID's Fisheries Management Service in Dhaka. Discussions are also underway with the Royal Netherlands Embassy concerning an extension of the work as part of the continued monitoring of CPP, which ended in July 2000.

Output 2: Limitations (including conflicts) and potential of existing system identified and related to local socio-economic and environmental conditions

The problem and needs assessment FGDs held with the various stakeholder groups enabled the research to prioritise the problems faced by people undertaking water resource-based activities.

The results of the FGDs do show variations between villages, between the two areas, and between livelihood groups, however, general patterns do emerge which cross all of these criteria. Summaries of the findings of all the FGDs by area are given in Tables 3 and 4. The results for the women are given in Table 5. Details of the concerns that lead to these conclusions and prioritisation can be found in Working Paper 1 (Annex 7) and the final report (Annex 10).

The key problems and conflicts in the communities in the Bartta area (non-project) as reported by the livelihood groups are:

- Lack of monsoon floodwater
- Siltation of rivers and canals
- Drawdown of the watertable
- Stagnation of the *beel*

In the Jugini area, the key problems were described to be:

- Lack of monsoon floodwater
- Poor operation of the CPP infrastructure
- Poor land drainage
- Reduced access to the *beel*
- Overfishing
- Irregular monsoon rains

Poor operation of flood control, irrigation and drainage infrastructure and concerns regarding impeded drainage were commonly cited priority problems in FAP project areas, as reported in the SRP evaluation (Soussan and Datta, 1999).

In the Jugini area the *beel*, a localised depression similar to a shallow lake, and the physical feature which forms the focal point for each of the research areas, is leased out. This has meant that activities such as bathing (particularly for women), agricultural practices such as the retting of jute and fishing by the local population was prohibited. Detailed descriptions of the findings of the problem assessment exercise are given in Annexes 7, 10 and 11.

The FGD information was further enhanced through the construction of system diagrams and rich pictures by key respondents. The groups outlined the various water resources-based livelihoods systems in operation in their area, the various links between them the system and highlighted limitations and points of conflict. Through the FGDs potential ways to mitigate for the various problems and conflicts found in the area were established in participation with the community.

For example, the rich picture developed by fishermen is shown in Figure 11, and the related bottlenecks identified in the process is shown below.

Table 3: Summary of Priority Problems and Rankings Identified by Livelihood Groups in the Jugini Area (Rank 1 indicates highest priority)

Kathua Jugini and Krishnapur Villages	**Lack of monsoon floodwater**	**Excess of iron in g'water**	**Drawdown of watertable**	**Reduced access to *beels***	**Poor drainage/ stagnation of *beel***	**Siltation of *nadi*s & canals**	**Poor land drainage**	**Irregular monsoon rains**	**Overfishing**	**Restricted movement of boats**	**Lack of electricity**	**Development of CPP infrastruc.**	**Poor operation of CPP infrastruc.**
Agric labourer	3	4		2									1
Small farmer	1	4	5	3	2	4							
Medium farmer	1	4	3	2									1
Large farmer	1	4	5				2						
Artisan	1	3		2							3		
Other water based activities	1			4					2	3			
Fish culture	2	4		1			3						
Water seller	1	5	2	3			4						
Business	2	4	3	1									
Non-agric	3		4	1			2						
Fishermen	1		3	2	4								
Modal Rank	***1***	***4***	***3***	***2***	***2-4***	***4***	***2***		***2***	***3***	***3***		***1***
Sapua and Dhitpur Villages													
Agric labourer	1									2			
Small farmer	1												
Medium farmer	1												
Large farmer						No FG held							
Artisan	1		2	3									
Other water based activities	1												
Fish culture	1	4	3										
Water seller	3	4	1					2					2
Business	2	4		3			1						
Non-agric	1	3		2									4
Fishermen	1												
Modal Rank	***1***	***4***	***1-3***	***3***			***1***	***2***		***2***			***2-4***

Table 4: Summary of Priority Problems and their Rankings Identified by Livelihood Groups in the Bartta Area (Rank 1 indicates highest priority)

Pathalia and Bartta Villages	**Lack of monsoon floodwater**	**Excess of iron in groundwater**	**Drawdown of watertable**	**Reduced access to *beels***	**Poor *beel* drainage/ stagnation**	**Siltation of rivers and canals**	**Poor land drainage**	**Irregular monsoon rains**	**Excess of weeds**	**Reduced area of Bartta *beel***
Agric labourer	1	4	2	5				3		
Small farmer	3		4			1		2		
Medium farmer	1		2					3		
Large farmer	2	3	1							
Artisan	2	3	1				4			
Other water based activities	No FG held									
Fish culture	1	5	4		3			2		
Water seller	1	4	5		2			3		
Business	1	3	2							
Non-agric	1	3	4							
Fishermen	1		2					3		
Modal Rank	***1***	***3***	***2***	***5***	***2-3***	***1***	***4***	***3***		
Bil Palima and Bil Barni Villages										
Agric labourer	1	3	2				4			
Small farmer	1	4	3		2					
Medium farmer	2	4	3			1				
Large farmer	2									
Artisan	2									
Other water based activities	No FG held									
Fish culture	1	3	4		2					
Water seller	1	3	2						4	
Business	1	4	2			3				
Non-agric	1	4	3			2				
Fishermen	1									
Modal Rank	***1***	***4***	***2-3***		***2***	***1-3***	***4***		***4***	

Table 5: Summary of Priority Problems and their Modal Rank Identified by Women, Jugini and Bartta Areas

	Lack of monsoon floodwater	Sand in tubewell	Excess of iron in g'water	Drawdown of watertable	Reduced access to *beels*	Pollution of water bodies	Siltation of *nadi*s and canals	Poor drainage
JUGINI AREA								
Kathua Jugini	3		2	1	4			
Dhitpur		4	1	2		3		
Sapua		2	1	4		4		
Krishnapur		4	3	1	2			
Modal Rank	*3*	*4*	*1*	*1*	*2-4*	*3-4*		
BARTTA AREA								
Bartta		3	1	2		4		
Bil Barni	2	3	5	1		4		
Bil Palima		3	2	1		4		
Pathalia	4		1	2		4		
Modal Rank	*2-4*	*3*	*1*	*1-2*		*4*		

The key bottlenecks identified by the fishermen to their livelihood activity are as follows.

Fries and fingerlings: Fishermen in the Jugini area have reported that there are insufficient places for fingerlings to enter the *beels*, *khals* and floodplain. This is because of: siltation of riverbeds, and construction of roads, embankments, sluice gates, and regulators in various locations along the migration route of the fingerlings. Consequently, there is a lack of wild fingerlings in the area and fewer mature fish available to harvest.

Pesticides, fertilisers and fish disease: The use of pesticides and chemical fertilisers on crop fields and water bodies damages fish resources in the area. The fishermen have observed disease and rapid deaths of fish, many of which exhibit ulcers.

Non-fishermen preventing fishing on the flood lands: There is a new trend for non-fishermen to prevent professional fishermen from catching fish in the rivers, stocking carp fingerlings in the flood lands and denying fishermen access to nearby common property resources.

Dhaleshari River Closed: The northern mouth of the river Dhaleshari was closed in 1995 during the construction of the Jamuna Bridge. It was one of the major fishing grounds for the professional fishermen but due to the closer of the northern intake, there are reduced water levels in the river and its tributaries, which has hampered fish production.

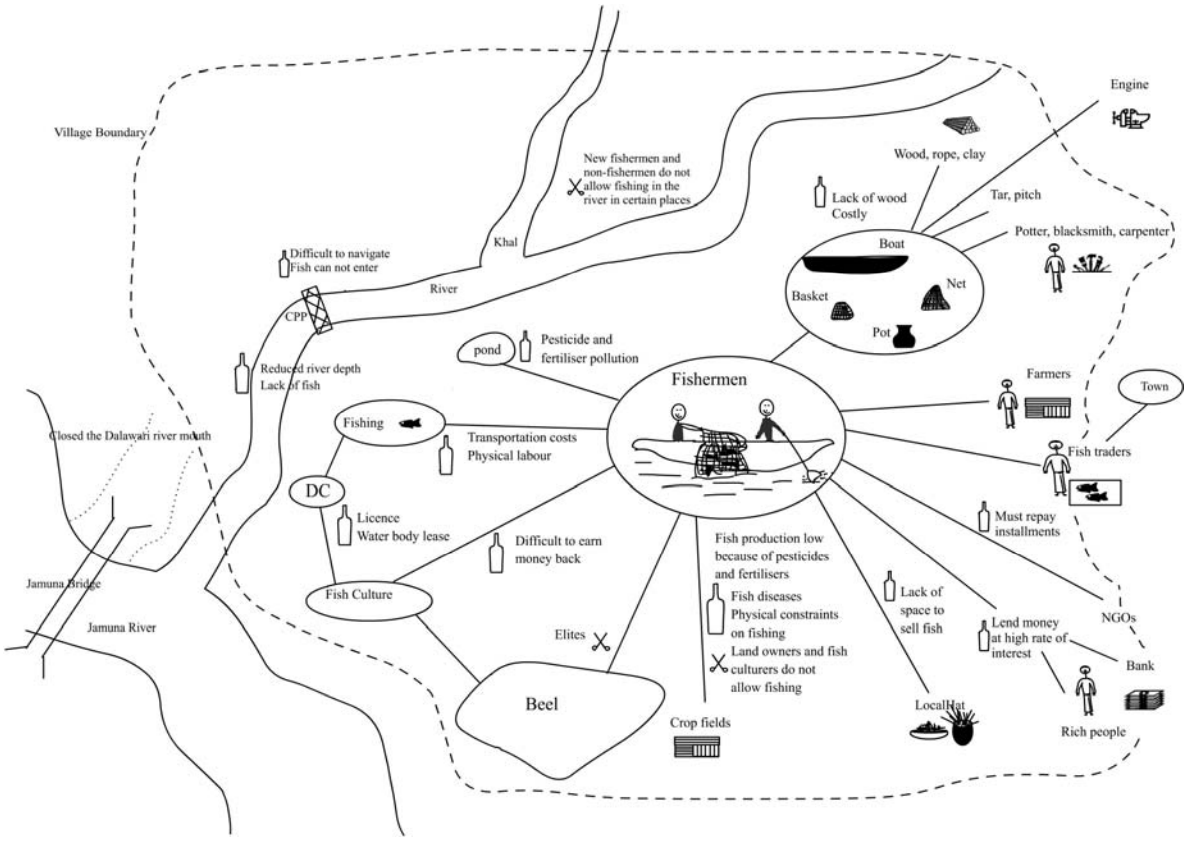


Figure 11: Fishing Rich Picture (including bottlenecks and conflicts)

Bank credit: Fishermen complained that they can not obtain bank credit as they are unable to fulfil the rules of application. This is principally because many fishermen do not have sufficient land on which to secure a mortgage. As a result, they must obtain credit or *dadon*), with high interest rates from local *mohajon* (fish traders) to purchase fishing equipment and other items required for their livelihood activity. There are other conditions attached, most importantly that the fisherman is forced to sell all harvested fish through the *mahajon*, which reduces the income of the fisherman.

Reclaiming debts: On occasions fishermen sell their catch on credit to consumers of traders but they often find it difficult to reclaim the money.

Hat Bazaar (market): It is difficult and costly to transport fish to the market and once there, some fishermen say they do not have enough space at the Jugini Hat to sell fish.

Jalmahal Lease: Every year the District Commissioner and Thana Nirbahi Officer (TNO) auction the lease of the jalmohal, the government owned *beel*. According to government rules fishermen should be given priority this process but in reality the powerful elite are most likely to receive the lease.

Navigation: The constructions erected in the area have not only affected the flooding regime but also access and the navigation system.

Timber: Fishermen reported that the area lacks timber for fishing boat construction and repair. If they were able to make larger, stronger boats they would be able to travel greater distances to find fish.

Major disagreements and conflicts reported revolved around two groups of fishermen in the Jugini area, one of which contain the wealthier fishermen. This group is attempting to obtain benefits from the powerful elite in the area but are not consulting with the other fishermen in the area. The marginal group of fishermen have become unhappy and voiced their discontentment to the other fishing group. It is their belief that the richer group are obtaining money intended for the entire fishing community but are not distributing the wealth among the members of the other group.

The flood assessment exercise undertaken during the 1998 flood and six months later provided detailed information on when people's livelihood systems are severely stressed. The problems highlighted by the two areas varied markedly. The Bartta area, where households in some villages had already planted their *aman* paddy was extensively flooded. Consequently, damage or destruction of crops was a key problem highlighted in this area. Lack of food supplies was also a key problem, as was lack of paid work. A further problem was damage or destruction of trees, seen as an important source of immediate cash income.

In the Jugini area, as a result of the CPP project, planting times are several days later than in the surrounding area. This and the crucial fact the CPP area itself did not flood meant that crop loss was less of an issue to Jugini households. Here, lack of paid labour due to flooding elsewhere in the area, and lack of food due to shortages of money as well as the threat of flooding were seen as much more important. Damage to homestead trees and loss of fish from fish ponds were also seen as key problems.

A more detailed analysis of the findings was gained by stratifying the results according to the wealth status of the respondents. For the poorest households from the Bartta area lack of food supplies was clearly the priority concern (Figure 12). For the second wealth group concerns over food supplies were overtaken by concerns regarding crop damage, whilst the priorities for the wealthier groups related to loss or reduction in capital assets (trees, fish).

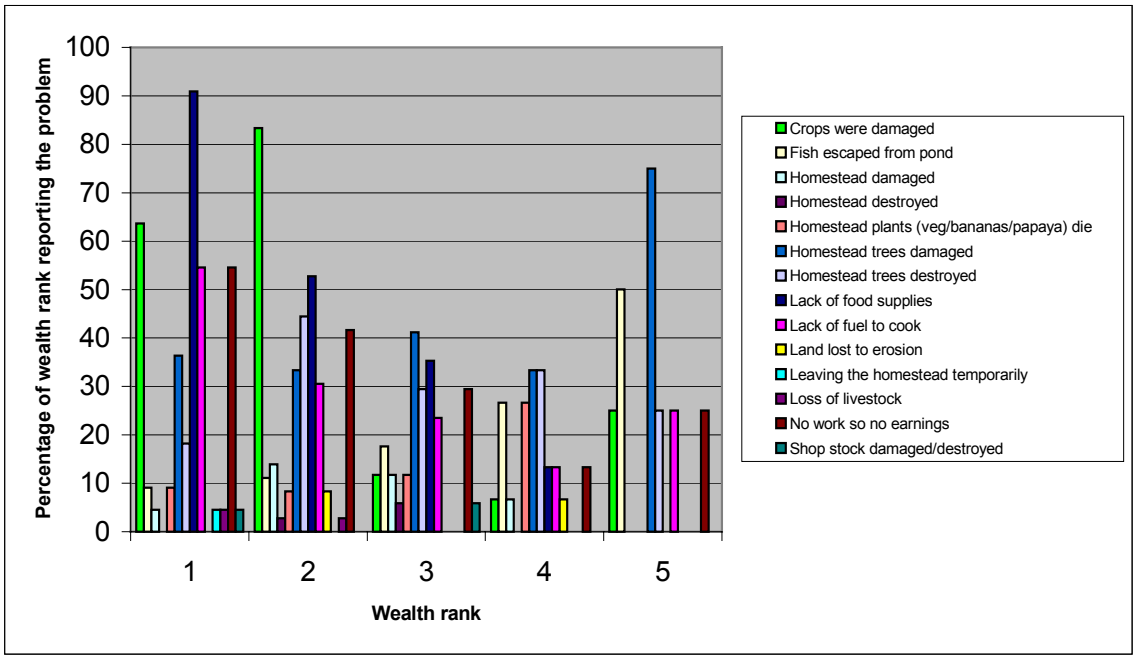


Figure 12: Key problems during the 1998 flood highlighted in the Bartta area

In the Jugini area the pattern was somewhat different (Figure 13). Not surprisingly, as the Jugini area was spared from flooding, fewer people highlighted problems. Of those that did, for the poorer households, lack of food supplies and loss of income earning work, as was the case in Bartta, were the key issues. However, because the majority of aman rice had not been planted, crop damage was only a significant issue for the wealthiest who had the most land planted up. Lack of fuel for cooking was highlighted as a problem by all groups.

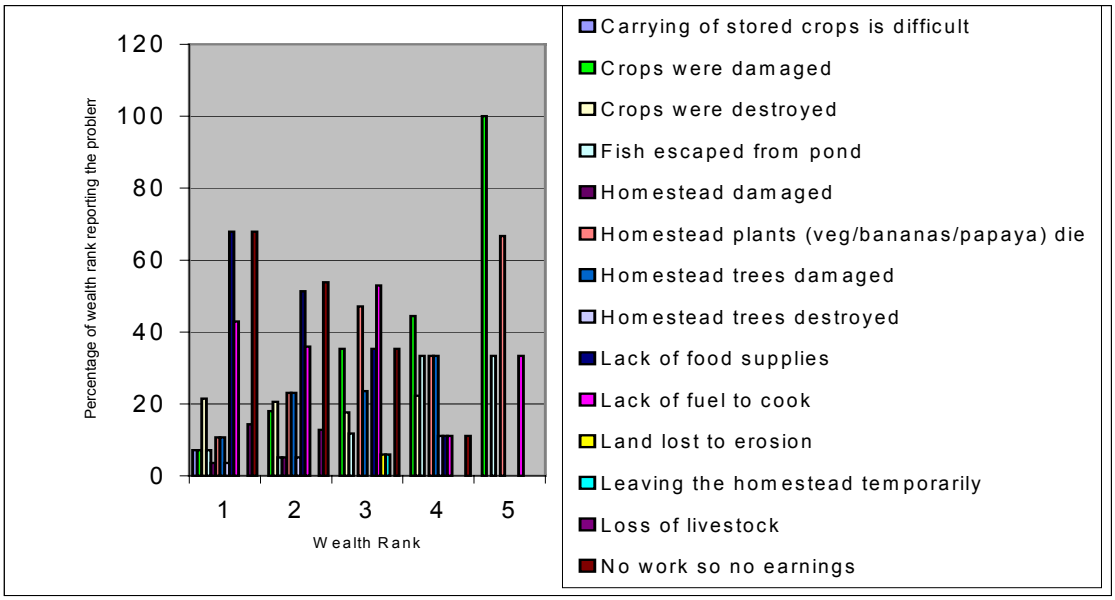


Figure 13: Key problems during the 1998 flood highlighted in the Jugini area

As the flood continued, vulnerable households were placed under increased stress, and eventually had to start utilising their assets. One of those to consumed, literally, was seed stored for future planting. Of those households forced to resort to this coping strategy two-thirds were from the lowest two wealth groups.

A further strategy is obviously to borrow money. A total of 53 percent of households questioned in Bartta and 39 percent in Jugini borrowed money at some point during the flood (Table 6). The largest proportion of this was from relatives.

Table 6: Percentage of sample households borrowing money by source

AREA	Source of loan	Percentage
Bartta	NGOs	10
	Government social welfare society	13
	Government bank	2
	Money lender	3
	Rich person in the village	5
	Relatives	20
Jugini	NGOs	6
	Government social welfare society	4
	Money lender	2
	Rich person in the village	10
	Relatives	14
	Rich person from nearby village	3

Further analysis of the information on the terms of repayment, shows clear evidence of profiteering with the most common form of repayment, in both areas, being an annual interest of over 100 percent! (Figure 14).

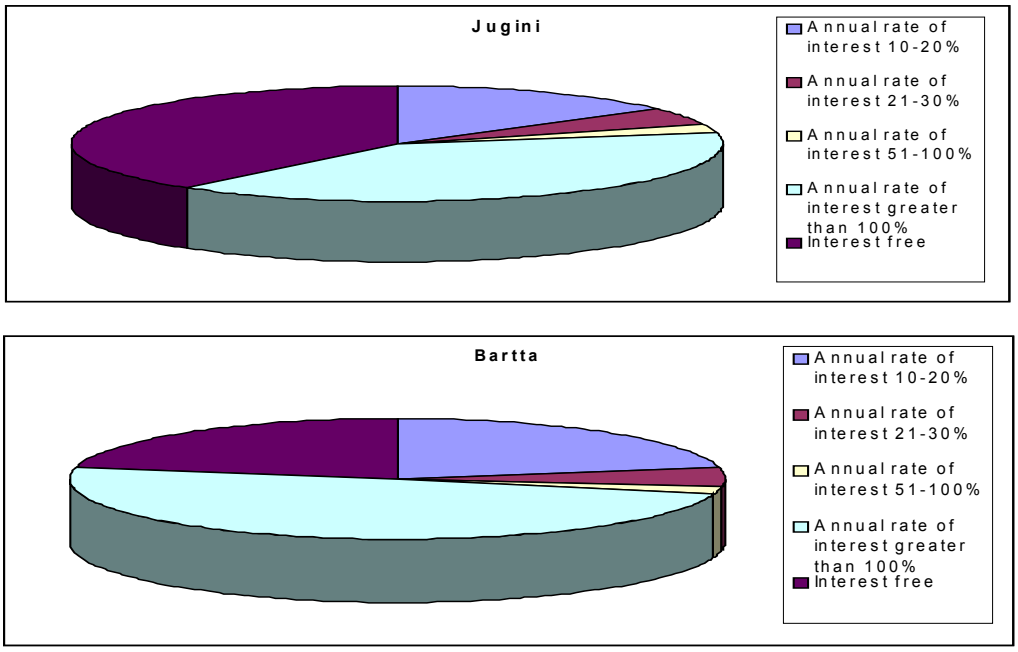


Figure 14: Credit arrangements for loans in the two research areas

The sale of possessions showed a similar pattern with 23 percent in Bartta and 16 percent in Jugini having to do so. Key possessions to be traded were livestock (goats, sheep and cattle), trees and foodstuffs (pulses and oilseed).

In both areas, relatively few households resorted to such drastic action and were the most vulnerable households. However, almost all of these people reported getting prices above the expected market price for that time of year. Market forces were also at work on land prices in Jugini where the price went up 33% in the space of a few weeks.

The strategy of collection of common property resource (CPR) foodstuffs is usually evident in drought scenarios. This appears equally to be the case in relation to flooding although interestingly, a high proportion were involved in the Jugini area than Bartta. The increased involvement manifested itself in several ways through the data. Roughly 50 percent of households in both areas said they were fishing more than they would in a "normal" year.

The majority of households who were fishing more said that there was a greater variety of fish on the floodplain and that the fish were of a greater size. Over 75 percent of households in both areas (nearly 90% in Bartta) said they were eating more fish in their diet this year than usual. As a result of this increased quantity of fish, both areas reported a reduction in the price of fish at market (Table 7).

Table 7: Respondents views on fish prices in comparison to the previous year

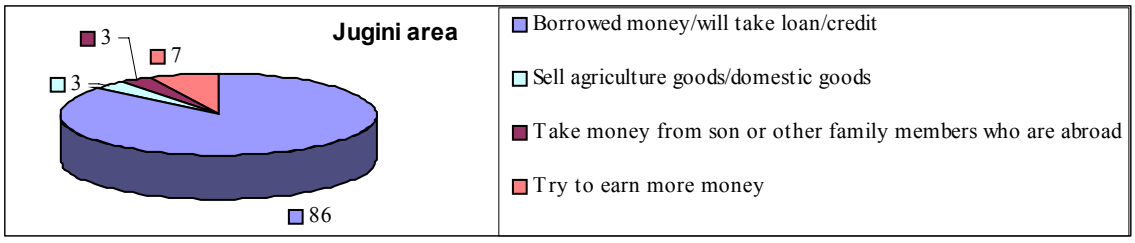
Area	Price of fish compared to last year	Percentage
	Same	2
Bartta	Higher	1
	Lower	96
	Same	2
Jugini	Higher	2
	Lower	96

Seventy-five of the households in the Bartta area had planted up crops prior to the flood compared to 59 in the Jugini area. Of these, the highest proportion of households who had planted up came from the most vulnerable groups.

The majority of people who lost crops said they intended to re-plant with the saying they would not need to hire additional labour to undertake this.

However, nearly three quarters in Bartta (73 percent) and half those in Jugini (48 percent) said that they did not have enough savings to cover the costs of planting again. When questioned about where they would find the additional money, the majority indicated they what try to secure new loans. A high proportion also indicated they would try to find additional income earning work (Figure 15 and 16).

However, the semi-structured questionnaire survey and discussions with people also reported a number of benefits associated with the flood. These included increased soil fertility, and flushing out of closed water systems such as ponds.



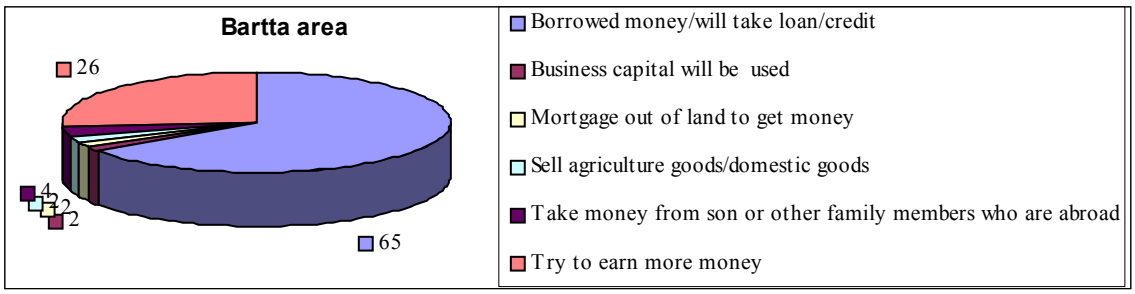


Figure 15: Proposed sources of funds to pay for replanting in the two research areas

When assessing the overall cost or benefit of the flood to their livelihood systems, slightly over half the households in the two areas concluded overall that the flood had hindered their livelihood system (Table 8).

Table 8: Peoples' Assessment of the Overall Effect of the 1998 Flood on their Livelihood

Peoples' Assessment of the Overall Effect of the 1998 Flood on their Livelihood	Percentage (N=174)
Better than before	36
Roughly the same	11
Worse than before	53

However, further analysis by area showed that in the areas where there was no large flood management infrastructural project, and where there was extensive flooding more than half the households asked concluded that overall the flood was a "good thing" in terms of maintaining their livelihood (Table 9).

Table 9: Peoples' Assessment, by Study Area of the Overall Effect of the 1998 Flood on their Livelihood

Area	Peoples' Assessment of the Overall Effect of the 1998 Flood on their Livelihood	Percentage (N=174)
Bartta	Better than before	51
	Roughly the same	1
	Worse than before	48
Jugini	Better than before	20
	Roughly the same	21
	Worse than before	59

The monitoring of events during and post flood has provided a valuable insight into the needs of households during extreme events. This is not to criticise the government and NGO network who handled the situation well under incredible pressure. However, what the findings do suggest is that:

- The speed at which food aid is delivered is crucial, not so much in terms of starvation but rather that it needs to arrive before households are forced to use up savings and put themselves in debt;
- Credit arrangements for the rural poor should be examined, the rates of interest charged by some moneylenders and institutions is crippling. Bizarrely, some said that the credit they had been seeking for small-scale enterprises only came available as a result of the flood.

Output 3: Improved water resource management strategies and options identified with local actors

Following the FGDs a number of local level workshops were held to discuss the findings and to elaborate and develop the options put forward by the livelihood groups. These workshops were held with a number of other stakeholders operating in the area. At these workshops options were discussed and stakeholders provided their advice and information on the practicalities of the options such as if, and if so how, they could be achieved and entry points for achieving the mitigation measures. The approach reflects wider policy developments in Bangladesh that emphasise decentralisation and broader participation, and seeks mechanisms through which this can be achieved. Tables 6-10 summarise the solutions identified at the workshops and the key institutional actors that would need to initiate the activities for the major water-related livelihood activities.

Table 6: Agriculture and water

Existing Urgent and Emerging Problems	Causes of the Problems	Potential Solutions	Possible actions agreed that need to be investigated further	Key institutional actors to be engaged
Lack of sufficient "normal" floodwater	Siltation on the river beds Normal floodwater prevented by the constructed un-planned roads, embankment, regulators and gates Lack of river/khal to carry water flow Less water delivered from upstream Improper operation of the CPP gates	Re-excavation of rivers and *khals* Re-establish water drainage system by constructing sufficient number and sizes of sluice gates and culverts Dig a link canal for re-establishing water flow between the river Jamuna and crop fields Arrange the CPP gate operation and maintenance of the structures properly in appropriate situations	River dredging Under take food for work programme for re-excavation of the *khals* Undertake govt. programme for constructing well-planned embankment and other structures Organise voluntary local labours for re-excavation of small *khals* and link canals Local committee and sub-committee should take initiative in operation of gate	Bangladesh Water Development Board (BWDB), Local Government and Engineering Department (LGED), Union Parishad (UP), Non-government Organisations (NGOs)
Problems in getting adequate ground water for irrigation	Drawdown of the ground water table Much extraction of ground water by using huge number of STWs Lack of normal flood water Insufficient and irregular rainfall Iron in irrigation water.	Install improved irrigation systems using modern irrigation devices Create surface water reservoir and introduce surface water irrigation Introduce deep tubewell (DTW) irrigation instead of STW Make concrete (*pucca*) drain for water distribution instead of earthen drain Afforestion programme.	Assess the ground water resources Accurate assessments of the ground water for irrigation Implement policy for ground water irrigation Introduce modern irrigation system Formulate govt project for making *pucca* drain. Increase public awareness Undertake tree plantation programme	Relevant govt ministries and departments, NGOs,
Water logging at the lower level crop field	Lack of water drainage systems Due to construction of roads and flood control embankments and structures Improper operation of the gates	Re-excavate the water drainage canals and *khals* Institute proper operation of the gate and maintenance of the structures	Programme for re-excavation of the khals Formulate landholders chalk committee and motivate then to undertake initiative for the gate operation and maintenance of the structures	BWDB, LGED UP, CPP sub-committee, NGOs
Declining soil fertility	Lack of silt deposit because of normal flood water lack Lower quality of water used for *boro* cultivation, or ground water quality is lower than surface water	Introduce system to use surface water irrigation and reduce ground water irrigation establish a system to allow flood water in he crop field during rainy season	Re-excavation of *khals* Undertake research for testing ground water quality and to take necessary steps for sustainable development of soil	LGED, BWDB, NGOs
Pollution of open water bodies	Improper and unplanned use of chemical pesticides and fertilisers	Advice from agricultural extension service or block supervisors	Provision of farmers' group-training	Agric. extension department, NGOs
Iron in groundwater	Unknown by the people	Test soil and get advice from experts	Need to undertake soil testing programme before sinking any tub-well	Department of agric. extension, research organisations
Insufficient/Irregular rainfall	Deforestation Environmental degradation	Stop deforestation Environmental awareness raising	Undertake awareness raising programme Tree plantation	Department of Forests, NGOs
Extreme flooding	Siltation on beds of rivers, *khals* and *beels* and reduced water carrying capacities and water holding capacities	Re-excavation of rivers, *khals* and *beels*	Formulate extensive govt. project for re-excavation of rivers Food for work for re-excavation of *khals* Voluntary work for re-excavation of small khals/link canals	BWDB, LGED, UP
Lack of water at the higher land	Water level in the CPP area is lower than the river	Change cropping patterns Adapt?	Awareness raising	Department of agric. xtension, NGOs
Weeds in crop fields	Lack of flood water during rainy season in the crop fields	Re-establish flood water entering system and maintain land under water for few months	Re-excavation programme by the govt. Individual initiatives	BWDB, LGED, UP

Table 7: Fisheries and water

Existing Urgent and Emerging Problems	Causes of the Problems	Potential Solutions	Possible actions agreed that need to be investigated further	Key institutional actors to be engaged
Lack of fish in the open water	Reduced area of the open water bodies due to construction to roads and embankments Fish fries/fingerlings unable to enter open water due to disruption of water connection between the river and open water bodies Illegal fishing of fish fries and fingerlings in the rivers and others Use of pesticide and unplanned chemical fertilisers Dry out river, *khal*, *beel*, pond and pagers Extensive fishing of small sizes fishes	Stop use of pesticides and reduce use of chemical fertilisers by using organic fertilisers Re-excavate/dig water bodies Establish reconnection of *beel* with the rivers Stop illegal fishing/harvest of under- sized fish f Conservation of fish in the open water bodies The CPP gate should be opened during the early flooding periods	Undertake re-excavation programme for re-establishing the water reconnection Voluntary work programme Fisheries laws should be enforced properly to stop illegal fishing Increase public awareness Undertake water-body excavation programme	Fisheries department, LGED, BWDB
Difficulties in fish culture	Ponds dry out in the dry season Insufficient/unsuitable land for fish culture Lack of funds for digging pond or initiating fish culture Difficulties in getting good quality fingerlings Lack of adequate fish culture knowledge Lack of sufficient rainfall Sandy soil at the bottom of ponds	identify places for digging new ponds for fish culture Increase pond depth Pond digging at the fallow lands Assure good quality of fingerlings supply Introduce a system for a sufficient amount of credit disbursement Arrange regular fish culture training at the local level	Excavate and re-excavate ponds Institute credit programme for fish culture Produce fingerlings and established marketing system Introduce and arrange area wide fish culture training programme Raise public awareness of fish culture	Fisheries department, NGOs, credit providing agencies
Fishes are dying from ulcerative and other diseases	Use of pesticides and uncontrolled chemical fertilisers	Stop use pesticide in the agricultural fields and water bodies Use organic fertiliser and reduced the use chemical fertilisers	Raising awareness Undertake govt. initiative and do necessary works	Fisheries department, Department of agric extension, NGOs
Fishing access restricted or reduced	Commercial fish culture in the open water bodies and flood lands Lease out of open water bodies for fish culture	Stop commercial fish culture into the flood lands Stop leasing out open water bodies for fish culture	Awareness raising Ensure open water bodies for the use of the local community	Relevant departments
Difficult to maintain fishermen livelihood	Lack of fish and fishing places	Fish conservation in the open water bodies Stop under size fish harvesting Maintain environmentally healthy water bodies	Govt. programmes Awareness raising Enforcement of fisheries law and water policy	Fisheries department, BWDB

Table 8: Domestic use and water

Existing Urgent and Emerging Problems	Causes of the Problems	Potential Solutions	Possible actions agreed that need to be investigated further	Key institutional actors to be engaged
Too much iron in hand pump water	Filter not located in the proper layer of soil	Need to do soil tests and take advice from the experts Re-established the iron filter plants in all areas where these were introduced by UNICEF	Encourage technical support from experts Undertake projects to test and identify suitable ground water level Undertake a research programme into the cause of enhanced soil iron	Directorate of Public health and engineering (DPHE) Govt and non-govt research organisations LC
Lack of water in open water bodies and hand pumps in dry season	Excessive extraction of ground water for irrigation by large STWs Draw down of ground water table Drying out rivers, *khals*, *beels*, ponds and *pagars*	Stop sinking STWs close to hand pumps Increase more tubes for the hand pumps Introduce surface water irrigation and reduce the extraction of ground water Excavate and re-excavate rivers, *khals*, *beels*, and ponds	Formulate govt. project Raise public awareness	LGED UP NGOs LC
Polluted water in open water bodies	Addition of pesticide residues and chemicals, household rubbish and human excrement to the surface water bodies Unplanned fish culture Surface water used in an unplanned way (for bathing, washing cattle, washing clothes, retting Jute)	Prohibit the addition of pesticide residues and chemical fertilisers and human wastes to water bodies used for other purposes Do not to allow the same water bodies for use for incompatible purposes like human bathing, cattle washing and as drains from waste from toilets.	Construct sanitary latrines and motivate people to use them Arrange meetings and show videos among people at different locations in the locality to raise public awareness. Construct embankment around the water bodies to prevent polluted materials drain out into the water bodies.	DPHE Govt. media NGOs LC
Fear of arsenic contamination of hand pump water	Unknown	Water quality testing for levels of arsenic Investigate methods for the removal of arsenic from HP water	Water quality testing programme and increase public awareness	DPHE NGOs
Lack of suitable water to use in the Jugini *beel*	Fish culture unplanned and non-scientific	Encourage well-thought out and scientific methods of fish culture	Government departments to take initiative	Fisheries department UP DC

Table 9: Rural industries and water

Existing Urgent and Emerging Problems	Causes of the Problems	Potential Solutions	Possible actions agreed that need to be investigated further	Key institutional actors to be engaged
Weaving activities hampered by the devastating floods and continuous rainfall in the rainy season	Unable to dry threat Problem of dying of treat Weaving house inundated	Re-establish handlooms at higher elevation	Individual initiative Provide financial support	Weaving community NGOs
Difficulties in the transport of pottery products	Disruption of navigation system due to siltation of all small rivers, *khals*, and *beels* Boat movement is difficult because newly built small sized gates and culverts	Need to re-established the navigation system by re-excavating rivers, *khals* and *beels* Construct well-planned embankments and larger sized gate, which would not hamper boat movement	Re-excavation programme to be undertaken by the government	BWDB, LGED UP, NGOs

Table 9: Navigation and water

Existing Urgent and Emerging Problems	Causes of the Problems	Potential Solutions	Possible actions agreed that need to be investigated further	Key institutional actors to be engaged
Lack of rivers and *khals* for navigation	Construction roads, flood control embankments, regulators and sluice gates Siltation of the river beds	Re-build larger gates Re-excavation of rivers and *khals*	Formulate a project to re-build water board structures Undertake re-excavation programme	BWDB LGED
Severe problem could arise in maintenance of the structure and operation of the gate after CPP	Project period ended in June 2000 and there is a lack of people's participation in the operation and maintenance of the structures	Ensure people's participation BWDB to undertake the project	Need to formulate committee with landholders by chalk ??for operation of gates and the maintenance of the structures. There should be a regular gate operator post from the government for operating the gate as well as for their maintenance	BWDB Specific local community
Weather changes	Insufficient and irregular rainfall Lack of trees	Tree plantation	Undertake tree plantation programme Awareness raising	Relevant govt departments NGOs Local community

The FGDs and local workshops have been able to elicit a considered view, based on local knowledge and experience, of the key problems that exist in the management of the water resource in relation to the provision of livelihoods. Also evident is considerable insight into the cause of the problems that have been identified, possible solutions and the actions that would need to be engaged in to bring about improvements. There is also realism about the institutions that might best tackle the required activities. There is also a degree of "optimism" born, it might be suspected of desperation. Certainly some of the solutions are not feasible under present economic constraints and, indeed, may b even undesirable. For example, widespread dredging or excavation could never be afforded. Even if finances were not a limitation, in such a hydrologically dynamic environment the benefits would be short-lived. There is a need to recognise the fact that the hydrology of the country has altered and done so permanently.

However, a number of the suggestions put forward have the potential for success and it is important that the authorities, with the local communities and NGOs, begin the long process of encouraging self-improvement and supporting, in a tangible way, some of the basic larger-scale actions required.

It is suggested that a strategy for action would be to give priority of action to the essentially local-based actions and some of the more far-reaching ones that depend crucially on central support and funding. Thus the following actions might be undertaken without much delay:

- tree-planting and maintenance work;
- improved public participation in decisions over the operation of CPP gates and other structures. This is an issue that has repeatedly been explored by CPP but there are clearly still problems. The researchers have approached the Dutch government for funding to monitor CPP infrastructure operation now the project has finished and has been handed over to the BWDB.

Time needs to be given to plan and organise:

- a concerted initiative on fish-culture to give guidance and the transfer of the necessary technological knowledge relating to aquaculture, combined with stricter enforcement of controls on fishing practices in open water bodies. It is recommended that such guidance be provided by the relevant NGOs. The possibility of NGOs being sub-contracted by government should be explored;
- rationalisation of the use of water bodies for specific purposes together with public awareness and educational programmes;
- adaptation of cropping systems to utilise available water and soil moisture more efficiently.

Even longer-term in the requirement necessary for successful implementation would be:

- the development and research, followed by an implementation phase, to deal with the problem of elevated iron levels in water;
- establish a system for the treatment (removal to safe levels) of water sources with elevated arsenic levels.

There are certain potential solutions to problems relating to water management which, in essence, are no more complex than those already mentioned but have major financial and organisational implications that it might not be realistic to imagine would be met in the short-term. Nevertheless they should not be lost sight of. These include:

- an investigation of means of improving the delivery of irrigation water. One option that should be investigated is the utility of developing community or private sector led DTW operation. Such a system was attempted the past but failed partly because of running costs and frequent breakdown of equipment. It may be that the equipment of today would be more cost effective and reliable. Whatever the solution, the problem of temporal drawdown of the watertable needs to be addressed quickly;

The consensus building in the two research areas are well under way. However, any further development of a micro-action plan leading to improved management strategies must find some means of including upstream and downstream users. This problem is not new but remains illusive. Recent work by MRAG (1999) into participatory management structures provides an insight into this for floodplain river fisheries. A key cornerstone of any successful approach for water resources management is governance, an issue the GOB has begun to address in detail under their Guidelines for People's Participation (GPP). These go as far as to detail that the government is considering the development of the formulation of a separate Act or rule for registration of local Water User Organisations for participatory water management. Consequently, it is recommended that any future developments in consensus building and community management of water resources take place within the framework of the new GPPs.

Output 4: Key strategies compared to those in other areas of Bangladesh

This output was not undertaken in the originally perceived format for several reasons. The development of strategies through participation and discussion is notoriously slow and the experience from this project confirms this. An attempt has been made, through grey literature, to determine the types of problems of water resource use encountered elsewhere in Bangladesh, and the solutions people proposed to mitigate for them. Major works that were utilised for this purpose include the Systems Rehabilitation Project (SRP), Meghna Estuary Study (MES), EGISII, Small-Scale Water Resources Development Project (SSWRDP) and the National Environmental Management Plan (NEMAP). There is was value to be gained in attempting to duplicate the work of the above studies particularly in view of the fact that those responsible for it were members of the research team (John Soussan and BCAS).

The NEMAP exercise concluded that the key concerns (no order of priority) of the rural population nationally in relation to water resources were:

- Flooding with the consequent loss of crops, damage to trees and housing, death and destruction of household animals, and scarcity of potable water and associated disease.
- River bank erosion.
- Decreases in water levels in *khals* and *beels* with a consequent decrease in the fish population.
- Water pollution leading to skin diseases/irritations.
- Fertilisers and pesticides altering the soils physical and chemical structure.
- The decline in the availability of water during the dry and rainy season.
- Embankments present the deposition of silt on the land.
- The number of water related insects are increasing.
- Groundwater levels are declining in the dry season leading to problems in relation to the availability of drinking water.
- Iron levels in the water are increasing.
- Little public consultation before FCD/I's are planned.

The vast majority of these key problems found at a national level through the largest public consultation process ever undertaken in Bangladesh echo those found in the two research areas.
Moreover, many of the actions recommended by NEMAP and the determination of the key actors also correspond to those being suggested by the livelihood groups in the research sites. A more detailed outline of the NEMAP and other studies findings is given in the final report (Annex 10).

At present the possibility of extending the research to other agro-ecological zones is being explored with the World Bank through their SEMP programme. However, the arrival of a new Secretary and his call for an internal review of SEMP projects prior to the initiation of new projects has meant this development been put on hold. It is envisaged that this work would establish the applicability of this study's findings elsewhere and identify potentially beneficial strategies that are already in operation.

Output 5: Institutional, economic and social context for disseminating options identified, validated and potentially implemented with local actors, NGOs and Government agencies

The research undertook a thematic study to investigate the existing dissemination pathways operating at local level in the two study areas. This research identified the sources of information for activities with a water resource components, and the form those sources utilised to disseminate information. Key respondents from the various livelihood groups evaluated both source and form. The respondents were also asked to identify the types of information they required and the preferred form in which they accessed this. The system diagrams also fed into this output as they provided information on the institutional context for each of the water-based activities.

Analysis of the results of the revealed that:

- BADC extension and Union Council (government agencies) tended to benefit the richer groups,
- Government credit systems were criticised. The richer groups who had access to government banking were attracted by the low interest rates offered by these sources but reported that the process of application and loan disbursement was time consuming and complicated. All the farmer groups were very interested in obtaining short-term loans for crop cultivation, and fish culture groups were interested in long-term low interest loans.
- NGO credit systems were good for the poor, but because the interest rates are high, are not attractive to the richer farmers.
- NGOs were observed to be very effective in transferring knowledge and technologies to all the poor groups. Participants made frequent reference to the interpersonal methods employed by NGOs. NGO activity with livestock and poultry, and fish culture was reported to be particularly good.
- Other farmers and neighbours are cited as good and sources of knowledge.
- Women respondents in Bartta reported that the health workers came to their village only very occasionally, which meant that many of the women had lost interest and instead relied on NGOs and more informal sources of knowledge.
- Respondents recognised that these local dealers had business interests and sometimes mislead them. In this situation respondents shared experiences with other farmers, providing some sort of evaluation of the information.
- In many cases information was provided in the form of written booklets, leaflets and newspapers, which seemed to be wholly inappropriate (especially in relation to women) considering literacy rates in the Tangail district stand at 36.1 percent for men, and only 22.4 percent for women.

- The mass media sources of television and radio were cited in relation to all activities, indicating huge potential for dissemination. All respondents stated that television was attractive media from which to gain knowledge. The attractiveness of television may have been due to television's association with entertainment, poor respondents reported that when they have the opportunity to watch television, they do so for entertainment.
- Jugini respondents indicated that activities relating to the Compartmentalisation Pilot Project (CPP) were perceived as being short-term and non-sustainable. This may have been due to experience of previous extension efforts.

The failure of government extension to reach the poor, and NGOs success in doing so, implies the possibility of further contracting of NGOs by government to provide information and knowledge dissemination to the poor. At present the Bangladesh government contracts NGOs to provide extension services for homestead gardening. Failure of BADC extension to farmers highlights the potential for contracting NGOs to provide effective extension to poor farmers and fish culture groups.

Widespread use of mass media such as radio, and to some degree television, also offers massive potential in dissemination of new knowledge and technologies to rural people in Bangladesh. If mass media programming were developed to take account of rural peoples' knowledge requirements, the range of people reached would be phenomenal. Increased access to television media, an attractive prospect for many Bangladeshis, would provide an even greater medium for knowledge dissemination.

The findings of the thematic study were discussed at the summary and regional workshops and provided an entry point for discussions of which institutions should to be involved in implementing the various options identified and how this could best be communicated and achieved. There was much interest in and general agreement with, the findings of the research, particularly those relating to water scarcity in the dry and monsoon season. Furthermore, both government departments and NGOs expressed their desire to participate in the process of movement from the strategic to the adaptive. However, the issue of resources was immediately brought to the fore. Workshop participants stated that whilst they welcomed the findings and the proposed actions, how did the project intend to implement these and what resources were available to achieve this? The consensus was that uptake pathways were contingent upon integration into the broader policy and planning processes discussed above and in Output 6.

Output 6: Criteria for assessing success/ failure of strategies and options developed; policy/strategy implications of findings identified and inputs into national policy/strategy processes made

Based on the series of workshops the first approximation of potential options and mitigation of existing management strategies were established. This process of development and implementation of these at local level is an ongoing task to which local NGOs and government departments have expressed their desire to contribute. However, given the limited resources available this process has only recently begun. This being so, specific strategies or options have yet to be instituted, so solution specific criteria cannot be established, and nor would one expect them to have been given the short amount of time that has elapsed between the research, the injection of the results into the public domain and the complexity of the system involving such a wide range of stakeholders.

However, preliminary criteria for the assessment of the likely success or failure of any strategy or option to be adopted will have to take account of:

- an evaluation of the level of agreement there is between stakeholders on the major problems identified;
- the level of unanimity of the feasibility of the problems-solutions suggested;
- the potential resources available to begin implementation of strategies or options; and
- the use of indicators to monitor reductions in the levels of the problems identified.

The research has identified broad strategy implications as follows:
- The need to continue the process of raising general awareness and addressing the issue of water scarcity during the dry season.
- The requirement to fund and promote alternative agricultural and fisheries strategies that are based on a response to the current conditions and constraints.
- The necessity for policies to incorporate an effective reporting and monitoring requirement as part of the implementation of alternative strategies.
- The encouragement of continued participation by stakeholder groups in the strategy formulation process

The project's dissemination strategy included the production of a number of reports and articles on thematic issues identified during the research. Many of these have been made available to, and discussed with, those involved directly in the policy process. For example, the research findings relating to dry season and monsoon season water scarcity have been considered during the development of the new National Water Management Plan (the Panel of Experts were all asked by the panel's head to read the project's working paper on water scarcity).

Several team members are actively involved in the policy process themselves. For example, Dr Saleemul Huq and Dr Atiq Rahman are both advisors for the Bangladeshi Government's national environmental management plan whilst John Soussan has been team leader for several major project evaluations and policy development exercises for the Royal Netherlands Embassy, the World Bank, the European Union the World Food Programme and the United Nations Development Programme. As a result, the findings of the research fed into this process (many of the problems reported in the research were also reported in NEMAP's findings).

6. Contribution of Outputs

Under the high potential production system programme, one of DFID's stated goals is the increased production of systems commodities through optimisation of inputs and outputs. This will include the development and promotion of appropriate and cost-effective techniques for water distribution, re-use and drainage. This is also a national policy priority.

The findings of the project have identified methods of improving the availability and management of water resources to enhance the production processes associated with the resource. The participatory nature of the research has ensured that the direct beneficiaries have both been exposed to the promotion of the findings and also contributed to them. However, given the complex nature of the issues, the environmental context within which these take place and the fully participatory nature in which the work as been conducted, the process has been slower than hoped. This is not unusual, rather the nature of the work, and as such a feature for which the researchers make no apology.

At the same time, promotion of these findings has also been directed to the target institutions through their involvement in the workshop and symposium activities and reports. A list of publications is included in Section 7 of this report. Funds are also being actively sought from

other sources to enable the next phase of wider applicability and implementation to be arranged.

Overall, the synergies achieved with the group's many other activities in the Bangladesh water sector have meant that the project's findings have had an unusually high impact on the development of discussions over, and policies on, a sector that is undergoing profound structural change. The direction of change is fully in line with DFID's overall and country priorities. The wider institutional context of the uptake pathways available to the team have been instrumental in furthering partnerships and collaboration between DFID Bangladesh, other donors, the Bangladesh Government and the wider NGO and research community.

7. Publications (and Dissemination)

As one of the specified outputs, the project undertook three literature reviews at the end of 1998. The project also produced an unsolicited Progress Report at the half way stage of the project.

Early on in the project the researchers arranged a one-day workshop for ongoing researchers working in Bangladesh on natural resources based research funded under the NRSP to meet. The meeting enabled many researchers to meet face to face for the first time and discuss both the research and the logistics of working in Bangladesh.
Particular thematic elements of the research have been developed as part of the School of the Environment's Working Papers Series. Two papers have been completed and two are in going to press. Copies were provided to, and discussed with senior staff at the Ministry of Water Resources (Dr Huda, Secretary), WARPO, the Water Policy Advisory Group, and the Panel of Experts for the National Water Management Plan (NWMP).

A paper concerned with the consequences of the 1998 flood in terms of the livelihoods of households who have lost their land to riverbank erosion has been accepted by the journal *Land Degradation and Development*. A paper has also been submitted to *Ambio* and one is under preparation following an invitation to submit to *Water Policy*.

The project has had several articles published in English and Bangla on some of the key findings in the National newspapers in Bangladesh. The project has also had two of its reports summarised in the Quarterly Newsletter of the NGO Forum for Drinking Water Supply and Sanitation. A paper based on the domestic water supplies thematic study was presented at a conference held by the CEN in Dhaka in January 2000.

As indicated, as part of the participatory programme involved a series of workshops with local livelihood groups, government agencies and NGOs in the two study sites. The process culminated in a final workshop held in Tangail attended by 100 participants which has led to the identification of priority actions for improved management of the areas' water resources. The workshop was covered by the National newspapers (Bangla).

At the end of the project a one-day symposium was held with the University of Newcastle. This was attended by 107 people including several team leaders of bilateral projects in Bangladesh, relevant government departments, DFID in-country advisors and programme managers from several other international aid agencies (Annex 2).

A number of ad hoc presentations have also been given on the work in the UK including presentations to researchers at the School of Oriental and African Studies (SOAS), Kings College London and the Institute of Hydrology (IH).

Working papers were also distributed at the World Water Forum and Ministerial Conference in The Hague in March 2000.

A list of publications is given below.

Chadwick, M.T., Soussan, J.G., Alam, S.S. and D. Mallick (1999) *From Flood to Scarcity: Re-Defining the Water Debate in Bangladesh, School of the Environment Working Papers, Environment and Development Series No. 1*, School of the Environment, University of Leeds, Leeds, UK.

Chadwick, M.T., Clemett, A., Hickman-Robertson, N., Alam, S.S., Mallick, D. and J.G. Soussan (1999). *Drinking Water, Bathing and Sanitation: The Risk to Human Health in Rural Bangladesh, School of the Environment Working Papers, Environment and Development Series No. 2*, School of the Environment, University of Leeds, Leeds, UK.

Chadwick, M.T., Alam, S.S., Soussan, J.G., and D. Mallick (to be published) *Flood: Friend or Foe? Assessing the Consequences of the 1998 Flood in Rural Bangladesh, School of the Environment Working Papers, Environment and Development Series No. 4*, School of the Environment, University of Leeds, Leeds, UK.

Clemett, A., Edwards, D., Mallick, D., Chadwick, M.T., Soussan, J.G., and Alam, S.S. (to be published) *Acknowledging Knowledge – Rural Peoples' Perceptions of Dissemination Pathways in Rural Bangladesh, School of the Environment Working Papers, Environment and Development Series No. 3*, School of the Environment, University of Leeds, Leeds, UK.

Soussan, J.G., Chadwick, M.T. and T. Martin (2000) *Bank Robbery:* The Real Losers in the 1998 Flood in Bangladesh, *Land Degradation and Development (with publishers).*

8. Internal Reports

Alam, S.S, Chadwick, M.T., and Soussan, J.G. (1998). Understanding Water Resources: Resource Characteristics and Water Sector Planning in Bangladesh. *Leeds, UK: Environment Centre [project report]*

Chadwick, M.T., Soussan, J.G., Alam, S.S. and Mallick, D.L. (1998). Understanding Indigenous Knowledge: Its Role and Potential in Water Resources Management in Bangladesh. *Leeds, UK: Environment Centre [project report]*

Chadwick, M.T., Soussan, J.G., Alam, S.S. and Mallick, D.L. (1998). Understanding Sustainable Local Water Resource Management in Bangladesh - Progress Report. *Leeds, UK: Environment Centre [project report]*

Soussan, J.G., Mallick, D.L., Alam, S.S. and Chadwick, M.T. (1998). Understanding Rural Change in Bangladesh – The Socio-Economic Trends and People's Participation in Water Resources Management in Bangladesh*, UK: Environment Centre [project report]*

References

Adnan, S. 1992. *People's Participation, NGOs and the Flood Action Plan,* Research and Advisory Service, Dhaka

BBS 1995. Yearbook of Agricultural Statistics of Bangladesh, Bangladesh Bureau of Statistics (BBS), Dhaka

BCAS 1997. 'Impacts of Flood Control and Drainage With or Without Irrigation Projects (FCD/I) On Fish Resources and Fingerling Community in Bangladesh'*, In: Tsai,C. and Ali,M.Y. Openwater Fisheries Bangladesh,* The University Press Limited (UPL), Dhaka

FPCO 1995. *Bangladesh Water and Flood Management Strategy,* Flood Plan Coordination Organisation (FPCO), Dhaka

Haggart, K., Huq, S., Rahman, A.A., Haq, E., Majumder, M.K. and Miranda, C. 1994. *Rivers of Life,* Bangladesh Centre for Advanced Studies, Dhaka

Howes, M. 1985. *An Investigation of the Consequences of Alternative Approaches to Small Scale Irrigation in Bangladesh,* Bangladesh Institute of Development Studies, Dhaka

Jansen, E.G. 1990. *Rural Bangladesh: Competition for Scarce Resources*. University Press Ltd. Dhaka

Mamun,M.Z. 1996. Awareness, Preparedness and Adjustment Measures of Riverbank Erosion-Prone People: a Case Study, *Disasters*, Vol. 20, No. 1, pp. 68-74

MFA 1993. *Flood Action Plan, Bangladesh - A Study of Debate on Flood Control in Bangladesh,* Ministry of Foreign Affairs, The Hague.

Rahman, A. 1995. *Beel Dakatia: The Environmental Consequences of a Development Disaster*, University Press Limited (UPL), Dhaka

Palmer-Jones, R.W., and Mandal, M.A.S 1987. *Irrigation Groups in Bangladesh, In: ODI/IIMI Irrigation Management Network Paper No. 87/2c*, Overseas Development Institute, London

RAS 1992. State of FAP: 1992-199*5*. *Monitor*, *1,1*

Sadeque, S. Z. 1992. Capture Fisheries and Other Common Property Resources in the Flood Plains of Bangladesh, *Journal of Social Studies*, 55 (special issue), pp. 20-34

SGK and Unnayan Shamannay. 1997. *People's Perceptions, Participation and Payment of Compensation: An Assessment of the Compartmentalisation Pilot Project*, Compartmentalisation Pilot Project, Dhaka.

Soussan, J. and Datta, A. 1998. *Final Evaluation Study of the Systems Rehabilitation Project: Social and Economic Impacts,* Ministry of Foreign Affairs, The Hague

Thompson,P.M. and Sultana,P. 1996. Distributional and Social Impacts of Flood Control in Bangladesh, *Geographical Journal*, No. 162, pp. 1-13

Tsai. C.F., Ali, M.Y., Ahsan, K., and Alam, S.S. 1993. Household Fish Consumption in Relation to Fishing and Fish Production in Flood Plains of Bangladesh*, Indian Fisheries Journal*. 40,30, pp.181-188

Wood, G.D., and Palmer-Jones R.W. 1991. *The Water Sellers: A Co-operative Venture by the Rural Poor*, Intermediate Technology Publications Ltd., London

9. Annexes

Volume II

Annex 1: **Understanding Water Resources: Resource Characteristics and Water Sector Planning in Bangladesh.** *Leeds, UK: Environment Centre* (42 pp) – School of the Environment, University of Leeds, Leeds, UK

Annex 2: **Understanding Indigenous Knowledge: Its Role and Potential in Water Resource Management in Bangladesh.** *Leeds, UK: Environment Centre* (48 pp) – School of the Environment, University of Leeds, Leeds, UK

Annex 3: **Understanding Rural Change: Socio-Economic trends and People's Participation in Water Resources Management in Bangladesh.** *UK: Environment Centre* (58 pp) – School of the Environment, University of Leeds, Leeds, UK

Annex 4: **Sustainable Local Water Resource Management in Central Bangladesh –Progress Report.** (125 pp) – School of the Environment, University of Leeds, Leeds, UK

Volume III

Annex 5: **Drinking Water, Bathing and Sanitation: The Risk to Human Health in Rural Bangladesh.** *School of the Environment Working papers, Environment and Development Series No.2* (36 pp) – School of the Environment, University of Leeds, Leeds UK

Annex 6: **From Flood to Scarcity: Re-Defining the Water Debate in Bangladesh.** *Environment Centre Working Papers, Environment and Development Series No.1* (29 pp) – School of the Environment, University of Leeds, Leeds, UK

Annex 7: **People's Livelihoods at the Land-Water Interface – Emerging Perspectives Between People and the Floodplain Environment.** *Symposium Proceedings* (80 pp) – University of Leeds and University of Newcastle, UK

Annex 8: **Bank Robbery – The Real Losers in the 1998 Bangladesh Flood.** *Paper accepted but publication date unknown)* (17 pp)

Annex 9: **Sustainable Local Water Resource Management in Central Bangladesh – Meeting Needs and Resolving Conflicts.** *Draft Final Report* (143 pp) – University of Leeds, Leeds, UK

Volume IV

Annex 10: Scarcity and Flood: Re-Defining the Water Debate in Bangladesh. ***Paper submitted to Ambio*** **(24 pp)**

Annex 11: **CD-Rom containing Microsoft Access database and ARC INFO coverages.**

Annex 12: **Various newsletters and newspaper articles:**

1. **From Flood to Scarcity of Water: Re-Defining the Water Debate in Bangladesh.** *Watsan 3rd year, 1st Issue, July-September, 1999* (4 pp)
2. **The International Drinking Water Supply and Sanitation Decade.** *Watsan 3rd year, 2nd Issue, October-December, 1999* (12 pp)
3. **From Flood to Water Scarcity – Redefining a Debate.** *Editorial* (1 pp)
4. **Utilising Water Resource the Pragmatic Way.** *The Independent, Editorial 8 July 1999* (1 pp)
5. **Bangladesh Environmental Newsletter.** ***Vol. 11 No.1 January-March 2000*** **(8 pp) – Bangladesh Centre for advanced studies**

Annex 13: **CD-Rom containing GIS Data – Field plots for the digitised villages, together with revised Microsoft Access database.**