Navigation

The Atrai River and Little Jamuna River are locally important for carriage of goods and passengers, although there are no all-year connections with the major boundary rivers of the Region. The country boat sector in general has been revitalised by mechanisation and is now competitive with truck transport. For example, the following freight rates were obtained in the 1992 FAP2 navigation survey:

Route	Type & Amount of Cargo	Boat Freight	Truck Freight
Mohadevpur-Dhaka	1 md rice	Tk 12-16	Tk 20-24
Naogaon-Nawabganj	1 bell jute	Tk 40-45	Tk 75-80

In the planning unit, lowland areas in particular are not well covered by roads and therefore boats have an important transportation rôle, particularly for the 5 months of the monsoon and post-monsoon. Particularly important landing centres are Mohadevpur, Atrai, Singra and Naogaon. The main commodity transported is paddy, but other commodities such as jute, fertiliser, diesel etc. are also shipped.

Boat transportation relies not only on the main rivers but also on the large numbers of natural channels that ultimately connect with those rivers. The channels provide a diffuse network that facilitates marketing of produce by farmers remote from road connections. The construction of FCD facilities such as Naogaon Polder have blocked these canals and reduced the capacity of many farmers to transport produce.

A further factor inhibiting navigation is siltation in the rivers and dry-season pumping for irrigation.

12.6 River System, Hydrology and Morphology

The Atrai River is the main river in the planning unit, but also important are the Little Jamuna and Nagor Rivers. The Lower Atrai forms one boundary of the unit and flows from the north west towards the south east. The Little Jamuna and Nagor Rivers flow roughly north to south through the planning unit to join the Lower Atrai at Rasulpur and Khorsuti respectively. At peak monsoon there is a backwater effect of the Atrai stretching up the Little Jamuna roughly as far as Naogaon, and up the Nagor River roughly as far as Talora. The Atrai itself is subject to the backwater influence of the Jamuna River from about mid-late June onwards.

The flood hygrographs at different stations along the Atrai, and also at stations on the Little Jamuna and Nagor Rivers, illustrate some of the characteristics discussed above. At the upstream end of the planning unit, i.e. Mohadevpur, the hygrographs for both 1988 and 1989 show a repeated series of peaks and troughs during June-early October. The Nagor River at Talora, and to a lesser extent the Little Jamuna at Naogaon, also show this pattern which is characteristic of flash floods. At stations further downstream along the Atrai River, however, the peaks and troughs are smoothed, although there are still indications of 1-2 peaks. The smoothing of peaks is due to flood attenuation as flood waters spread over the land, and also the backwater effect from the Jamuna which keeps levels high for 3-4 months both in normal and high flood years.

The tributary rivers become dry after onset of rabi-irrigation season when large scale groundwater abstraction and low-lift pump based irrigation starts.

Discharge and water level data of Atrai railway bridge, are given in Table 12.3 and 12.4 respectively. Similar data for Naogaon on the Little Jamuna is presented under Planning Unit 9.

Rainfall data of Atrai are given in Table 12.5 as representative stations of the planning units.

Morphology

The Atrai River has a width in its middle reaches of about 200 m. and depth of about 3.5 m. At Astomonisha, south of the planning unit, the river width is about 100 m. but depth has increased to 6-8 m. The river is a meandering one but bank movement is not significant. In contrast, the Little

Jamuna River increases its width downstream and is eroding its banks. The average bed slope of the Atrai at Atrai railway bridge is about 0.000047, indicating a very flat slope in the reach covered by the planning unit. The average bed slope of the Little Jamuna is 0.000222.

Table 12.3 Max Mean Daily Discharges (m^3/s)

Gauge Station	July				August				September			
	1:2	1:20	1987	1988	1:2	1:20	1987	1988	1:2	1:20	1987	1988
Atrai RB (Atrai)	455	727	754	320	509	773	806	365	465	673	575	323

Table 12.4 Max Mean Daily Water Levels (m PWD)

Gauge Station	July				August				September			
	1:2	1:20	1987	1988	1:2	1:20	1987	1988	1:2	1:20	1987	1988
Atrai RB (Atrai)	12.97	13.79	14.03	13.72	13.19	13.99	14.18	14.14	13.10	13.82	13.36	14.31

Table 12.5 Rainfall (mm/month)

	July				August				September			
	1:2	1:20	1987	1988	1:2	1:20	1987	1988	1:2	1:20	1987	1988
Atrai	346	705	532	250	273	508	176	430	174	701	206	72

12.7 Existing FCD Developments

The planning unit area falls within MPO Planning Areas 8, 9, and 13. The main MPO Catchment Areas falling within the Planning Unit are 33 and 34, and parts of 39.

The planning unit has been extensively covered by a number of FCD schemes. Originally outlined in the 1964 Master Plan (IECO), the units have since been planned and executed in isolation, as follows:

- Naogaon Polder (Bogra Polder 1) - Gross area 46,100 ha.

- Bogra Polder 2 - Gross area 42,000 ha.

    - Roktadoha-Lohachura scheme
    - Nagor Valley Project
    - Upper Nagor Valley Project.

- Bogra Polder 3 - Gross area 35,800 ha.

    - Nagor River Project
    - Upper Nagor River Project.

In addition,there are other schemes being implemented in adjacent planning units which might affect the area, for example the Tulshiganga embankment schemes upstream as well as the Chalan Beel Polders on the right bank of the Atrai.

Naogaon Polder

A feasibility study was first carried out in 1973-75. Construction started in 1986 through the IDA-funded project FCD-III and is scheduled for completion in 1993. About 50 km. of full FCD embankment is under construction. About 6 km of embankment plus 3 outfall regulators at the downstream end remain to be completed. The total estimated cost of the project is about US $200 m.

The Naogaon Polder scheme has not yet been completed and therefore its effectiveness cannot be judged fully. Some problems are indicated however: first, the scheme area is open at the northern side, allowing rainfall run-off to come into the area. It remains to be seen whether the main regulator at the southern end will be sufficient for drainage purposes, or whether drainage will be possible given the rise in Atrai and Little Jamuna levels in the monsoon. Second, farmers outside the scheme on the right bank of the Little Jamuna are being adversely affected: since the embankment is very high, river spills are all diverted to the east causing considerable crop damage for greater than in the pre-project situation.

In addition to these problems, the high cost of the scheme, allied to possible inadequate drainage facilities, raises questions about its feasibility.

Bogra Polder 2

A feasibility study was carried out of Bogra Polders in general in 1974-78, but implementation was done in a piecemeal manner by BWDB, financed by the EIP project. About 117 km. of embankment has been constructed along with 15 drainage regulators.

Polder 2 is scheduled for redesign during 1992 under EIP.

Bogra Polder 3

Polderisation of this area was started in 1980 and completed in 1991 under the EIP project. About 50 km. of embankment were constructed and 17 drainage regulators.

Bogra Polder 4

In the Bogra Polder 4 area regular flooding occurs in the downstream portion. The area was studied by EIP and proposed for embanking but the proposal was rejected at on recent appraisal in 1991. EIP also studied Gur-Nagor mini-polder for a pilot area for controlled flooding, but this proposal has also been recently rejected.

12.8 Flooding and Drainage Problems

Flooding

The figures shown in Table 1 give the distribution of flood phase through the planning unit. The largest amount of land is F0 land, i.e. rarely subject to flooding, and 62% of land is F0 or F1, i.e. at most shallowly flooded. Conversely, 38% of land is moderately or deeply flooded. There is considerable variation between thanas in the distribution by flood phase, with the thanas further north having relatively higher proportions of F0 land as would be expected.

In Bogra Polders 2 and 3 a clear distinction can be made between the effectiveness in the upper reaches and the lower reaches. In the upper reaches, embankments have not been breached or cut, suggesting that they are relatively effective in keeping out floods. However, this land is higher and less susceptible to flooding in any case.

In the lower reaches, a number of cuts and breaches have been caused in the Roktadoha-Lohachura scheme, Nagor Valley and Nagor River projects. In the R-L scheme breaches occurred at Rasulpur in 1991 due to piping failure and these breaches have not been repaired. People living in the vicinity of the Nagor Valley project cut the embankment to relieve their b. aman crops from submergence, and this water rushes into the Nagor River, causing either breaches or public cuts of the Nagor River embankment also, in the vicinity of Khorsuti. The result, according to the RRA of FAP 12, is that the Nagor River project is an almost total failure: instead of protecting the b. aman crop, the crop is destroyed every year. The only benefit has been the protection of the boro crop from early flash floods, but these floods only occur in some years.

The lowland areas are therefore the areas of main flooding, as would be expected. The main flooding problems at present, however, seem to be those caused by failure of the flood protection infrastructure. Farmers in these areas have indicated that they would be satisfied if they could grow b. aman and get a crop most years: this is currently not possible in the nominally protected parts of the planning unit, as levels of risk would appear to have increased.

In addition, since most of the now unprotected lowland is at the downstream end of the planning unit, it is affected by the confinement effect of all the FCD works carried out on both sides of the Lower Atrai. This impact may have made conditions worse for growing b. aman.

The flooding problems in the highland areas do not appear to be very great, although in the transitional zone there is a possibility of flooding causing damage to t. aman, and early flash floods damage to boro in some years. The existing schemes do appear to provide effective protection against this type of damage.

12.9 Options for Development

12.9.1 General

The options considered here are based on the identification of current problems as being closely associated with:

- the confinement effect on the Atrai, and

- the non-functioning of parts of the schemes already constructed. In general, therefore, full FCD which was studied in the first part of NWRS, was rejected as a viable development scenario for the Lower Atrai, even with the possible intervention of the major drains (The Interceptor and Diversion). An exception is Naogaon Polder, but that is partly to do with the large amount of money already invested in that scheme: its operation should be closely monitored for the first few years to see if it can function effectively and achieve the benefits predicted.

A general approach of allowing flow into some polders, providing full CFD protection in more upland areas, and sub-dividing polders to facilitate drainage, was therefore adopted for this planning unit. In addition, Polder 4 (and, early stages of planning, Naogaon Polder), was considered as flood storage zones.

In areas where full CFD is not considered practical, an option is to provide partial protection and improved drainage. This might have two objectives:

- protection of the boro harvest from flash floods (as in NE Bangladesh)
- control of the rate of rise of monsoon water levels so that TDW aman can be grown.

The need for pre-monsoon protection of boro is not as critical in the north-west region because of the different climatological conditions. These influence the onset of flooding and the planting/harvesting timings for crops.

For the CFD areas a form of compartmentalisation is envisaged whose primary functions is to prevent transfer of flood flows across drainage basin boundaries within protected areas. As far as possible, such flows will be routed to the main or internal rivers bordering the compartments. Maximum use will be made of existing infrastructure such as local roads to provide compartment boundaries and control structures.

Flood proofing is an important component in unprotected areas.

12.9.2 Detailed Options

The major options which were considered were as follows:

Naogaon Polder

Option 1 - Full CFD

As Naogaon polder is nearing completion, this option covers its full completion to CFD facilities. Two sub-polders for improving the agriculture and distributing the rainfall run-off, through effective

flood management, were also studied. The boundary of the sub-polders follows the Manda-Naogaon road.

The polder is receiving flows from upstream areas. Options to improve this were studied as part of the Upper Badalgachi project under planning unit 9.

Option 2 - Partial Protection

Option 2 studied the possibility of reducing peak water levels in the Atrai by allowing storage through partial protection only of the downstream unit of the polder. In this option CFD facilities would be provided in the unit located at higher elevation as for Option 1.

Bogra Polder 2

Bogra Polder 2 is surrounded by the Little Jamuna on the west, the Nagor on the east and the Lower Atrai on the south. But the polder is open to the north receiving rainfall run-off from the north basin outside of the polder.

Full confinement of the Little Jamuna and the Nagor along the polder would effectively protect the polder from flooding without causing serious adverse effect to the downstream reaches. But full confinement of the Lower Atrai has proved to be impractical because it makes the river stages very high along the whole reaches of the Lower Atrai. This results in public cuts in the lower reaches.

Under this situation, the lower unit of the polder needs to be an area of partial protection to avoid the high stages of the Lower Atrai, while the upper unit can be fully protected without adverse effect. Therefore partial protection is proposed for the lower unit and CFD facilities in the upper unit. An embankment behind the lower unit is needed because otherwise the backwater would extend well inside the upper unit. This embankment would have facilities for controlled flooding into the upper unit.

Accordingly a flood control embankment is planned from Atrai railway bridge to Hingolkandi following a village road. Since the embankment is passing through the valley a drain is proposed to collect the drainage flow as well as an embankment. Sub-poldering through Raninagar to Parghate following a village road is also planned. In total, seven units are planned to reduce the drainage load on the lower reaches, by diverting upland flow to the internal rivers.

Bogra Polder 3

As for polder 2 it may be noted that public cuts are made in the lower reaches of the polder, but not upstream. Therefore flooding through partial protection is proposed for the lower unit and CFD facilities are proposed in the upper units.

CFD embankments are planned from Hingolkandi to Pakuria following a village road, with necessary structures for controlled flooding and drainage.

Sub-poldering is recommended to reduce drainage load to downstream reaches.

Bogra Polder 4

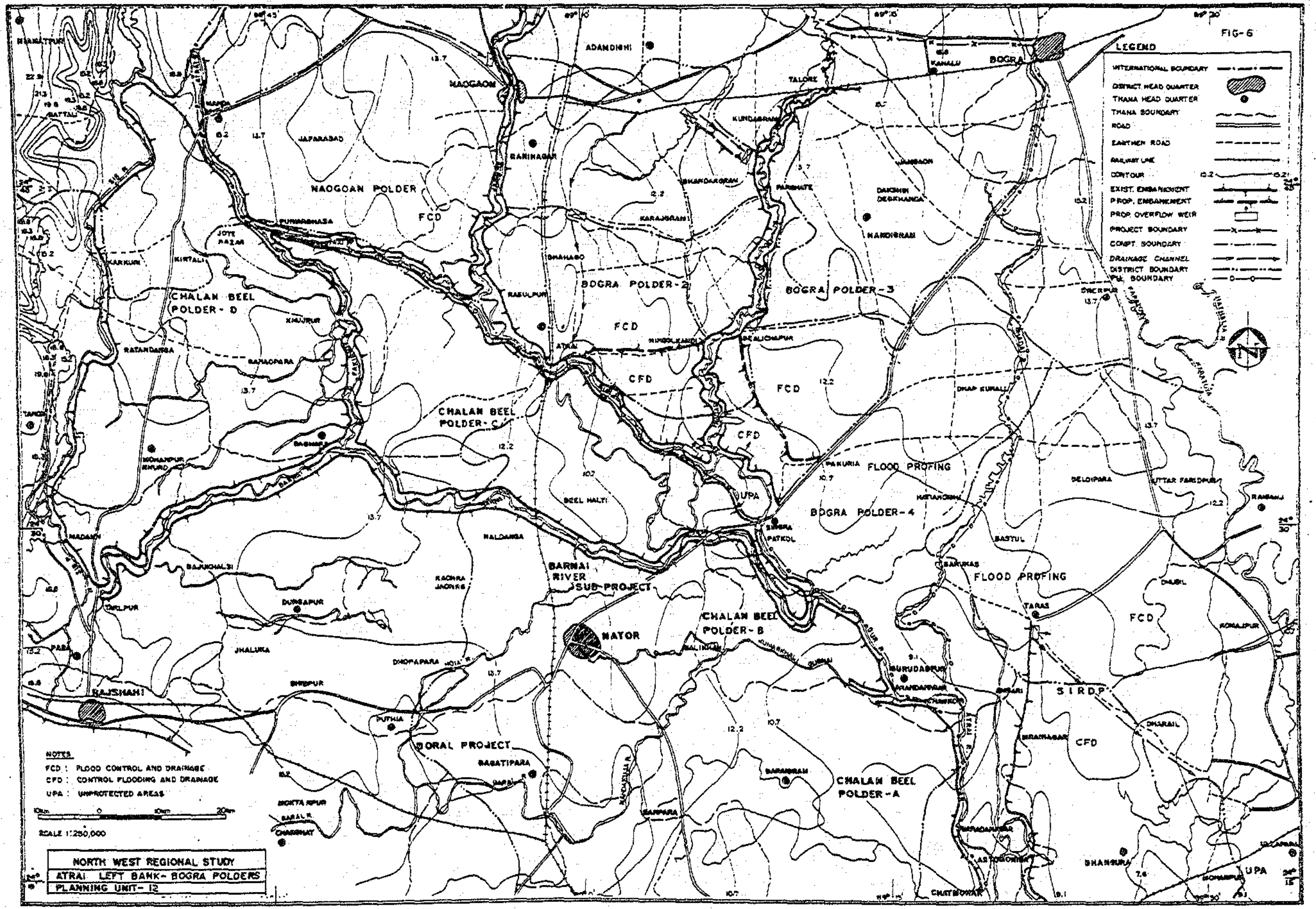
Option 1

Historically this area is a flood storage area, and any flood control development will reduce the storage capacity of the basin. No embanking is proposed under this option. Flood proofing facilities would be provided to reduce suffering and discomfort and to minimise damage to infrastructure.

Option 2

In this option the lower part of the area would remain un-embanked as at present. In the upper reaches full controlled flooding and drainage provision would be made. Possible alignments for these embankments include the Pakuria-Hatiandighi road, and the Taras-Baruhas road. Embanking of the upper reaches of the Badai may also be required.

FIG-6



NOTES
FCD : FLOOD CONTROL AND DRAINAGE
CFD : CONTROL FLOODING AND DRAINAGE
UPA : UNPROTECTED AREAS

SCALE 1:250,000

NORTH WEST REGIONAL STUDY
ATRAI LEFT BANK - BOGRA POLDERS
PLANNING UNIT - 12

PLANNING UNIT 13

LOWER ATRAI RIGHT BANK

13.1 Basic Data

The planning unit is situated in the districts of Rajshahi, Natore, Naogaon and Pabna. It is bounded by the river Atrai in the north, river Baral and railway line in the south east, River Ganges in the south and the Sib-Barnai river in the west. It covers the Chalan Beel polders and the Baral and Barnai project areas.

Basic data of the planning unit is presented in Table 1.3.1. The gross area is 301000 ha.

The population of the whole planning unit was 2.02 million in 1981 at a population density of 6.7 persons per gross ha, which is about the regional average.

The population in the Chalan Beel Polders is estimated at about 1.3 million, compared with 537,000 in 1961.

Household surveys conducted in Polders A, B and C by the MARS/DHV Assessment Study (1992) suggest an increase in landlessness from 21% of households in 1968 to 26% in 1983-84. Over the same period, average farm sizes declined from 1.7 ha. to 1.3 ha. (In Polder D the decline was from 1.5 ha. to 1.0 ha. in 1987). Despite these small average farm sizes, it is widely believed that some landholding are very large in the area, or else have been subdivided by "benami" transfer to avoid legal land ceilings. There is, not surprisingly, little strong evidence on this issue.

The MARS/DHV surveys found the following land size distribution amongst farming households:

	% hh.	Polder A			Polder B			Polder C		
		% Cult. land	Av. Farm Size (ha)	%	hh % Cult. land	Av. Farm size (ha)	%	hh % cult. land	Av. Farm size (ha)	%
Small Farmer	67	38	.50	53	21	.51	52	28	.64	
Medium Farmer	26	37	1.24	30	34	1.48	39	48	1.49	
Large Farmer	7	24	2.96	17	45	3.60	9	24	3.36	

Small farm households are dominant, but medium-large farm households control most land, particularly in Polder B.

13.2 Present Agriculture

13.2.1 Soils

The Lower Atrai Basin as a whole mostly comprises smooth, low-lying basin land. Some ridges penetrate into the basin in the areas bordering the Lower Atrai Floodplain, and relief is locally irregular near the river channels.

Table 13.1 Planning Unit 13 Basic Data

Thana	Percentage in Planning Unit	Percentage in Thana
MANDA	8	57
PABA	4	50
MOHADEVPUR	tr	0
NATORE	13	100
RANINAGAR	tr	1
MOHONPUR	5	99
DURGAPUR	7	100
CHARGHAT	5	92
BOALIA	1	23
SINGRA	5	28
GURUDASPUR	6	83
BARAIGRAM	3	25
BAGMARA	12	100
BAGHA	6	89
NIAMATPUR	tr	0
TANORE	tr	2
ATRAI	4	43
PUTHIA	7	100
LALPUR	6	76
BAGATIPARA	5	100
CHATMOHAR	2	18
TARASH	tr	1
ISWARDI	1	15

Gross Area (ha) : 300649
Nca Area (ha) : 267872

Total population (1981) : 2021637 Population Density : 6.72
(per ha Gross area)

Flood Phase :

F0 (ha) :	106501	F0 % of NCA (ha) :	40
F1 (ha) :	70174	F1 % of NCA (ha) :	26
F2 (ha) :	55584	F2 % of NCA (ha) :	21
F3 (ha) :	35488	F3 % of NCA (ha) :	13
F4 (ha) :	127	F4 % of NCA (ha) :	0

Irrigation Equipment Operating :

STW 81	992	STW 89	15903
DTW 81	268	DTW 89	464
LLP 81	542	LLP 89	1672

Irrigation Coverage (%) Yr 81 6 Irrigation Coverage (%) Yr 89 35

TABLE 13.2 CROPPING PATTERN

LAND TYPE	AMOUNT(HA)
F0	106501
F1	70174
TOTAL	176675
F2	55584
F3	35488
TOTAL	
F4	125
GTOYAL	267872

IRRIGATION BALANCE	
HYV BOR	61481
WHEAT	7191
HYV AUS	15707
TOTAL	84379

DISTRIBUTION OF LAND BY IRRIGATION STATUS BY FLOOD PHASE

LAND TYPE	IRRIGATE AREA	NONIRRI AREA	TOTAL AREA	% IRRIG
F0	12119	94382	106501	11
F1	15789	54385	70174	22
TOTAL	27908	148767	176675	16
F2	32517	23067	55584	59
F3	23954	11534	35488	67
F4			125	
TOTAL	84379	183493	267872	

CROPS ON F0+F1

RABI SEASON		AUS SEASON		AMAN SEASON		ANNUAL CROPS	
HYV BORO	11522	B. AUS	60710	HYV TAM	43315	SUGARCA	30796
WHEAT	22987	HYV AUS	7191	L.T. AMA	19208	ORCHAR	399
POTATO	24731	JUTE	12011	VEGETAB	260		
TOBACCO	18652	OILSEEE	3174	SPICES	1312		
PULSES	16989	SPICES	1988				
OILSEED	6348	VEGETAB	866				
SPICES	1988						
VEGETABLES	606						
Sub-Total	103823	Sub-Total	85940	Sub-Total	62783	Sub-Total	31195
Total	283741						
CROPPING INTENSITY	161						

CROPS ON F2 LANDS

HYV BORO	26005
DW AMAN	47394
PULSES	4739
JUTE	0
L.BORO	0
Total	78138
CROPPING INTENSITY	141

CROPS ON F3 LAND

HYV BORO	23954
LOCAL BORO	408
D.W.AMAN	17523
PULSES	0
Total	41885
CROPPING INTENSITY	118

Grand Total	403764
CROPPING INTENSITY	151

The main physiographic units represented in the area are the Ganges Floodplain, Teesta Floodplain including the Atrai Floodplain as a sub-unit, Old Floodplain Basins, and Barind Tract. The Ganges Floodplain dominates the area.

The main soil type in the area is non calcareous Dark Grey Floodplain Soils: these mainly comprise dark grey heavy clays which occupy moderately deep or deeply flooded basin sites which stay wet for all or part of the dry season.

13.2.2 Cropping Patterns

Cropping patterns are dominated by paddy, although there is quite widespread cultivation of rabi crops and cash crops such as sugarcane and betel leaf. As would be expected from the wide variation in flood depths, the types of paddy grown also vary.

The most important crop is HYV boro, grown under irrigated conditions in the dry season. The expansion in HYV boro cultivation occurred quite early in Chalan Beel as a response to flooding and technological innovation (the introduction of the LLP and later the STW). Very high yields of HYV boro have been reported in parts of the area.

Taking all the polders together, the area of b. aman and t. aman cultivated is quite similar, although there are variations between the polders: for example, in Polder C the b. aman area is larger, while in Polder D the t. aman area appears to be larger (mostly local aman).

If a comparison is made between conditions at the time of the original feasibility study in the early 70s and conditions at present, there have been some major changes in cropping patterns, at least in terms of types of paddy. The major change has been the introduction of HYV boro cultivation but, as already stated, this is not due to flood control. Another major change has been a sharp decline in cultivation of b. aus and mixed b. aus/b. aman, but this is primarily a reflection of the switch to boro cultivation.

There has been a decline in b. aman cultivation of possibly about one-third: some of this decline is probably also a reflection of the substitution of HYV boro in a single-cropped system. Some of the decline also probably reflects replacement of b. aman by t. aman, since the expansion of the latter crop is another significant change. In this sense flood control has had some impact in reducing flood depths to allow cultivation of t. aman, although a relatively high proportion is local t. aman still exists.

There has not, however, been any major change in cropping intensities. In fact in some areas cropping intensity has reduced. For example, the feasibility study report gives a cropping intensity of 155% for Polder A (in 1967/68), while the recent Assessment Study gives a cropping intensity of 145%. Respective intensities for Polder B are 149% and 159%, and for Polder C 131% and 146%. The FAP 12 PIE of Polder D gives a current cropping intensity of 124% against 137% in the feasibility study report.

The changes discussed above also have to be viewed with some care since the Assessment Study cropping patterns are based on what farmers would normally grow. In more recent years, crop production in all the polders has been adversely affected by numerous breaches and public cuts, which not only cause crop damage, but also cause some farmers to revert to what they see as safer crops, i.e. b. aman rather than t. aman. The breaches and public cuts are symptomatic of the general problems with the overall flood control development concept.

About 66% of the land area is highland or medium-highland, but this leaves a substantial amount of land which is medium or lowland. Most of this land lies close to the Atrai River in the Chalan Beel system.

Overall cropping intensity is 151%, based on 1989 BBS statistics, and irrigation coverage is 35%. HYV boro is the main dry season crop, but there are many other important crops including b. aus, wheat, potato, pulses, tobacco and jute. Sugarcane is also a major annual crop on the higher ground.

In the aman season the total aman area is almost equally divided between t. aman and deepwater aman. Within t. aman, HYV t. aman is now significantly greater than local t. aman.

Cropping patterns are shown in Table 13.2.

13.2.3 Crop Damage

Crop damage can be expected during high flood years, and also as a result of breaches and public cuts in embankments. In the 1987 floods an estimated 38% of the planted area of aman crops was fully damaged, while in 1991 the corresponding figure was 12%. All of the Chalan Beel polders are badly affected by crop damage. Details on the impact of the existing FCD schemes are presented in Section 13.8.

13.3 Present Fisheries

The Atrai right bank contains some 72000 ha of water bodies which yield about 8700 tonnes of fish annually.

Fishing Sector	Area (ha)	Yield (KG/ha)	Production (mt)
Beels	9920	220	2182
Rivers	7600	78	593
Flood Plains	50000	69	3450
Total Capture Fish:	67520		6225
Fish Ponds:			
- Cultured	1450	950	1378
- Culturable	2137	450	962
- Derelict	1176	120	141
Total Culture Fish:	4763		2481
Overall Total:	72283		8706

The 1992 Assessment Study estimated a total of 6772 full-time fishermen in Polders A, B, and C. The FAP 12 PIE of Polder D estimated another about 2500 full-time fishermen in that polder. In addition, a large number of households undertake subsistence fishing during the monsoon: the Assessment Study estimated over 33,000 involved in Polders A, B, and C.

Both studies point out the significant decline that has taken place in capture fisheries: FAP 12 estimate a decline of around 40% in catches in Polder D. Part of this decline can be attributed to the FCD development although there are also other causes. The benefits expected to aquaculture have not taken place as expected.

13.4 Infrastructure

13.4.1 Major Infrastructure and Industry

Major infrastructure is mainly highways and feeder roads. The Bogra-Natore and Rajshahi-Naogaon highways run through the area and there are large bridges, for example at Singra. The railway line between Naogaon and Ishwardi passes north-south through the Lower Atrai Basin and includes a number of bridges, e.g. the bridge over the Atrai River. The railway line is subject to wave action during floods.

There are many feeder roads connecting the thanas: important feeder roads are:

- Bagmara-Mohanpur
- Mohanpur-Tanore
- Ahmedpur-Baraigram-Gurudaspur
- Atghoria-Chatmohor-Bhangura.

Despite the above roads, there is not a dense road network in the area and boat communication remains important especially during the monsoon.

The main industries in the planning unit, although outside the Chalan Beel polders, are jute and sugar mills:

- Hariana Sugar Mill (Paba Thana)
- Hariana Jute Mill (Paba Thana)
- Rajshahi Jute Mill (Rajshahi Thana)
- Natore Sugar Mill (Natore Thana)

These industries are mostly situated on high land and are not affected by flood, but the sugar mills maintain a number of roads for carrying sugarcane from the fields. These roads are usually damaged by moderate flooding.

13.4.2 Infrastructure Damage

In 1987 there was very large damage to BWDB infrastructure (Tk. 1007 lakh). This reflects widespread damage to the Chalan Beel polder embankments, and also to the Ganges Left Embankment downstream of Rajshahi. In the same year damage to LGEB infrastructure was estimated at Tk. 106 lakh.

In 1988 BWDB infrastructure was damaged even more, at Tk. 1496 lakh, in the same locations. LGEB infrastructure damage was estimated at Tk. 240 lakh. In this case the damage was mainly in the south of the planning unit, in the Barnai and Baral project areas.

In the 1988 flood an estimated Tk. 372.5 lakh of damage was caused to R&H roads and bridges.

The Mohanpur-Tanore road is affected by floods almost every year.

There are also many rice husking mills which are often affected by moderate flooding. The larger mills, involved in the growing business of rice export out of the area, are mostly located along the main roads on higher ground.

13.5 Special Issues

(i) Environment

The Chalan Beel area of the Lower Atrai Basin was once the largest and best known beel in Bangladesh. The beel was formed when the old Brahmaputra changed its course into the Jamuna channel. The Jamuna impeded the flow of the Padma (Ganges), causing the latter to deposit sediment at the mouths of the Karatoya and Atrai Rivers. The diverted flow of these rivers created the beel. The beel is rapidly silting up, however. Over the last 150 years, the southern edge of the beel has shifted about 20 km. northwards due to silt deposition by the Padma. Originally, the whole area of the beel was about 107,000 ha., more recently it has been about 25,000 ha., of which most is only seasonal beel area giving only about 2500 ha of permanent water body. Nonetheless, prior to polderisation, most of this area was flooded during the monsoon to depths of upto 3-4 metres.

Chalan Beel was formerly a very important wintering location for ducks, geese and wading birds, but with drying out of the beel in early winter, relatively few migrant birds now visit. During the monsoon, however, the beel is still important for a wide variety of resident waterfowl.

Capture fisheries remain important and many households depend on these fisheries, as noted above. The construction of FCD works has contributed to a decline in capture fisheries, although this decline would have been greater had the polders functioned as intended.

The role of Chalan Beel as a retention reservoir, effectively attenuating peak flooding from upstream and backwater influences from downstream, has not been fully assessed but is probably important. It is therefore not surprising that the polderisation of the whole area has actually worsened flooding problems in Chalan Beel and in adjacent areas.

The environmental evaluation of Polder D undertaken by FAP 12 gives an analysis of the impacts of polderisation which is probably fairly representative of all the polders. The evaluation finds quite significant negative impacts (-2) within the polder on the extent of waterbodies, fish communities/habitats, micro-fauna and aquatic vegetation, equity and social cohesion, institutional activity, public participation and cultural continuity (particularly Hindu fishermen having to give up fishing).

Quite significant positive impacts (+2) were found in terms of reduced flooding and increased land availability, i.e. the project achieved some of its stated aims (although not to the extent expected) but at the cost of the above negative factors.

The worst negative impacts (-3) however have been on areas outside the polder, particularly the Shib River area and downstream areas. These negative impacts are on river flow, river morphology, worsened flooding and drainage, reduced crop cultivation, damage to infrastructure, reduced human carrying capacity of outside areas, reduced health and nutrition, increased disruption, reduced safety and survival capacity, decline in social cohesion (demonstrated by public cuts and confrontations between gainers and losers), decline in incomes, employment and land values, lack of public participation and overall decline in quality of life.

This long list of severe negative impacts only strengthens the case for adopting an integrated basin-wide approach to planning in such areas.

(ii) Gender

There are few sources of information specifically on women's status or activities in the area. The FAP 12 PIE assesses the impact of Polder D on women. It concludes that there has been a modest increase in women's work, mostly associated with crop processing. Rice husking work, however, has declined since more rice is now husked using STW engines. There appear to have been increases in production from homestead plots, and increases in ownership and rearing of small livestock: both activities tend to be carried out by women. These increases have occurred equally in the "control" area, however, so are probably not attributable to polderisation.

The FAP 12 survey and FAP 2's own surveys indicate that there is still a period of food crisis during the monsoon, with a peak around August, and at this time women reduce their consumption more than anyone in the household. Furthermore, FAP 12 indicate that in general the rice intake of women is 20-25% less than that of men. Nonetheless in general FAP 12 found low incidence of poverty and generally adequate levels of nutrition.

FAP 12 also enquired about women's main problems during floods. The main problem related to adequate sanitation facilities, followed by safe drinking water. The emphasis on problems with latrines was also found in FAP 2's surveys.

(iii) Navigation

The boat sector has been transformed by mechanisation and is now competitive with truck transport. Boats are the main form of goods and passenger transport in the area during the monsoon and are able to penetrate into many areas where there are no road facilities. In this respect boat transport enables the marketing of produce from quite remote locations. The boat sector is also an important source of local employment.

The impact of polderisation has been quite strongly negative on boat transport. Although main rivers have been kept open, the connections of those rivers with hundreds of natural channels have to a large degree been cut off by the embankments. Another major factor inhibiting boat transport is the seasonal drying out of the Atrai and other rivers. People make cross dams at various locations, mostly to facilitate irrigation and other uses, and stretches of the rivers are consequently unnavigable for upto 6 months. This cross bunding of channels is a serious cause of increased sedimentation int eh channel network which has many additional effects. Other stretches can be navigated only by small boats.

Information from FAP 2's initial navigation survey in Chalan Beel shows that traders make good use of boat transport during the monsoon and would do so during the dry season if boats could ply. The single most important trade is in paddy. Local traders collect paddy from rural markets and transport it to the large boiler mills: outside traders then carry the husked rice out of the area.

The problems of seasonal drying up of the rivers (added to by increasing siltation) and the blockage of routes by embankments constrain the growth of the sector despite its new-found competitiveness. The restoration of links between rivers and channels inside the polders, either by providing navigation locks, landing points at the confluence of major channels, or weirs or gaps in the embankments where full FCD is not functioning properly, needs to be carefully considered.

13.6 The River System

There are a large number of rivers in the planning unit, of which the Atrai River is the main one. The Chalan Beel system is bounded by the Lower Atrai to the north and east, the Shib River to the west, and the Barnai and Baral-Nandakuja Rivers to the south. The Shib River joins the Barnai River in the south west, and the Atrai and Barnai Rivers are linked by the Fakirni River between Polders D and C. The Barnai River flows into the Atrai-Gur River just south of Singra Bridge (between Polders C and B), and the Baral-Nandakuja River joins the Atrai-Gur at Gurudaspur (between Polders B and A). Just south of Gurudaspur, the Bhadai River flows into the Atrai-Gur from the north east.

The concept of polderisation was intended partly to take into account the large number of rivers: although the need for embankments would thereby increase, there would be less interference with the hydrology of the area and navigation along the rivers would be maintained. Nonetheless, confinement of the Atrai River has had a significant effect in raising monsoon water levels and on the effectiveness of the polders themselves. In hindsight it is clear that there has been inadequate allowance for flood plain conveyance, adjacent embankments have been built for too close to each other and consequently too close to the active channel.

The upper reaches of the Lower Atrai are subject to flash floods, but there is an attenuation effect further downstream, even though this effect has been reduced by FCD works. From about mid-late June onwards there is a backwater effect from the Jamuna River which influences water levels nearly upto the Atrai railway bridge. These characteristics are shown in the flood hygrographs for different stations along the Atrai. At the upstream end at Mahadebpur, hygrographs for both 1988 and 1989 show a repeated series of peaks and troughs during June-early October. Moving downstream, the attenuation effect and backwater effect result in smoothing of the peaks and troughs although there are still indications of 1-2 peaks. The attenuation effect continues partly as a consequence of failure of the embankments: the polders still partly act as retention reservoirs in contradiction to their aims.

The Baral used to carry significant flow from the Ganges into the Chalan Beel area during monsoon; the mouth of the river was closed around 1980 and a regulator was placed at the offtake which now controls the inflow from the Ganges into the planning unit. Atrai, Baral and Shib-Barnai together mainly control the hydrological condition of the planning unit 13.

Discharge and water level data of Naohata, Malonchi and Atrai railway bridge, and Naldangla railway bridge on Shib, Baral, Atrai and Barnai rivers respectively are given in Table 13.3 and 13.4 respectively.

Rainfall data of Natore and Atrai are given in Table 13.5 as representative stations of the planning units.

Table 13.3 Max Mean Daily Discharges (m³/s)

Gauge Station	July				August				September			
	1:2	1:20	1987	1988	1:2	1:20	1987	1988	1:2	1:20	1987	1988
Malonchi (Baral)	332	624	38	136	583	958	155	135	623	1010	135	161
Atrai RB (Atrai)	455	727	754	320	509	773	806	365	465	673	575	323
Noldanga (Barnai)	95	156	126	176	107	164	152	185	113	156	125	161

* Frequency analysis with data before 1982.

Table 13.4 Max Mean Daily Water Levels (m PWD)

Gauge Station	July				August				September			
	1:2	1:20	1987	1988	1:2	1:20	1987	1988	1:2	1:20	1987	1988
Malanchi (Baral)	13.92	14.50	11.38	12.77	14.82	15.38	12.89	12.78	14.84	15.42	12.57	13.19
Atrai RB (Atrai)	12.97	13.79	14.03	13.72	13.19	13.99	14.18	14.14	13.10	13.82	13.36	14.31
Noahata (Barnai)	13.59	14.56	14.35	14.57	13.87	14.97	15.34	15.14	14.03	14.95	15.07	15.02
Naldanga (Barnai)	13.01	13.48	12.82	13.37	13.37	13.82	13.80	13.64	13.47	13.87	13.57	13.73

Table 13.5 Rainfall (mm/month)

	July				August				September			
	1:2	1:20	1987	1988	1:2	1:20	1987	1988	1:2	1:20	1987	1988
Natore	344	584	540	392	280	510	476	280	228	466	277	105
Atrai	346	705	532	250	273	508	176	430	174	701	206	72

13.7 Existing FCD Developments

FCD development in the Lower Atrai basin has been in process since the late 70's with the original construction of the embankments for Polders A.B. and C. There are now various existing schemes and on-going projects, many with different protection standards and design criteria.

In the planning unit as a whole, the following FCD developments exist or are under construction or planning:

- Chalan Beel Polder A - 30,690 ha
- Chalan Beel Polder B - 32,105 ha
- Chalan Beel Polder C - 43,640 ha

- Chalan Beel Polder D - 53,110 ha
- Barnai project - 56,580 ha
- Baral Basin project
- Ganges Left Embankment.

Chalan Beel Polder A is incomplete. It comprises about 18 km. of embankment following a village road on the Atrai-Gur right bank, and the condition of the embankment is very poor. Culverts are built on the road-cum-embankment to facilitate its function for communication, but the culverts allow the entrance of river flooding during the monsoon causing crop damage.

Polder B is also incomplete. The original plan proposed 86 km. of embankment but so far only 48 km. has been completed. The embankment was built on the Atrai right bank but not along the Nandakuja; about eight sluices have been constructed to protect against river flooding. One public cut was made in 1988 to relieve flooding near Singra, but generally the embankment is not cut in this (potential) polder. The banks of the Nandakuja are quite high and embankments are not thought to be necessary there. In the 1980s part of the polder came under the coverage of the Barnai River sub-project.

Construction of Polder C was started in 1973-74 by FFW. About 152 km. of embankments were constructed and 11 sluices. The polder has suffered a large numbers of public cuts and breaches and does not function properly.

Construction of Polder D started in 1982: 138 km. of embankments and 17 sluices were completed by 1987 with IDA funding. However, public cuts of the west embankment at Tengra (Tanore thana) to relieve flooding of outsiders by the Shib River has caused serious flooding and crop damage inside the polder.

The Barnai project (63,000 ha) is under construction through the IDA-funded FCD-IV programme, and scheduled for completion in 1993. The Barnai project lies to the south of Polders C and D. Construction started in 1990 and 50 km. of embankment are planned to be built on the right bank of the Barnai River: this construction is almost complete and construction of structures is underway. The southern boundary is the Rajshahi-Pabna road, whilst the northern boundary is the Shib-Barnai river. The project area drains towards the north-east, with provision for some flushing from the Shib-Barnai with LLP. The project would be affected by other proposals for the Lower Atrai to the extent that further development may raise confinement levels and reduce freeboard. On the other hand, any reduction in levels or flows may have an effect on the dry season flushing supplies. The project itself has a significant impact in raising levels on the Shib-Barnai.

The Baral Basin project is an irrigation/drainage project currently under study with CIDA funding. The purpose of the proposed project is to increase agricultural production in the project area through irrigation development. The project area covers about 1000 sq. km. The Baral Basin project is planned as a lift irrigation project: the scheme provides for irrigation from the Ganges River with large scale pumps. At present there is a regulator across the Baral River at Charghat where it flows into the Ganges and where monsoon spillage into the Baral is controlled: the proposals for further development involve building another regulator across the Baral River at Atghoria to create a reservoir: this would be supplemented by pumping from the Ganges River and the water would be used, probably for supplementary irrigation of t. aman.

13.8 Flooding and Drainage Problems

Between 1982 and the present there were over 100 public cuts in the Chalan Beel polders: most of these have been in Polders C and D. The latter polders have therefore not functioned according to design. Most public cuts have been made by people living outside the polders, but it should be recognised that a high proportion of people with land inside the polders actually live on the river bank outside: this is particularly the case in Polder C. It is therefore not simply a case of gainers inside and losers outside: if water enters into the polders through a breach or cut, it is often necessary for people inside the polder to make a further cut to drain the water out. It is clear that, at least in Polder C, the drainage structures are inadequate to drain out the water that collects inside the polder. This particularly applies when the polders are flooded due to cuts: drainage designs can not be expected to accommodate such situations.

The case of Polder D is rather more straightforward: the main public cuts are made on the western embankment by outsiders whose lands and houses are severely flooded almost every year by the Shib River. The cuts cause a huge volume of water to rush into the polder, causing extensive crop damage.

Therefore, although in Polders C and D there appears to have been some switch on basin margins from b. aman to t. aman, this switch is not secure, and both b. aman and t. aman are now being extensively damaged. Farmers express a common desire to be able to get a secure b. aman crop: this aim may now be more important than taking the risk of trying to plant a t.aman crop.

Polder A has also not been effective, but that is partly because it has never been completed, and the main regulator has to be rebuilt. In addition, the area is subject to overtopping by rising water confined between the polder and the SIRDP embankment at Taras.

Polder B has been more effective but has been cut on some occasions, and the drainage system is not fully effective.

In addition to the problems within each polder, these are compounded by the interaction between polders, and between these polders and other FCD works in the basin. The construction of the Bogra Polders, for example, has combined with the Chalan Beel Polders to give a significant rise in Atrai water levels. Further downstream the SIRDP embankment continues the confinement effect. The cuts in Polder D cause an onrush of water that ultimately drains into the Fakirni River and results in cuts and breaches in Polder C.

In conclusion, the system as a whole is not working and needs redesign. An overall assessment of the area, taking into account external and downstream impacts, would almost certainly conclude that the developments as a whole have not been effective in meeting their stated aims and in addition have had further negative impacts in terms of loss of fisheries, increased social conflicts etc.

13.9 Planning

13.9.1 Approach to Planning

Planning for the Lower Atrai is based on the premise that full protection and exclusion cannot be made to work in the basin: even if it did, it would be at the expense of other areas and might only function properly for a short time. The basic reason why full protection cannot work is the volume of flow that comes into the area which cannot be drained because of the backwater influence of the Brahmaputra. This flow, once confined, builds up large head differences between "protected" and

"unprotected" areas. In addition, construction has gone ahead without proper consideration of people outside the polders who are adversely affected. These people contribute to the failure of the system by cutting the embankments, but even if they were compensated or resettled, the basic hydrological condition of the basin would still be likely to frustrate full protection.

It should be noted that, at this stage, many farmers would be satisfied if they could get a b. aman crop in most years. Instead of ambitious plans to replace b. aman by t. aman, in some areas neither crop can now be obtained because of the impact of breaches and cuts. It is worth emphasising that there has been remarkable growth in paddy output in the Chalan Beel area, but this has mostly been a result of introducing irrigated HYV boro, which is not dependent on flood control (except for occasional flash floods). Farmers are mostly dependent on HYV boro to give them food security and a surplus, while the aman crop is now seen as an important supplementary crop. A safe, if lower-yielding crop, in the monsoon season would probably satisfy most farmers.

In addition, when the needs of capture fisheries and navigation are taken into account, a strong case emerges for a system which allows more scope for the gradual flooding which used to occur before polderisation. The proposed options for development are based on these considerations.

The implications of all the options considered are that the level of nominal protection and size of protected area will be less, but the benefits on a basin-wide measurement should nonetheless be greater. The principle to be aimed at is to reduce the confinement effect while at the same time allowing productive activity (probably b. aman and fisheries). In some more upland areas where t. aman could be grown, there might be a case for providing more effective flood control. As on the left bank the concept of compartmentalisation (meaning the prevention of flood flows across drainage basin boundaries where possible) has been an integral part of basin planning.

The flood retention function of the Chalan Beel polders have also been taken into account in option planning. Where areas are being considered as offstream storage areas, flood proofing measures to deal with severe floods are important.

13.9.2 Planning Options

Polder A

Option 1

The area has been divided into three sub-units based on topographic features. A sub-unit adjacent to the Atrai is provided with partial protection only; crops in this area are frequently damaged due to the onrush of flood waters. In the remaining areas, controlled flooding and drainage facilities will be provided. Provision of the controlled flooding area will also reduce the confinement effect. Drainage improvements are also proposed.

Option 2

Controlled flooding and drainage measures were considered for the whole area of Chalan Beel A. Since the area provided with partial protection under Option 1 in quite small, Option 2 would have little effect on raising levels. However the area which would be enclosed under Option 2 is an area of deep flooding and an important area for fisheries.

Polder B

Option 1

Polder B is divided into four sub-units based on its topographic features. Partial protection is proposed in the low lying area adjacent to the Atrai and Barnai rivers. More comprehensive controlled flooding and drainage measures are planned for the remaining area.

Option 2

If sufficient flow width and flood storage are made available on the left bank of the Atrai, opposite Polder B, this may enable the more comprehensive flood control and drainage measures to be considered for the whole of Polder B including the low-lying area adjacent to the Atrai and Barnai rivers.

Polder C

A large part of polder C would be allocated to allow flood flows at peak monsoon.

A structure is proposed at Bandiakhari to allow flood flows in the polder C and natural flood flows to the beel Halti. Since the driving head along Atrai is more than the Barnai there will be an outfall structure on the Atrai upstream of Singra.

Three small areas of Polder C which are on higher ground may be divided into three sub-polders for controlled flooding and drainage measures. The embankment would be strengthened with a berm for improvement and stability. In this polder brick mattressing work in embankments to prevent wave attacks will be considered.

Flood proofing are proposed for unprotected areas inside the polder and affected areas outside the polder. Due to the importance of boat transport in the Lower Atrai, adequate navigation facilities are planned.

Polder D

The main requirement in Polder D is to make provision for drainage from the Shib river on the western boundary across the polder to the Fakirni in the east. (This proposal is similar in concept to that of the Chalan Beel study recently carried out by MARS consultants).

For improvement of the agricultural production the area is divided into three sub-polders, the northern area is Compartment D/1, the middle area is compartment D/2, the southern area is compartment D/3. Compartment D/1 and Compartment D/3 will be provided with CFD facilities. However the compartment D/2, which allows drainage of Barind Tract west of Polder D, will be provided with dwarf embankment for protection of DWT Aman. The crest level of the dwarf embankment is fixed at water level of 5 year return period on 3rd decade of June ,depending on the protection of DWT Aman. This adjustment in the plan will solve the drainage problem of the west of the Polder D area and improve the low area of the Polder D by protecting TDW Aman.

All of these options would require sub-poldering within Polder D, with the intention of maximising agricultural, fisheries and navigation benefits as appropriate. Andasuria beel in the northern Polder

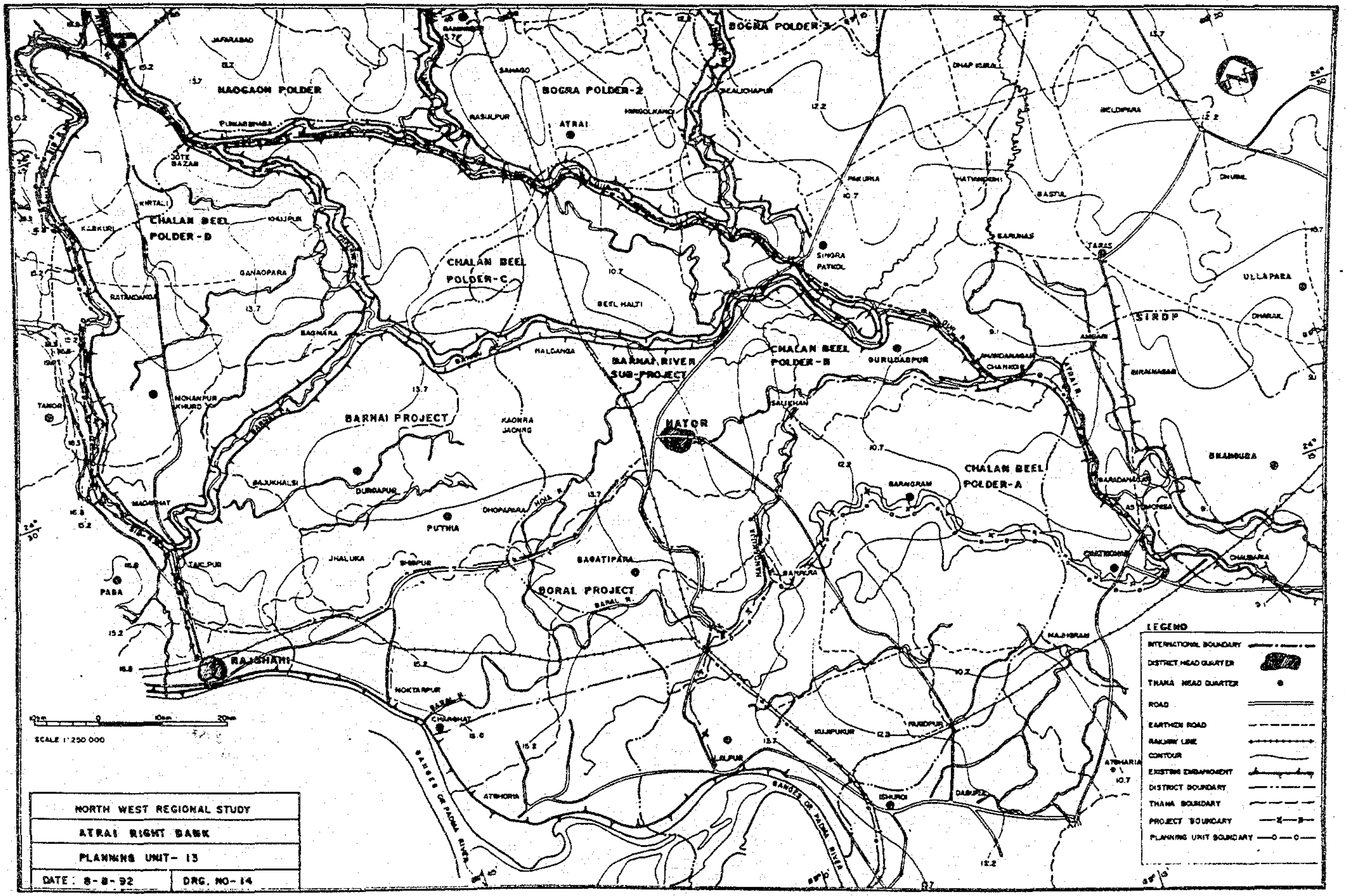
D is an important area for a possible conservation project since it contains at present a wide diversity of species.

Barnai Project

This project is nearing completion. As its effect on confinement levels in the Atrai is small, no alternative plans have been prepared. However, it has significant impact on levels in the River Shib, and therefore has implications for planning in Polder D. Thus its impacts should be monitored.

Baral Basin Project

This project is under study. Proposals being made include strengthening of the Ganges left embankment. As the effect of the proposed project on confinement levels and other scheme areas in the Atrai is small, no alternative plans have been prepared.


NORTH WEST REGIONAL STUDY
ATRAI RIGHT BANK
PLANNING UNIT- 13
DATE : 8-8-92
DRG. NO- 14
LEGEND
INTERNATIONAL BOUNDARY
DISTRICT HEAD QUARTER
THANA HEAD QUARTER
ROAD
EARTHEN ROAD
RAILWAY LINE
CONTOUR
EXISTING EMBANKMENT
DISTRICT BOUNDARY
THANA BOUNDARY
PROJECT BOUNDARY
PLANNING UNIT BOUNDARY
SCALE 1:250 000
NAOGAON POLDER
BOGRA POLDER-2
BOGRA POLDER-3
CHALAN BEEL POLDER-D
CHALAN BEEL POLDER-C
CHALAN BEEL POLDER-B
CHALAN BEEL POLDER-A
BARNAI RIVER SUB-PROJECT
BARNAI PROJECT
BORAL PROJECT
SIRDP
NATOR
RAJSHAHI
ATRAI
PUTHIA
GURUDASPUR
BAGATIPARA
ULLAPARA
BHANGURA
CHATMOHAR
TAHOR
PABA
GANGES OR PADMA RIVER

PLANNING UNIT 14

LOWER BANGALI BASIN

14.1 Basic Data

The planning unit is situated in the district of Pabna, Sirajganj and Natore. Sirajganj-Komarganj-Sherpur road is situated on the north of the planning unit, the River Brahmaputra in the east, the River Baral-Hurasagar in the south and the Bhadai River in the west.

Basic data of the planning unit is presented in Table 14.1. The gross area is 18,200 ha.

In 1981 the population was 1.33 million, at a density of 7.3 persons per ha gross. Population densities are above average for the region, particularly in the partly-urbanised thanas. In Taras it is much lower. This may be partly a reflection of the relative isolation of the thana, and the regular flooding which occurs there.

14.2 Present Agriculture

14.2.1 Soils

Agro-echologically the area falls within Karotoya-Bangali flood plains, lower Atrai Basin, Active Brahmaputra - Jamuna floodplain and level Barind tract. Topographically the area is relatively level to gently undulating with local areas of irregular relief near the river channels. The soils are mostly medium to moderately fine textured (silt loam to silty clay loam) to moderately fine textured (silty clay to clay).

14.2.2 Cropping Patterns

Almost 60% of the land area is highland or medium-highland, but this leaves a substantial portion of land which is medium to lowland. Cropping patterns are therefore constrained by flooding conditions over much of the area.

Overall cropping intensity is 155%, based on 1989 BBS statistics, and irrigation coverage is high at 44%.

The main dry season crop is HYV boro, while b. aus, wheat and pulses are also widely grown. In the aman season, t. aman is more important than b. aman, and local t. aman more widespread than HYV t. aman.

Cropping patterns are shown in Table 14.2.

Table 14.1 Planning Unit 14 Basic Data

Thana	Percentage in Planning Unit	Percentage in Thana
TARASH	13	79
SIRAJGANJ	3	18
SANTHIA	tr	1
CHOWHALI	1	11
CHATMOHAR	4	24
SAHJADPUR	17	92
RAIGANJ	9	62
GURUDASPUR	tr	2
ULLAPARA	23	100
SHERPUR	9	55
BELKUCHI	6	77
FARIDPUR	4	49
KAMARKANDA	5	86
BHANGURA	5	80
BERA	tr	3

Gross Area (ha) : 181874
Nca Area (ha) : 157310

Total population (1981) : 1334040 Population Density : 7.33
(per ha Gross area)

Flood Phase :

F0 (ha) :	36932	F0 % of NCA (ha) :	23
F1 (ha) :	56593	F1 % of NCA (ha) :	36
F2 (ha) :	35429	F2 % of NCA (ha) :	23
F3 (ha) :	25203	F3 % of NCA (ha) :	16
F4 (ha) :	3154	F4 % of NCA (ha) :	2

Irrigation Equipment Operating :

STW 81	1529	STW 89	14362
DTW 81	39	DTW 89	401
LLP 81	299	LLP 89	345
Irrigation Coverage (%) Yr 81	7	Irrigation Coverage (%) Yr 89	44

TABLE 14.2 CROPPING PATTERN

LAND TYPE	AMOUNT(HA)
F0	36932
F1	56593
TOTAL	93525
F2	35429
F3	25203
TOTAL	
F4	3154
GTOYAL	157310

IRRIGATION BALANCE	
HYV BOR	50253
WHEAT	15518
HYV AUS	3445
TOTAL	69216

DISTRIBUTION OF LAND BY IRRIGATION STATUS BY FLOOD PHASE

LAND TYPE	IRRIGATE AREA	NONIRRI AREA	TOTAL AREA	% IRRIG
F0	7276	29656	36932	20
F1	16978	39615	56593	30
TOTAL	24254	69271	93525	
F2	24800	10629	35429	70
F3	20162	5041	25203	80
F4			3154	
TOTAL	69216	88094	157310	

CROPS ON F0+F1

RABI SEASON		AUS SEASON		AMAN SEASON		ANNUAL CROPS	
HYV BORO	5291	B. AUS	27906	HYV TAM	21946	SUGARCA	2066
WHEAT	21060	HYV AUS	3445	L.T. AMA	33915	ORCHAR	145
POTATO	8965	JUTE	8473	VEGETAB	85		
TOBACCO	1320	OILSEEE	7446	SPICES			
PULSES	11872	SPICES	1872				
OILSEED	0	VEGETAB	200				
SPICES	1872						
VEGETABLES	150						
Sub-Total	50530	Sub-Total	49342	Sub-Total	55946	Sub-Total	2211
Total	158029						
CROPPING INTENSITY	169						

CROPS ON F2 LANDS	
HYV BORO	24800
DW AMAN	18788
OILSEED	4989
PULSES	7515
	50
Total	56092
CROPPING INTENSITY	158

CROPS ON F3 LAND	
HYV BORO	20162
LOCAL BORO	759
D.W.AMAN	9323
Total	30244
CROPPING INTENSITY	120

Grand Total	244365
CROPPING INTENSITY	155

14.2.3 Crop Damage

Crop damage in the area is largely the result of inflows from the Brahmaputra through breaches in the BRE, but there is also crop damage due to flows from the Lower Atrai through the SIRDP embankment at Taras. Crop damage is therefore widely distributed throughout the planning unit.

In the 1987 flood an estimated 47% of the planted areas of aman crops was fully damaged, while in 1991 the corresponding figure was 19%

14.3 Fisheries

There are about 50000 ha of water areas in the planning unit, yielding about 5000 tonnes of fish per annum.

Fishing Sector	Area (ha)	Yield (KG/ha)	Production (mt)
Beels	1518	220	334
Rivers	18100	78	1412
Flood Plains	28000	69	1932
Total Capture Fish:	47618		3678
Fish Ponds:			
- Cultured	1357	850	1153
- Culturable	768	120	92
- Derelict			
Total Culture Fish:	2125		1245
Overall Total:	49743		4923

Thana and District data sources for this area contained highly suspect information which has had to be adjusted by FAP 2, based on field observation and better experience elsewhere in NWR .

The area has a problem of very high iron content in tubewell water which makes hatchery work almost impossible.

14.4 Infrastructure

14.4.1 Major infrastructure and industries

The Nagarbari-Bogra - Rangpur road passes through the planning unit from south to north while the Ishwardi-Sirajganj railsway line traverses from south west to north east. An important inland port is located in the Baghabari and an oil terminal is located there. Recently a power station was constructed to strengthen the northern power grid. The area has a large number of cottage handloom industries which are creating job opportunities to poor villagers.

A large milk processing factory is situated at Baghabari, at the confluence of the Atrai and the Bangali.

14.4.2 Infrastructure Damage

In 1987 BWDB infrastructure damage was estimated at Tk. 440 lakh, while that for LGEB it was Tk. 55 lakh. The main BWDB damage was to the BRE embankment but it also occurred along the Hurasagar project embankment.

In 1988 the value of damage to BWDB infrastructure was estimated at Tk. 224 lakh, mainly in the same locations as in 1987. LGEB damage was estimated at Tk. 752 lakh. Some of this was located in the SIRDP scheme area.

An estimated Tk. 540 lakh of damage was caused to R&H roads and bridges by the 1988 flood. A large proportion of this damage was on the Bogra-Rangpur highway.

14.5 Special issues

Environment

The environment of the area has significantly changed after the polderisation of the lower Atrai and lower Bangali basin. The lower part of the SIRDP area is basically a large beel. Large numbers of wild birds and wet land habitat use to stay or visit the beel but their numbers are reducing after polderisation. However, during monsoon 3-4 meter deep water bodies remain in the beel areas.

Navigation

The river Atrai-Hurasagar is navigable round the year, large cargo boats use to ply regularly. The milk processing factory at Baghabari used to maintain the fresh milk supply through the river transportation system. During monsoon river transportation system also include the Karatoya channel. Hence, in planning the flood control facilities possible impacts on the navigation network requires to be investigated.

14.6 Hydrology and morphology

River

Atrai-Gur-Gumani-Hurasagar and Bangali are the major rivers in the planning unit, however the Brahmaputra flows along the eastern border of the planning unit. Other minor rivers in the area are the Durgadaha and Baral.

Gauging Stations

Water level gauge stations in the planning unit are Baral railway bridge on the River Baral, Gumani railway bridge on the River Gumani, Nangoora railway bridge on the River Dargadaha, Ullahpara on the River Bangali, and also at Chanchkoir and Astomonisha on the River Gur. The flow data for the principal river is available at Gumani railway bridge for a significant period.

Discharge and water levels at the Gumani railway bridge and Baghabari gauge respectively are given in Table 14.3 & 14.4.

The rainfall data for Ullapara for the high rainfall months are given in Table 14.5.

Table 14.3 Max Mean Daily Discharges (m^3/s)

	July				August				September			
	1:2	1:20	1987	1988	1:2	1:20	1987	1988	1:2	1:20	1987	1988
Gumani RB	313	996	-	-	497	1260	-	-	542	1069	-	-

Table 14.4 Baghabari Maximum Daily Water Levels (m PWD)

	July	August	September
1:2	10.15	9.99	9.89
1:20	10.61	12.13	12.04
1987	10.53	11.50	10.59
1988	10.55	17.08	12.32

Table 14.5 Ullapara Rainfall (mm / month)

	July	August	September
1:2	358	245	214
1:20	551	669	617
1987	494	419	331
1988	423	301	107

Morphology

The Atrai-Hurasagar river in the area is about 150 to 200 meter wide and the depth of flow at bank level is about 6 to 8 metres. The river meanders but there are no bank movements. The Bangali river is also a meandering one. Since these rivers do not carry much silt in this reach there is little bank movement. The river Brahmaputra is eroding its bank near Betil.

The river Atrai had however abandoned its course quite a few times and adopted new channels as its course. The last change was the adoption of the the Gur course from above Singra by abandoning its course which joined Barnai near the tail end of Chalan Beel Polder C. At present the two ends of this reach of the river are closed by structures.

14.7 Existing FCD infrastructure

The planning unit lies within MPO planning areas 6, 13 and 14.

SIRDP is a "completed" project of 62730 ha gross but still subject to severe flooding, particularly in its southern part. The western embankment was rehabilitated in 1990. A study was undertaken in 1990, which recommended that the southern part should be reserved for controlled flooding, and a side overflow weir was completed in 1991. The part north of the railway line was recommended for full FCD. However, the east embankment is the R&H highway, along which there are 67 bridge or culvert openings. Now, the escape structure was completely washed away during 1991 flood. Besides this there were public cuts and breaches occurred along the western embankment of SIRDP.

The Hurasagar project is IFAD financed FCDI project of --- ha gross and the area is bounded by the BRE on the east the Karotoya river on the west, the Baral and the Hurasagar river on the south. The northern side closed off with a road-cum-embankment and road diversion channel, with objective of providing full FCD to the protected area. Hurasagar scheme was intended to provide full FCDI in year 1990 after completion of retired embankment along Hurasagar river and the works were completed accordingly. However the west and south embankments were breached in mid June, 1991.

14.8 Options for Development

In lower Bangali basin farmers opined that they benefit when they grow b. aman in this area (lower part) instead of t. aman (SIRDP area and Hurasagar Scheme). The possibility of growing TDW aman was also investigated. People living outside the SIRDP area particularly in the Bogra polders have strong belief that the SIRDP embankment is creating drainage constraints. As such they cut the western embankment. People living north of SIRDP area particularly at Taras have also expressed drainage and flooding problem of their area. People living in Taras area wants drainage through SIRDP area.

The existing FCD infrastructure in this planning unit has therefore generally not proved effective, so planning is primarily concerned with redesign of the original projects. Flooding is extensive and regular throughout the lower parts of the area.

SIRD Project

The SIRDP area is divided into 3 sub-units for effective flood control and flood management. Units 1 and 2 are proposed for controlled flooding and drainage and unit 3 is proposed for offstream flood storage and partial protection.

Opening of existing six closed bridge gaps is proposed along the Taras-Nimaichara embankment for allowing flows across the lower sub-unit adjacent to the Atrai. The CFD embankment would follow the Taras-Ullapara road. This area will also be suitable for capture fisheries. Flood proofing facilities should be provided.

For adopting full flood control in the northern sub-units, it is suggested to construct a new embankment along the right bank of Karatoya river from Ullahpara to Chandaikona without disturbing the roads and highway boundary to protect the flow from Karotoya. The right embankment of Karatoya will protect the area from flooding and will close off distributaries (such as the Durgadah) which currently drain through the project area.

The northern portion would be divided into two compartment in respect of drainage facilities and topographical pattern :

Compartment 1

The west of the Durgadah river, the area bounded by Taras-Ullapara road forms the western compartment. The gross area is 11,210 ha.

Compartment 2

The area east of the Durgadah river, bounded by the Dharail-Ullapara road and the Karatoya on the east. The gross area is 15,358 ha.

Hurasagar North Unit

For the north unit the following are the main flooding problems.

- breaches in the BRE,
- backwater effect of Brahmaputra,
- upland drainage from the River Karatoya.

The protection of the north unit depends on the strengthening of BRE south of Sirajgonj. Full CFD embankment is also an option along left bank of Karotoya river from Baghabari to Nalkasengal. The bridge openings along the proposed northern boundary are required to be closed (Sirajgong/Chandganti/Komajpur road), so that no intrusion of water enters into the project area. To divert the rainfall run-off in the upstream area of the Sirajgonj road, a drainage channel could be constructed following the existing channel.

Hurasagar Southern Unit

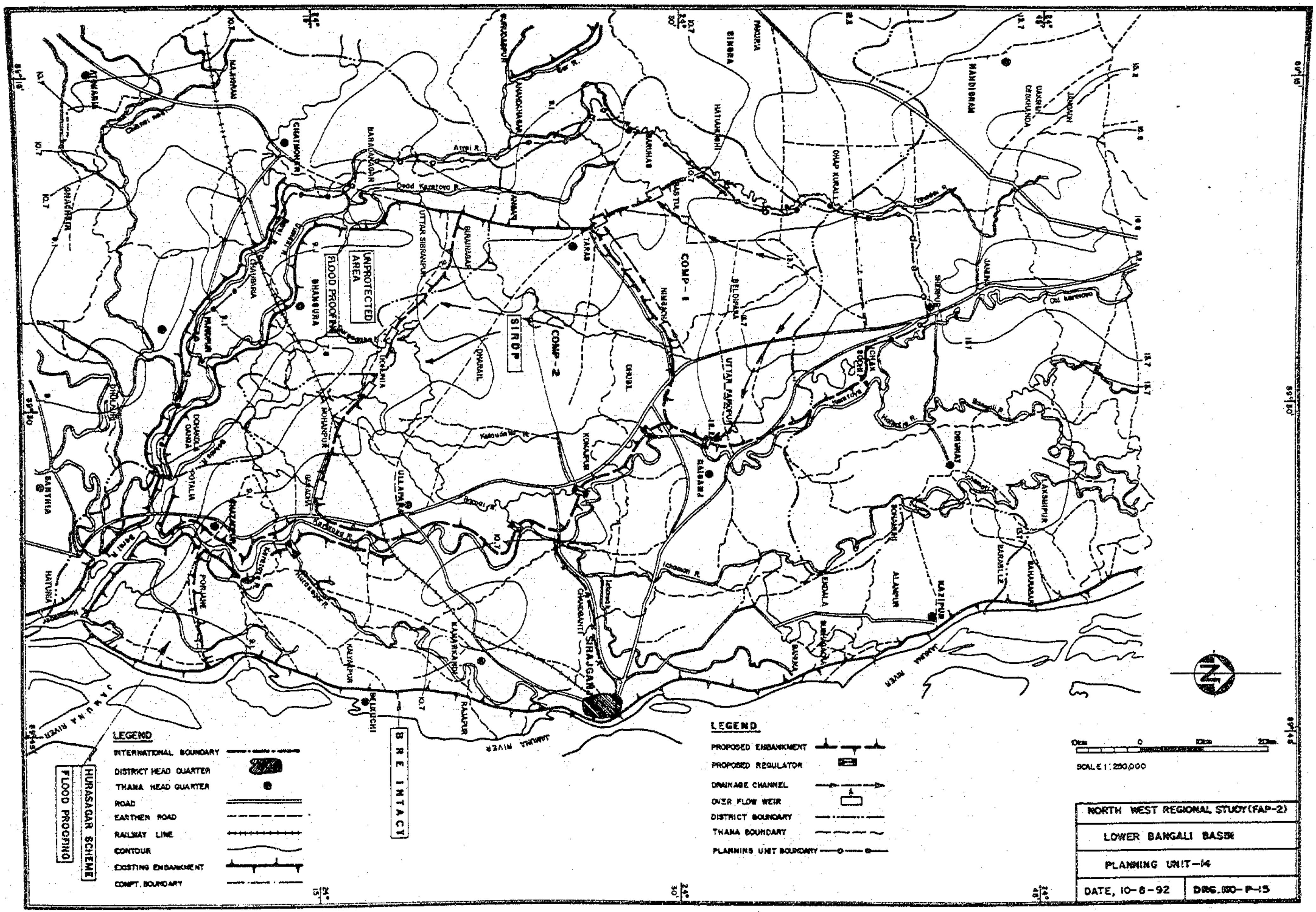
Option 1

This area is nominally covered by the Hurasagar FCD project. However, the project is largely ineffective and the embankments are regularly breached. The area could be an important conservation area for fish recruitment and wild life etc. This option would therefore provide partial protection only to the South Unit, so that it would be subject to flooding during the monsoon period after harvesting boro crops.

Flood proofing will be provided as appropriate to mitigate the suffering of the area.

Option 2

Evidence from Landsat imagery is that, even at the peak of the 1987 floods, the Hurasagar southern unit was not seriously flooded since the Hurasagar at this point has a wide, deep section. Consideration could therefore be given to comprehensive controlled flooding and drainage measures to the Hurasagar area, provided that appropriate designs and methods of construction were applied. Since the area is at the lower end of the Atrai basin, major embankment protection measures would not contribute significantly to adjacent or downstream impacts.



NORTH WEST REGIONAL STUDY (FAP-2)
LOWER BANGALI BASIN
PLANNING UNIT-14
DATE, 10-6-92
DRG.NO-P-15
SCALE 1:250,000
LEGEND
PROPOSED EMBANKMENT
PROPOSED REGULATOR
DRAINAGE CHANNEL
OVER FLOW WEIR
DISTRICT BOUNDARY
THANA BOUNDARY
PLANNING UNIT BOUNDARY
LEGEND
INTERNATIONAL BOUNDARY
DISTRICT HEAD QUARTER
THANA HEAD QUARTER
ROAD
EARTHEN ROAD
RAILWAY LINE
CONTOUR
EXISTING EMBANKMENT
COMPT. BOUNDARY
HURASAGAR SCHEME
FLOOD PROOFING
B R E INTACT
UNPROTECTED AREA
FLOOD PROOFING
SIRDP
COMP-1
COMP-2
SIRAJGANJ
JAMUNA RIVER
NANDIGRAM
SHERPUR
DHUNAT
KAZIPUR
RAIGANJ
TARAS
ULLAPARA
BHANGURA
CHATMOHAR
SHAHZADPUR
SANTHIA
BELKUCHI

PLANNING UNIT 15

PABNA

15.1 Basic Data

The planning unit is situated in the district of Pabna and Natore. The planning unit is bounded by the mighty River Brahmaputra in the east, the River Ganges in the south, Ishwardi-Rajshahi railway line in the west and the River Boral-Hurasagar in the north.

Basic data of the planning unit is presented in Table 15.1. The gross area is 215,000 ha.

The population is 1981 was 1.37 million, at a density of 6.3 persons per ha gross. Population densities in the area are about the regional average. High densities are found in thanas Pabna and Shahjadpur, and low densities in Baraigram.

15.2 Agriculture

15.2.1 Cropping Patterns

The planning unit lies within MPO planning areas 13 and 14. It is covered by the Ganges Flood Plain physiographic unit.

Although rice is the dominant crop in the project area, a wide range of other crops are grown, especially on higher, better drained ground. Improved communications have led to a growth in vegetable cultivation, particularly along the Bagabari-Pabna-Ishurdi road, while the sugar mill at Gopalpur provides an outlet for large areas of cane grown at the north-western end of the project area. In deeply flooded areas, deep-water aman is grown, followed by dry season crops grown on residual moisture. The expansion of minor irrigation has led to a substantial growth in the area of boro rice.

About 50% of the land area is highland or medium-highland, and 50% medium or lowland.

Overall cropping intensity is 154%, based on 1989 BBS statistics, and irrigation coverage is 23% increasing from 6% in 1981

Due to the relatively low irrigation coverage, the HYV boro area is considerably less than b. aus area, and about the same as the wheat area. Other significant dry season crops include pulses and potato.

In the aman season, the total coverage of t. aman is slightly larger than the b. aman area, and within t. aman, HYV t. aman is slightly more important than local t. aman.

Cropping patterns are shown in Table 15.2

Table 15.1 Planning Unit 15 Basic Data

Thana	Percentage in Planning Unit	Percentage in Thana
SANTHIA	14	99
CHATMOHAR	8	58
FARIDPUR	3	51
SAHJADPUR	tr	2
BERA	7	55
ISWARDI	10	77
ATGHORIA	8	100
PABNA	17	100
BHANGURA	1	20
BAGATIPARA	tr	0
BARAIGRAM	13	75
SUJANAGAR	14	81
LALPUR	1	11

Gross Area (ha) : 215481
Nca Area (ha) : 182867

Total population (1981) : 1367332 Population Density : (per ha Gross area) 6.35

Flood Phase :

F0 (ha) :	40402	F0 % of NCA (ha) :	22
F1 (ha) :	51537	F1 % of NCA (ha) :	28
F2 (ha) :	39266	F2 % of NCA (ha) :	21
F3 (ha) :	40884	F3 % of NCA (ha) :	22
F4 (ha) :	10775	F4 % of NCA (ha) :	6

Irrigation Equipment Operating :

STW 81	1176	STW 89	7097
DTW 81	197	DTW 89	569
LLP 81	196	LLP 89	186
Irrigation Coverage (%) Yr 81	6	Irrigation Coverage (%) Yr 89	23

TABLE 15.2 CROPPING PATTERN

LAND TYPE	AMOUNT(HA)
F0	40402
F1	51537
TOTAL	91939
F2	39266
F3	40884
TOTAL	
F4	10775
GTOYAL	182867

IRRIGATION BALANCE	
HYV BOR	28254
WHEAT	13760
HYV AUS	45
TOTAL	42059

DISTRIBUTION OF LAND BY IRRIGATION STATUS BY FLOOD PHASE

LAND TYPE	IRRIGATED AREA	NONIRRI AREA	TOTAL AREA	% IRRIG
F0	2107	38295	40402	5
F1	7731	43806	51537	10
TOTAL	9837	82102	91939	11
F2	11780	27486	39266	30
F3	20442	20442	40884	50
F4			10775	
TOTAL	42059	140808	182867	

CROPS ON F0+F1

RABI SEASON		AUS SEASON		AMAN SEASON		ANNUAL CROPS	
HYV BORO	2849	B. AUS	47220	HYV TAM	33711	SUGARCA	5635
WHEAT	16268	HYV AUS	45	L.T. AMA	25005	ORCHAR	456
POTATO	12142	JUTE	10086	VEGETAB	251		
TOBACCO	4447	OILSEEE	2973	SPICES	2015		
PULSES	10004	SPICES	6037				
OILSEED	0	VEGETAB	838				
SPICES	3053						
VEGETABLES	586						
Sub-Total	49350	Sub-Total	67199	Sub-Total	58967	Sub-Total	6091
Total	181607						
CROPPING INTENSITY	198						

CROPS ON F2 LANDS

HYV BORO	4983
DW AMAN	29792
WHEAT	8760
PULSES	5002
OILSEED	6037
JUTE	2017
L.BORO	0
Total	56591
CROPPING INTENSITY	144

CROPS ON F3 LAND

HYV BORO	20422
LOCAL BORO	814
D.W.AMAN	20957
PULSES	1667
Total	43860
CROPPING INTENSITY	107

Grand Total	282059
CROPPING INTENSITY	154

15.2.2 Crop Damage

Crop damage in this planning unit appears to have been lower than in other planning units with significant proportions of medium lowland. This may be at least partly due to the effectiveness of the major flood embankments.

In the 1987 flood an estimated 21% of the planted area of aman crops was fully damaged, while in 1991 the corresponding figure was 5%. These losses are properly due to internal drainage and the existence of some areas which cannot be drained by grants due to high water levels in the Jamuna River.

15.3 Fisheries

The annual production of fish in the project area in 1990 was, based on to DOF data, 4855 tonnes; with over half coming from capture fisheries. This may be an overestimate, being based on rather optimistic yield levels for some of the areas of capture fisheries. Recalculation using more realistic yields gives a lower estimate of current production of about 3500 tonnes. However DOF data is thought to give a valid indication of historic trends and shows that production has declined by 63% since 1984, a fall which is attributed to the flood protection element of Phase 1 of the Pabna project. The major carps predominate in the ponds, whereas minor carps and other small fish form the bulk of the fish population in the open water capture.

Fishing Sector	Area (ha)	Yield (KG/ha)	Production (mt)
Beels	752	450	338
Rivers	13218	78	1031
Flood Plains	5173	70	362
Total Capture Fish:	19143		1731
Fish Ponds:			
- Cultured	2092	850	1778
- Culturable	684	120	82
- Derelict			
Total Culture Fish:	2776		1860
Overall Total:	21919		3591

Ponds are the principal constituent of the culture fishery which, although comprising only 13% of the surface water area, produces 52% of the total fish catch. Of the 19,791 ponds in the project area, about a third are regularly stocked. The remainder are either stocked irregularly or are derelict.

15.4 Infrastructure

15.4.1 Major Infrastructure and Industries

Road

The project area is transversed by two major national highways running from the important river port of Nagabari. One runs north past Bera to Bagabari and on to Bogra, the other west to Pabna and Rajshahi. Other roads connect thana centres and there is another ferry crossing from Paksey across the Ganges south to Kushtia. However, apart for these links, the internal road network is poorly developed and most minor roads are only suitable for bullock carts.

Rail

The railway line to Rajshahi forms the western boundary of the project area, while a branch line runs from Ishurdi through Chatmohar to Serajganj.

River

Nagabari is an important river port served by a ferry service across the Jamuna to Aricha (and so completes the road link with Dhaka). Boats also ply up the Ganges and Baral rivers on the northern and southern boundaries of the project. River communications within the project area are less important and have declined with the construction of the flood embankment which has prevented access by boats to internal rivers, and reduced the internal water levels. Nevertheless, in the remaining seasonally inundated areas, especially Gozna beel, small country boats remain an important means of communication during the monsoon season.

15.4.2 Infrastructure Damage

No damage to BWDB infrastructure was reported as a result of the 1987 flood, while only Tk. 20 lakh value of damage was reported to LGEB infrastructure.

In 1988 LGEB infrastructure was reported damaged to the tune of Tk. 135 lakh, in the vicinity of Chatmohar, Atgharia, Madhapura and Bera.

An estimated Tk. 83 lakh of damage was caused to R&H road and bridges by the 1988 flood.

15.5 Special Issues

The planning unit covers the area of the Pabna scheme. This is discussed later under section 15.7

The planning unit is at the downstream end of the region. Proposals for the unit will therefore not, is general, have adverse impacts on other parts of the region

15.6 Hydrology and Morphology

The planning unit is bounded on two sides by major rivers, the Jamuna and Padma. The northern boundary of the unit is the Atrai. Discharges are measured at Baral Bridge and Nagarbari on the Atrai, and water levels are recorded at Dohakoladanga. Discharges are also measured on the Baral at Malonchi Bridge. Discharges and water levels are given in Table 15.3 and 15.4.

No long periods of discharges and water levels are available for rivers inside the planning unit.

Typical rainfall data for the planning unit is given in Table 15.5. Annual rainfall in the area falls between 800 mm and 2400 mm in the last 30 years.

Table 15.3 Maximum Daily Discharges (m^3/s)

Discharge Station	River	July			August			September		
		1:2	1:20	1987	1:2	1:20	1987	1:2	1:20	1987
Baral Bridge (Baral)	Atrai	120	301	77	180	403	282	192	336	213

Table 15.4 Maximum Daily Water Levels (m)

Station	River	July			August			September		
		1:2	1:20	1987	1:2	1:20	1987	1:2	1:20	1987
Malonchi Bridge (Baral)	Baral	13.60	14.48	11.38	14.56	15.30	12.89	14.54	15.35	12.57
Baral Bridge (Baral)	Atrai	10.29	10.92	10.76	10.73	12.00	12.01	10.57	11.98	11.41
Baghabari (Atrai)	Atrai	10.15	10.62	10.53	9.99	12.13	11.50	9.89	12.04	10.59

Note : Malonchi Bridge records are after construction of Charghat Regulator.

Table 15.5 Rainfall at Sujanagar (mm/month)

	July	August	September
1:2	155	89	67
1:20	302	328	398
1987	685	548	310
1988	293	225	371

15.7 Existing FCD Infrastructure

In 1968 to 1970, a feasibility study on the Pabna Irrigation and Rural Development Project was conducted. Construction of certain flood control and drainage components of the adopted plan was initiated in 1971 based on studies completed to that date. The gross area of the project was about 196,700 ha of which about 184,600 ha was under flood control by embankments.

The Asian Development Bank provided funding for an updated feasibility study in 1978. This study focused on an area of 29,000 ha selected as the Phase I stage of development. In 1980 detailed implementation designs and construction of Phase I including four primary pumping plants, and flood control embankments and sluiceway were started. Flood control and drainage facilities are now complete.

The floods of 1987 and 1988 caused severe damage to many already completed and under construction structures together with the damage to crops and properties. After the flood of 1988, ADB mission reviewed the status of implementation of the project as affected by 1988 flood and then requested BWDB to carry out detailed study for rehabilitation of flood control component of the project. BWDB organized a task force and carried out the study and recommended the rehabilitation of existing works together with some new flood control facilities for the project.

A feasibility study for the Phase II development of the Pabna scheme was completed in 1991. Further development plans for the unit are presented in the Pabna Phase II report. These are reviewed in the remainder of this paper. No separate plans for the unit have been prepared under FAP-2.

15.8 Flooding and Drainage

Flooding in the scheme area has reportedly reduced very significantly since the construction of the main embankment (160 km length) around the area. Previously a large part of the area had been flooded by spills into the area from the major rivers, as well as through backflow up the natural drainage channels of the Atrai and Baral rivers, the Kageswari Channel, the Ichamati and Sutikhali Channels. These inflows led to significant flooding in the Gandahesti, Ghughudaha and Pindurihati Beels.

Current flooding is experienced through the spillage of water from the River Ganges which passes through the cross drainage culverts on the Paksey to Abdulpur railway line and hence into the scheme area.

Another source of overland flooding results from spillage from the Nandakuja channel in the north; these flows pass through Chalan Beel Polder A into the Mora Baral Channel and then into the scheme area. This latter occurrence is infrequent, significant flows having only reportedly taken place in the severe monsoon floods of 1988.

The last major source of flooding is from the monsoon rains, particularly the heavy rainstorms which give the resulting waters little time to infiltrate or evaporate.

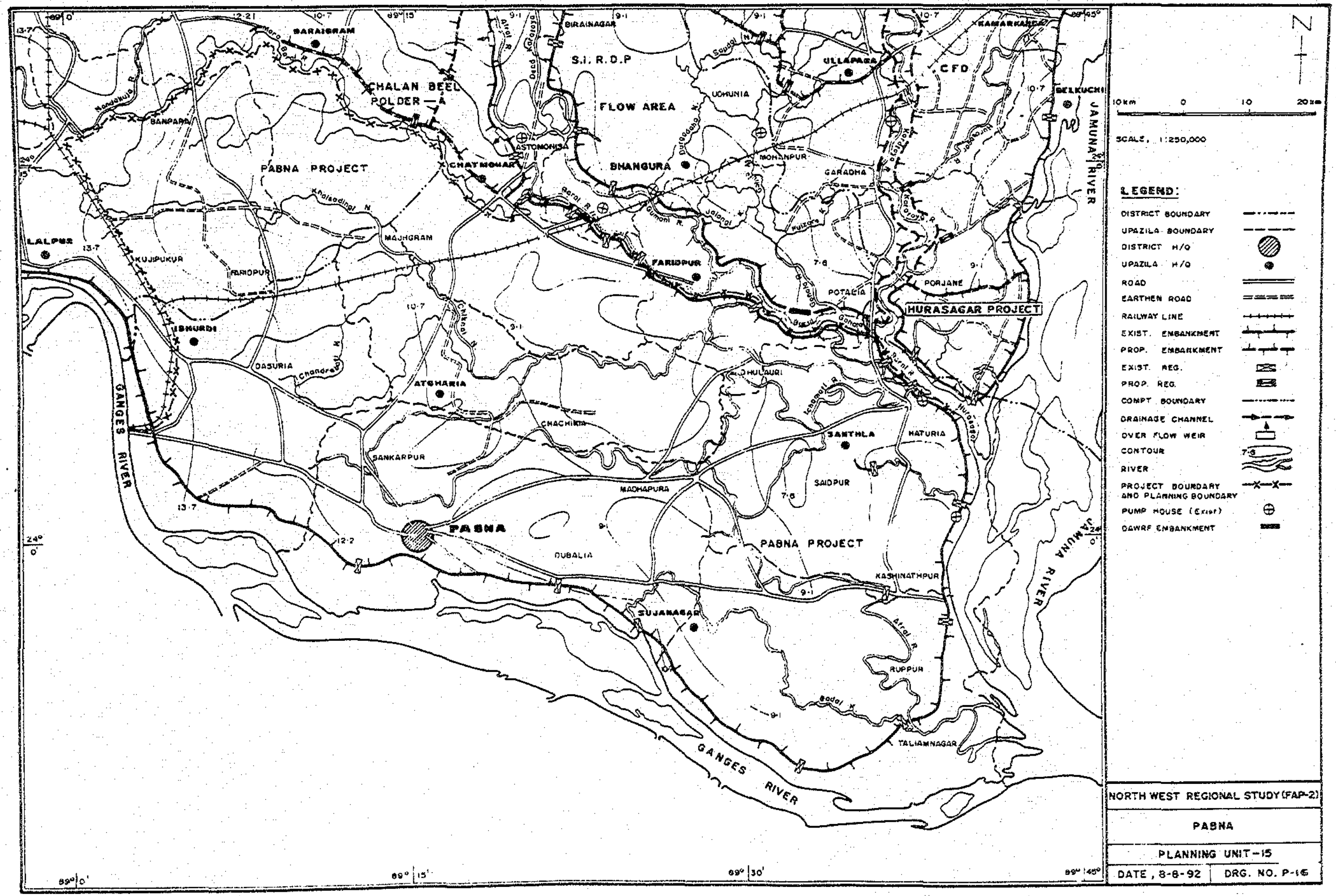
15.9 Planning Options

The area has fairly effectively been provided with major (1:100 year) flood protection facilities. Drainage facilities have also been provided both by gravity and pumped means. Major impacts have

already been effected both to fisheries and navigation. The Pabna Phase II Feasibility Report put forward extensive proposals for cultured fisheries to attempt to provide a degree of mitigation to the area.

Further development options are focused on securing the existing facilities and to provide further works to address shortcomings in the existing system.

This area is located at the downstream end of the region and flood protection facilities do not have any adverse effect to any other area. Accordingly CFD suggested in the above recommendation may be supported by *this regional planning*.



NORTH WEST REGIONAL STUDY (FAP-2)
PABNA
PLANNING UNIT-15
DATE, 8-8-92
DRG. NO. P-16
SCALE, 1:250,000
10km 0 10 20km
LEGEND:
DISTRICT BOUNDARY
UPAZILA BOUNDARY
DISTRICT H/Q
UPAZILA H/Q
ROAD
EARTHEN ROAD
RAILWAY LINE
EXIST. EMBANKMENT
PROP. EMBANKMENT
EXIST. REG.
PROP. REG.
COMPT BOUNDARY
DRAINAGE CHANNEL
OVER FLOW WEIR
CONTOUR
RIVER
PROJECT BOUNDARY AND PLANNING BOUNDARY
PUMP HOUSE (Exist)
DAWRF EMBANKMENT
JAMUNA RIVER
GANGES RIVER
HURASAGAR PROJECT
PABNA PROJECT
CHALAN BEEL POLDER — A
S.I.R.D.P
FLOW AREA
CFD
PABNA
SARAIGRAM
ULLAPARA
BELKUCHI
KAMARKANDA
BHANGURA
FARIDPUR
CHATMOHAR
ASTOMONISA
BIRAINAGAR
UDHUNIA
MOHANPUR
GARADHA
POTAJIA
PORJANE
ATGHARIA
SANTHIA
SAIDPUR
NATURIA
MADHAPURA
DUBALIA
SUJANAGAR
KASHINATHPUR
RUPPUR
TALIAMNAGAR
DHULAURI
CHACHKIA
SANKARPUR
ISHURDI
DASURIA
MAJHGRAM
FARIDPUR
KUJIPUKUR
LALPUR
BANPARA
89° 0'
89° 15'
89° 30'
89° 45'
24° 0'