BANGLADESH FLOOD ACTION PLAN

Ministry of Water Resources

Flood Plan Coordination Organization (FPCO)

The Dynamic Physical and Human Environment of Riverine Charlands: MEGHNA

April 1995

Prepared by

Environmental Study (FAP 16)

Geographic Information System (FAP 19)

ISPAN

IRRIGATION SUPPORT PROJECT FOR ASIA AND THE NEAR EAST

Sponsored by the U.S. Agency for International Development

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TABLE OF CONTENTS

APPENDICES

TABLES

FIGURES

9

FOREWORD

This report is one in a series of reports covering the immediate riverine lands of the major rivers of Bangladesh—the Jamuna, Ganges, Padma, and Meghna. Riverine charlands are defined in this study as areas frequently subject to erosion and accretion within and adjacent to the main rivers of Bangladesh and unprotected by embankments. This report covers the part of the work of Phase 2 of ISPAN's resource inventory of riverine chars, the charlands of the Meghna River. It includes a summary of the river's recent morphological changes. This was based on satellite images from 1984 and 1993. The study was carried out by ISPAN under Flood Action Plan Supporting Studies FAP 16 (Environmental Study) and FAP 19 (Geographic Information System). The first phase of the study (the Brahmaputra-Jamuna) started in early 1992, this phase was undertaken in 1993.

There are two major data sources: a field inventory of resources and satellite image analysis. The field inventory was developed by using a questionnaire to interview key informants in charland areas. The inventory was carried out by Development Planners and Consultants (DP&C) under contract to ISPAN. The image analysis, which was done by FAP 19, consisted of developing and analyzing maps of land use and changes in the physiography of the land. A socio-economic component was added to the study in 1993.

The full set of reports is shown in the table below.

Overview Reports	Inventory Reports	Other Reports
Charland Summary Report	The Dynamic Physical and Human Environment of Riverine Charlands: Brahmaputra-Jamuna	Upper Jamuna (Brahmaputra) Charland Socio-Economic RRA
Charland Socio-Economic Summary Report	*The Dynamic Physical and Human Environment of Riverine Charlands: Meghna*	Middle Jamuna Charland Socio-Economic RRA
	The Dynamic Physical and Human Environment of Riverine Charlands: Padma	Upper Meghna Charland Socio-Economic RRA
	The Dynamic Physical and Human Environment of Riverine Charlands: Ganges	Meghna Confluence Charland Socio-Economic RRA
		Padma Charland Socio-Economic RRA
		Ganges Charland Socio-Economic RRA
		Charland Flood Proofing Study

ACKNOWLEDGEMENTS

This report is the result of a team effort involving many of the staff of both FAP 16 and FAP 19, which was coordinated by Keith Pitman, Chief of Party, ISPAN. It has depended heavily on field work undertaken by about 16 enumerators organized through a field work contract with Development Planners and Consultants.

The inventory study was coordinated by Paul Thompson. Aminul Islam assisted with survey design, Sachindra Halder, Golam Monowar Kamal, and Shanawaz Siddiqui supervised the 1993 surveys. Mamoon Hamid and Qazi Salimullah were responsible for the databases and tables. Abdul Matin Miazi prepared the inventory derived maps. Tim Martin was responsible for overall supervision of the FAP 19 team. David Savory was responsible for the image analysis and GIS work, which was started up by Mike Pooley. Iffat Hoque undertook the image analysis. Colin Thorne contributed to interpretation of channel dynamics and river morphology. The following worked on the GIS and mauza digitization: Nazmul Alam, Mustafa Kamal, and Nasreen Khan. Several members of the FAP 19 team carried out ground truthing.

We are grateful to the Flood Plan Coordination Organization and to its Panel of Experts for providing overall direction to this study.

GLOSSARY

acre	-	Acre = 0.4047 ha
aman	-	Late monsoon season paddy planted before or during the monsoon and harvested November-December
aratdar	-	Wholesale trader with warehouse
aus	-	Early monsoon paddy planted in March-April and harvested in June-July
B. aman	-	Broadcast aman paddy, usually grown in deeper water
babla	-	Gum arabic tree
BARC	-	Bangladesh Agricultural Research Council
bari	-	A homestead, usually consisting of more than one structure arranged around a central common area
BBS	-	Bangladesh Bureau of Statistics
beel	-	An area of open water away from a river
BIDS	-	Bangladesh Institute of Development Studies
bigha	-	A local unit of area most commonly equalling 0.33 acre or 0.14 ha
boro	-	Dry season paddy transplanted in December-January and harvested in April-May
BRAC	-	Bangladesh Rural Advancement Committee
BTM	-	Bangladesh Transverse Mercator (map projection)
BUET	-	Bangladesh University of Engineering and Technology
BWDB	-	Bangladesh Water Development Board
china	-	A variety of millet
chowki	-	Bed/platform
cumecs	-	Cubic meters per second
dacoit	-	Bandit
dal	-	Any of a variety of pulses (lentils); a high-protein food staple usually eaten with rice
decimal	-	Unit of area equal to 0.01 acre
DEM	-	Digital elevation model
dhaincha	-	A nitrogen-fixing plant used as live fencing, fuel, and building material
district	-	A large administration unit under the authority of a Deputy Commissioner, now known as a zila
EIA	-	Environmental Impact Assessment
FAP	-	Flood Action Plan
FCD/I	-	Flood Control and Drainage or Flood Control, Drainage, and Irrigation
FPCO	-	Flood Plan Co-ordination Organization
FWC	-	Family Welfare Centre
GIS	-	Geographic Information System
GPS	-	Global Positioning System
gur	-	Locally produced molasses
haor	-	Deeply flooded basin of NE Bangladesh
hat	-	Periodic market
hectare (ha)	-	Hectare = 2.4711 acres
hogla	-	A bullrush (*Typhus angustata*) used for making mats
HSC	-	Higher School Certificate
HTW	-	Hand tubewell
HYV	-	High Yielding Variety

jangal -	Ground cover shrubs used for fuel and as herbs
jhau -	Tamarisk bush used as fuel and an herb
JPPS -	Jamalpur Priority Project Study
kaisa -	A variety of catkin grass (*Saccharum spontaneum*) giving three cuttings a year
kani -	Local unit of measure equal to .13 ha (.33 acres)
kash -	*kaisa*
kayem -	Permanent or old
kaon -	Fox-tail millet
khas -	Publicly owned
kheya -	Local boat landing point
khal -	A drainage channel or canal either natural or man-made
kharif -	Summer/wet season
kilogram (kg) -	Kilogram = 1.11 sheer
kilometer (km) -	Kilometer = 0.625 miles
kobiraj -	Traditional healer
kutcha -	Flimsy construction of a temporary nature, in the chars usually of grass, bamboo, straw, or similar materials
macha -	A raised platform
mashkalai -	A type of pulse (lentil); see *dal*
matabar -	Leader of the local community
maund -	A unit of weight, 1 Maund = 40 sheer = 37.5 kilograms
mauza -	A village revenue collection and cadastral mapped unit
MCSP -	Multipurpose Cyclone Shelter Program
mile (mi) -	Mile = 1.6 kilometers
MPO -	Master Plan Organization (of Ministry of Irrigation Water Development and Flood Control)
MSS -	Multi-Spectral Scanner (Landsat satellite sensor)
musur -	A type of pulse (lentil); see *dal*
nara -	Straw
NGO -	Non-Government Organization
paiker -	Wholesale trader
para -	Neighborhood
PoE -	Panel of Experts (of FPCO)
pourashava -	a municipality, usually the urban center of a district
pucca -	Sturdy construction of a permanent nature, usually of such materials as brick, concrete, or corrugated iron sheets
rabi -	Winter/Dry Season
RDRS -	Rangpur Dinajpur Rural Development Service (an NGO)
return period -	average interval in years between floods of a given magnitude
RRA -	Rapid rural appraisal
sadar -	The urban core (administrative headquarters town) of a thana or district
salish -	local informal court
samaj -	Society, community; a formal arrangement between members of a community whereby each member has certain rights and privileges
SCI -	Service Civil International (an NGO)
sheer -	A unit of weight = 1/40 maund = 0.94 kg
shon -	A variety of grass (*Imperata cylindica*) giving one cutting a year
SPARRSO -	Space Research and Remote Sensing Organization

SPOT	-	System Pour Observation de la Terre
SRDI	-	Soil Research Development Institute
SSC	-	Secondary School Certificate
suji	-	An improved variety of *kaon* (fox-tail millet)
Taka (Tk.)	-	Bangladesh currency, US$ 1 equalled approximately Tk. 40 in late 1992-early 1993
T. aman	-	Transplanted aman paddy
thana	-	A sub-division of a zila, or district
TM	-	Thematic Mapper
ton	-	An imperial ton = 1,016 kg
til	-	Type of oil seed
union	-	Sub-division of a thana, formerly known as upazila
upazila	-	Previous name for a thana (subdivision of a zila or district)
ustha	-	Bitter gourd (*Momardica charantia*)
WHO	-	World Health Organisation
zila	-	A large administration unit formerly known as a district

EXECUTIVE SUMMARY

The residents of chars and the mainland adjacent to main rivers have a precarious existence, subject as they are to erosion and flooding that can destroy crops and homesteads, render land unproductive, and kill livestock. In short, they are among the most hazard-prone people of Bangladesh. Structural flood protection is unlikely to benefit these people, and embankments may even increase the risks to which they are exposed by raising flood levels. Reliable information about these areas and the people who live in them has always been scarce. The limited accessibility of chars and their constantly changing environment has made studying them a complicated undertaking. As a result, prior to this study, what little information was available did not cover in any detail all the main river charlands. This study, then, fulfills the need—foreseen in the Government of Bangladesh/World Bank Flood Action Plan of 1989—for a socioeconomic study of the people and resources of these perilous lands.

"Charland" is the Bengali term for a "mid-channel island that periodically emerges from the riverbed as a result of accretion" (Elahi, Ahmed, and Mafizuddin 1991). For this study, the definition was widened to include areas of erosion and accretion along the banks of the river. Land, which was studied on mauza level, was classified as follows:

- Island chars.
- Right and left bank attached charland.
- Right and left bank setback land.
- Right and left bank unprotected mainland (other than setback land).

The figure below illustrates this classification system. In the Upper Meghna, in addition to the categories shown, there are old, established islands separated from the mainland by secondary river channels; these have been termed "detached mainland" in this study.

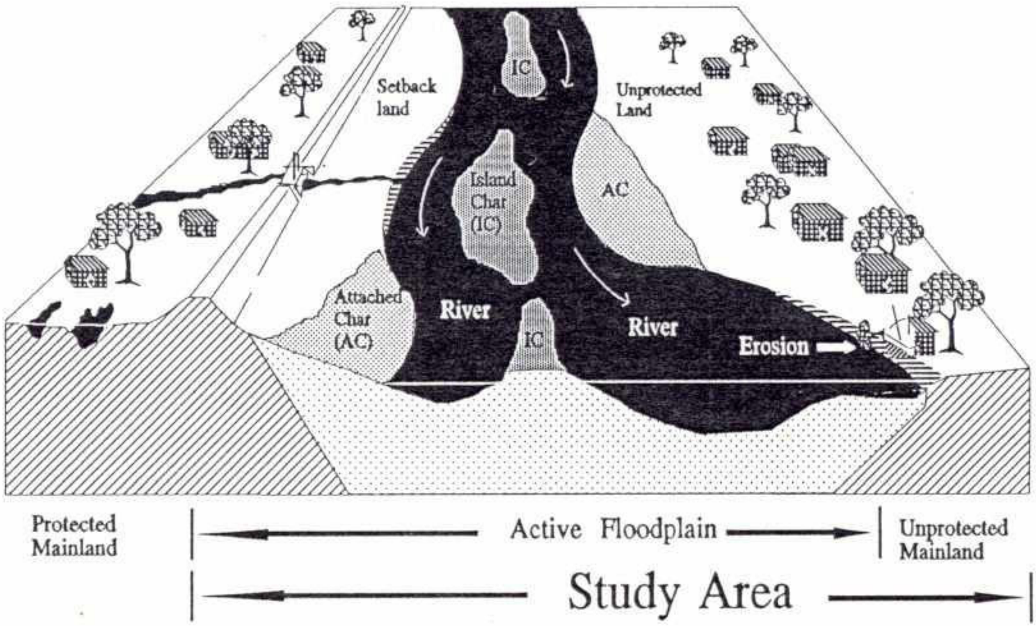


Figure 4: Charland Classification

The Meghna study area, which includes the whole Padma confluence, is partly bounded by embankments along the east bank of the confluence and Lower Meghna. On the west bank of the Upper Meghna the alignments of proposed embankments were used as the boundary. Where necessary, features that limit flooding, such as roads, were used. The study extended in the Upper Meghna to the first narrowing of the river into a single channel, just north of the detached mainland. The southern limit, which is also the northern limit of the main cyclone risk zone, was the southernmost boundary of Hizla Thana.

Before about 1780, the Upper Meghna was the main channel for the Brahmaputra flow (catchment of 590,000 km^2), but since the Brahmaputra's diversion into the Jamuna, the catchment of the Upper Meghna has been reduced to the Sylhet Basin and the Old Brahmaputra (catchment of 80,000 km^2). Almost half of the Meghna's catchment lies within Bangladesh, but it includes the hills adjoining the Sylhet Basin, which have the highest annual rainfall in the world. Its dominant discharge is about 9,000 cumecs. The upper reach of the river has been stable since about 1800 in comparison with the lower reach.

The Lower Meghna, a highly dynamic system, receives the combined flow of the Padma and Upper Meghna, has a tidal regime, and carries the highest sediment load in Bangladesh. Since it carries the flow of the Padma, it has a total catchment of some 1.7 million km^2 (the combined catchments of the Brahmaputra and Ganges). It is fed by runoff from the highest, most tectonically active mountain range in the world, the Himalayas, as well as from the highest rainfall area in the world. Young alpine mountains like the Himalayas are naturally subject to severe erosion, and as a result, the Lower Meghna carries a very heavy sediment load. The highest estimates put it at an average of one billion m^3 per year (FAP 4, 1993). This reach is a wandering river characterized by unstable banklines and rapid rates of lateral movement. The pattern of channels and chars in the Meghna confluence and lower reach changes annually in response to the year's sequence of flows.

Flow in the Lower Meghna is characteristically high from June through September—the result of Himalayan snowmelt and monsoon rains—and very low in the winter. Annual flood peaks are on the order of 100,000 cumecs, five times the peak flow of the Mississippi (Coleman, 1968), and may exceed 160,000 cumecs in a 100-year return period flood (FAP 4, 1993).

The strong inflow of the Padma's discharge from the west has created in the Lower Meghna a historical tendency for eastward erosion, particularly in the large bend at the confluence of the two rivers. Analysis of dry season satellite images from 1984 and 1993, however, shows that the Lower Meghna has widened due to rapid west bank erosion. Since 1984, the centerline of the Lower Meghna has shifted west an average of 121 m per year, while the Upper Meghna has hardly moved.

In the confluence, the channel has widened from an average of 8 km in 1984 to 9 km in 1993, and in the lower reach from 5.7 km to 8.8 km. This means that over a nine-year period the Lower Meghna widened an average of 339 m per year. The west bank has eroded at an average of more than 290 m per year between 1984 and 1993, and the east bank has eroded about 47 m per year. This indicates prolonged, rapid—even "catastrophic"—bank erosion in the lower reach compared with analysis of erosion rates over a 19-year period on the Jamuna, where such rapid erosion rates rarely persist for more than four or five years.

Tables 1, 2, and 3 summarize some of the most important inventory data by land type and reach. The inventory estimates the total 1993 study area population to have been 1.17 million, of which 320,000 lived in mauzas covering the 54 existing island chars. The attached char population was 260,000, there were 170,000 living on the detached mainland (islands), and there were 410,000 people on unprotected mainland, including setback land. Between 1981 and 1993 the total charland population grew by 20 percent, but within this period there were major shifts in the distribution

Table 1 Qualitative Summary of Differences between Reaches

Characteristic	Upper Meghna	Confluence	Lower Meghna
Land	Sand in small area of chars, large area of detached mainland, 76% vegetated.	Most of sand in study area and water, 60% vegetated.	Little sand, 47% water, large island char on west side of main channel.
Population	Highest density, average 1,005 per km² in 1993 and growth greater than national average since 1981.	Moderate density (612 per km²). Locally high population on east bank mainland, low on west bank south of Padma, but low growth overall.	Lowest density, 312 per km². Growth much lower than national average since 1981 on west bank and island chars (eroding). Higher on east bank.
Erosion Pattern	Small areas eroding slowly and steadily, but densely populated.	Widening results in erosion of densely populated mainland. Much erosion and accretion of island chars.	Rapid west bank erosion in past decade; few mid-channel chars to erode.
Migration in 1992	Very little migration of any type reported (under 1% households involved), consistent with stable environment.	High incidence permanent in-migration (9% of 1993 households came in 1992) due to rapid changes in island char complex where 26% are in-migrants.	High seasonal in- and out-migration in Hizla island char linked with seasonal demand for farm labor, and in new low-lying chars only cultivated in dry season.
Infrastructure	Good provision of primary and high school and health facilities. Access constrained by river channels.	Good primary and high school and health facility provision.	Poor provision of primary and high school and health facilities in all land types (inhabited mauzas only).
Occupations	54% households cultivate own land, 14% mainly fish.	High percentage fishing on island chars.	High percentage (34%) fishermen in all land types.
Agriculture	Diverse, HYV boro and B aman important.	B aus + aman and wide range of rabi crops.	L & HYV boro and T aman important in island char.
Livestock	High livestock numbers compared to land area and human population.	Moderate numbers.	Lowest numbers relative to land and human population, higher in island chars.
Boats	More mechanized boats relative to people.	Lowest numbers in Meghna, in attached chars.	About 68 households per mechanized boat.
Deaths	Concentrations of flood and disease deaths.	Lowest incidence of hazard-caused deaths.	Most flood deaths, particularly in attached chars.
Floods	Normal floods longer and more extensive than other reaches, high incidence of house damage in 1987 and 1988.	Extent as in upper reach but duration less in normal and peak floods, 98% houses flooded in 1988 but only 32% in 1987.	Normal floods much shorter duration, less impact in 1987 and 1988 floods when fewer houses flooded (37% in 1988), lowest damage.

Source: FAP 16 Charland Inventory

Table 2 Summary of Mauza Inventory Data by Char Land Type

Parameter	Island Char	Attached Char	Detached Mainland	Unprotected Mainland	Bangladesh*
Area (ha)	89,736	51,039	14,133	40,753	14.4 million
Percentage water	39	29	7	24	na
Percentage sand	5	2	1	1	na
Percentage vegetated	56	69	92	75	na
1993 population	325,485	260,635	169,248	410,419	109.9 million
Population per km^2 in 1993	363	511	1,198	1,007	763
Percentage increase, 1981-93	+33	-3	+31	+25	+26
Cultivable land per capita (ha) in 1993	0.12	0.13	0.08	0.07	0.09
% permanently out-migrating in 1992	2.0	2.0	0.2	1.7	na
% seasonally in-migrating in 1992	6.1	2.5	0.0	1.0	na
% mauzas with primary school	47	64	65	54	74
% mauzas with high school	6	19	14	16	13
% mauzas with health facility†	6	9	14	17	4
% households mainly farming	45	44	54	43	na
% households mainly fishing	22	21	11	19	na
Cropping Intensity	147	143	147	159	172
Cattle per household	0.74	0.56	1.09	0.70	1.33
Households per mechanized boat	43	63	64	66	na
1988 flood deaths per 100,000	50	64	59	57	1.4
1988 % area flooded	57	99	100	99	46
1989-92 % area flooded	39	68	57	64	na
1988 mean flood duration (days)	42	60	41	74	na
1989-92 mean flood duration (days)	28	40	14	51	na
% houses flooded in 1988	54	95	97	95	na
% houses flooded in 1989-92	6	11	2	14	na
% houses destroyed in 1988	26	38	50	33	na
% houses destroyed in 1989-92	1	2	1	3	na

Source: FAP 16/19 inventory and satellite image analysis

*BBS (1993), except flood data, which is from Rogers, *et al.* (1989). Population figures are for 1991. Comparisons are for rural Bangladesh.

†Facilities below the union health center level, such as private doctors, may have been included in the inventory.

Table 3 Summary of Mauza Inventory Data by Reach

Parameter	Upper Reach	Confluence	Lower Reach	Bangladesh*
Area (ha)	50,572	68,294	76,794	14.4 million
Percentage water	22	34	47	na
Percentage sand	2	6	1	na
Percentage vegetated	76	60	52	na
1993 population	508,031	418,055	239,701	109.9 million
Population per km^2 in 1993	1,027	665	363	763
Percentage increase, 1981-93	+34	+15	+6	+26
Cultivable land per capita (ha) in 1993	0.08	0.10	0.17	0.09
% permanently out-migrating in 1992	0.6	2.3	2.3	na
% seasonally in-migrating in 1992	0.5	3.2	4.5	na
% mauzas with primary school	58	61	46	74
% mauzas with high school	14	17	8	13
% mauzas with health facility†	13	12	7	4
% households mainly farming	52	42	40	na
% households mainly fishing	14	15	34	na
Cropping Intensity	155	145	150	172
Cattle per household	0.92	0.63	0.58	1.33
Households per mechanized boat	47	69	68	na
1988 flood deaths per 100,000	73	26	77	1.4
1988 % area flooded	100	99	61	46
1989-92 % area flooded	68	61	41	na
1988 mean flood duration (days)	86	40	16	na
1989-92 mean flood duration (days)	28	40	14	na
% houses flooded in 1988	97	98	37	na
% houses flooded in 1989-92	7	8	14	na
% houses destroyed in 1988	41	37	20	na
% houses destroyed in 1989-92	1	1	5	na

Source: FAP 16/19 inventory and satellite image analysis

*BBS (1993), except flood data, which is from Rogers, *et al.* (1989). Population figures are for 1991. Comparisons are for rural Bangladesh.

†Facilities below the union health center level, such as private doctors, may have been included in the inventory.

20

of people due to bank erosion. Between 1984 and 1993, just under 20,000 ha of mainland eroded, and only 1,300 ha accreted, a loss of 15 percent of the mainland in the study area. This area of eroded mainland was estimated to have supported about 140,000 people in 1984, therefore, bank erosion must have forced 13 percent of the 1984 study area population to move between 1984 and 1993. This erosion mainly affected people in the Meghna-Padma confluence and the Lower Meghna.

Population displacement in the Upper Meghna was localized, and there was rapid growth in the population on the island chars, which may have accommodated some erosion victims. In the confluence and Lower Meghna, population has declined within the 1984 banklines. Although 4,000 ha of new charland accreted in the Lower Meghna between 1984 and 1993 the area lost to bank erosion exceeds that amount. Moreover, the new land is very low and can only be occupied in the dry season. The dynamism of the confluence char complex in this period has resulted in considerable movement of people within the chars, and limited the ability of the area to absorb displaced mainland people. Instead, there has been very rapid population growth since 1981 in the east bank mainland mauzas, particularly in the lower reach (from 351 people per km^2 in 1981 to 1,111 people per km^2 in 1993), and char people are thought to have settled in this unprotected mainland. Even so, the figures suggest that about 57 percent of lower reach erosion victims and all the confluence erosion victims, a total of some 120,000 people, have moved out of the Meghna charlands.

It is impossible to make erosion rate predictions for the Meghna based on a comparison of images covering only nine years. However, if the east bank is stabilized at Chandpur it has been suggested that the present trend for rapid west bank erosion downstream of that point would continue deflecting the flow into west bank off-take channels. In the longer term the bend in the confluence north of Chandpur, where the huge discharge of the Padma is turned from flowing east to south, is likely to continue eroding eastward until more resistant sediments are reached east of Chandpur.

Future erosion is clearly a threat to the mainland settlements by the confluence and Lower Meghna, but for the 238,000 people living on mid-channel chars in the confluence and Lower Meghna it is an ever-present danger. The inventory compiled data on homestead erosion in all areas, including the island chars. Even in the Upper Meghna much homestead erosion was reported in the period 1987-92 (over 50 percent of all homesteads reportedly eroded), reflecting the high population density in this area. The reports indicate that about 15 percent of households in the Meghna study area were displaced by erosion of some kind between 1987 and 1992.

In 1992, less than 2 percent of households migrated out of their mauzas, although there were locally higher rates, particularly in the lower west bank. On the other hand, 4 percent of households in the study area in 1993 had moved into their mauza in the previous year, mainly to colonize accreting island chars, particularly in the confluence and lower reach. Seasonal in- and out-migration were both common in the island chars. This apparently is an adjustment to the hydrologic cycle, whereby people move into island chars and attached chars to cultivate, raise livestock, and meet seasonal labor demand during the dry season and leave when the land is flooded.

Based on analysis of March 1993 Landsat imagery, the study area covered about 196,000 ha; of this, 36 percent was water, 3 percent was sand, and 61 percent was cultivated or vegetated. Within the banklines, 74 percent of the area was either sand or water and only 26 percent was vegetated or cultivated. The area of vegetated (productive) island chars increased more or less proportionally with the widening of the river, increasing by about 6,500 ha between 1984 and 1993.

The resource base of the Meghna charlands is dominated by farming: 45 percent of households cultivate land for a living and 23 percent depend on day labor, which is predominantly agricultural. The Meghna is the main riverine fishery in Bangladesh, and 19 percent of households fish as a primary occupation, and for another 16 percent fishing is a secondary source of income. In the lower reach fishing is almost as important as agriculture for the charland economy.

The availability of cultivable land in the Meghna charlands is similar to the national average (0.10 ha per capita compared with 0.09 ha for the nation), and on the mainland there is only 0.07 ha per capita. About 80 percent of mauza land areas are reported to be cultivated. Cropping intensity averages 150 percent and is lower in the chars than mainland, particularly in the confluence island chars. There is slightly more sandy land in the Upper Meghna channel, and dry-land crops, mainly groundnuts and sweet potatoes, are more common in the island chars of this reach, otherwise a wide variety of winter crops are grown.

Broadcast aman (monsoon season paddy), which is tolerant of deep water, is most common in the upper reach, where flooding is deep and prolonged. Aus and B. aman appear to be damaged by floods on average three times in 10 years. Transplanted aman, although offering higher yields, is vulnerable to flooding and mainly grown in the lower reach around the island of Hizla, which is largely flood-free. Local boro (winter-sown paddy) is widely grown on low land in the island chars. In the island char of Hizla, where irrigation is apparently available, HYV boro is also grown. Despite the abundant supply of water, there is otherwise only a moderate area of irrigated land in the chars.

Numbers of cattle and buffaloes in the Meghna charlands are lower (only 0.73 per household) than in Bangladesh as a whole. Numbers of goats and sheep are also lower than average. In some areas of the upper reach and confluence livestock are fattened commercially on the abundant dry season grazing and crop residues. Extensive deep monsoon flooding appears to constrain livestock numbers.

Floods are the main natural hazard faced by char dwellers. In 1987, more than 70 percent of cultivated land was reported to have been flooded. In 1988, 87 percent was reported to have been flooded and flooding lasted an average of 56 days. By comparison, the average for 1989-92 "normal" monsoon conditions is 57 percent of land flooded for an average of 37 days. There was a strong trend toward more extensive and longer-duration flooding in the north and less extensive in the south, and in 1988 durations fell from 86 to 16 days between the upper and lower reaches.

The 1988 flood was estimated to be about a 1-in-30-year event in the Meghna. In that year, 82 percent of houses in the Meghna charlands were flooded and 34 percent destroyed. Fewer were affected in the Lower Meghna island of Hizla. On average, only 9 percent of houses were flooded in each year during the 1989-92 period. Only in 1988 were there a substantial number of flood-related deaths: more than 660 people were killed, particularly in the upper reach. Epidemic diseases were reported to have killed more people during the period 1988-92, particularly in the island chars of the upper and middle reaches.

Service and infrastructure provision is the key to improving the char people's lives given the hazards with which they live. Study area health care facilities are concentrated in the detached and unprotected mainland. In the Meghna charlands, while coverage by health workers is comparatively good, there are fewer health care facilities than in other areas, particularly in the lower reach, and they are far from many char people. Most people normally drink tubewell water, but in the 1988 flood, 70 percent of households drank river water, seriously compromising their health. Only 55 percent of inhabited mauzas have a primary school, almost 20 percent lower than the national average, and island chars have the fewest schools. There are 54 percent more children per high school in the charlands than in Bangladesh as a whole, and such schools are rare in island chars.

Access problems limit the use of both health and education facilities, and river transport is also vital for coping with floods and erosion in the island chars. Local boat transport is entirely within the private sector, and mechanized boats have come to play an important role in linking the chars with such mainland facilities as markets. Mecha-

22

nized boats are fairly numerous in the Meghna, especially in the island chars (about 43 households per boat) compared with the unprotected mainland (about 66 per boat). Yet flooding and erosion could mean that a whole village would need to evacuate by boat in a short time. There are an average of 8 households per non-mechanized boat throughout the area, but small boats are hazardous during peak floods.

This is the first study to collect data for the whole of the Meghna charlands. The inventory data and Geographic Information System (GIS) that have resulted from this study offer a means of directing development programs to likely priority areas in terms of service provision and program location. The maps that form the core of this report already draw attention to high-priority needs. More detailed assessment using the GIS would assist in local planning and directing needs assessment to the areas with greatest hazards and least services.

A number of studies and proposed projects may affect the charlands. Bank protection, for example, might reduce erosion rates and, therefore, population displacement, but may deflect the Meghna to erode new areas. Flood proofing measures, such as shelters and emergency transport services, could assist people in coping during severe floods. In addition to programs directed specifically at charland hazards, there is a more general need that government and non-government development work give proper attention to the charlands, and that planning and service provisions be appropriate to the charland environment and society. Improved crop and livestock farming, for example, could involve research and development on dry-land farming, irrigation in chars, and livestock cooperatives or groups to improve access to credit and transport. In the stable Upper Meghna, infrastructure investments have somewhat lower risks than such investments in the confluence and Lower Meghna. Much of those areas has a high erosion risk, so structures built on island chars (and in some mainland areas) should be movable.

There are 1.17 million people living in the Meghna charlands who will continue to be at risk from flooding. At present, flood risk is greatest in the upper reach of the river, which experiences more extensive flooding for longer durations every year. The upper and confluence reaches were worst affected in the 1988 flood. Flood modelling by FAP 25 indicates that there would be little impact from embankment improvements on the other main rivers. Even with the Upper Meghna fully embanked, normal monsoon water levels would fall (runoff from the adjacent floodplain would be retained by embankments), and only at Chandpur is an increase in water level predicted for a 1988-magnitude flood (similar to the normal monsoon water level increase following a 35 cm increase in sea level). While the Meghna char people are likely to face the same flood risks in the future, they would still benefit from measures to help them cope.

Many char people are also at risk from erosion. Bank erosion has displaced many people who are presumed to have left the Meghna charlands in the past decade, and there is no reason to believe that the next decade will be any different. In particular, the change of direction in the bulk of the flow from eastward in the Padma to southward in the Meghna results in fluctuating waves of erosion along the east bank in the confluence as the main channel shifts location. Continual erosion will increase the population pressure both on the remaining charlands and in the rest of the country. River training works may be a viable way to stem this loss of land and consequent population displacement, particularly in the Upper Meghna where there are very high population densities and slow erosion. In the Lower Meghna, the impacts on river morphology are uncertain. Measures to stabilize and prolong the lives of island chars could also benefit the 320,000 people living on them.

Chapter 1

INTRODUCTION

1.1 Background to the Study

1.1.1 History

The original design of the Flood Action Plan (World Bank, 1989) included among its components a socioeconomic study of the active floodplains of the Brahmaputra-Jamuna, Ganges, Padma, and Meghna rivers. The active floodplain was defined at that time as areas within the main river channels and nearby areas of mainland, both of which are frequently subject to erosion and accretion and cannot be protected from floods. The aims of the active floodplain study were to:

- assess present agricultural practices, settlement patterns, and disaster responses;
- estimate the number of affected households on chars (mid-channel islands created by accretion) and within a short distance of the river banks;
- estimate the number of households on existing embankments; and
- prepare guidelines to be used in feasibility studies to ensure that in project planning full account is taken of the active floodplain populations.

As the detailed terms of reference (TOR) of FAP 14, the Flood Response Study, were being drawn up by the government of Bangladesh and finalized with donor agencies, it became apparent that the intended study would not immediately be possible. A more general study first was needed to establish—for the full range of flood environments inside and outside the chars—the context in which flood response occurred. In addition, the active floodplain study required the use of remote sensing data and satellite image interpretation, but the facilities and trained staff to achieve this within the FAP would not be ready until at least late 1991.

During 1991, the first full year of FAP studies, it became clear that regional studies were unable to devote sufficient resources to the specialized work of socioeconomic study of the active floodplain. Most used the main rivers as their study area boundaries. Of the regional FAP studies only FAP 3.1, the Jamalpur Priority Project, attempted detailed socioeconomic studies in the chars, investigating those along the reach of the Jamuna adjacent to the project in 1992 (see Section 1.1.4). In addition, FAP 14, the Flood Response Study, carried out socioeconomic surveys in 10 active floodplain villages.

Finally, in 1992 ISPAN, on advice from the Flood Plan Coordination Organization (FPCO), agreed to undertake an inventory of resources and people in the main river charlands. This study, then, fulfills the need—foreseen in the Government of Bangladesh/World Bank Flood Action Plan of 1989—for a socioeconomic study of the people and resources of the active floodplain. Although it does not consider in detail the populations living long-term on embankments along the main rivers, analysis of erosion and accretion patterns has been added.

The inhabitants of the charlands are among the most hazard-prone people of Bangladesh, exposed as they are to floods and erosion. Structural flood protection measures are unlikely to benefit these people, and embankments may even raise flood levels within the charlands, increasing the risks to

28

which they are exposed. Reliable information about these areas and the people who live in them has always been scarce. The difficulty of gaining access to chars and their constantly changing environment has made studying them a complicated undertaking. As a result, prior to this study, what little information was available did not cover in any detail all the main river charlands.

1.1.2 The Charland Study

This Charland Study is a special study under the Bangladesh Flood Action Plan (FAP). It was executed jointly by FAP 16, the Environmental Study, and FAP 19, the Geographic Information System (GIS), both of which are undertaken by the Irrigation Support Project for Asia and the Near East (ISPAN) and funded by USAID.

This study has two objectives. The first is to develop databases and a geographic information system (GIS) that can be used as planning tools both for direct interventions in the charlands and for other interventions (such as embankments) that may affect the char areas. The second objective is to use the data collected, along with additional socioeconomic studies, to make general policy recommendations for the charlands and to test and develop means of rationally identifying potential flood proofing measures and assessing their potential benefits in these areas.

Five tasks have addressed these objectives.

- Making an inventory of resources, people, and infrastructures in the Brahmaputra-Jamuna, Meghna, Padma, and Ganges charlands and collecting additional information on hazards (led by FAP 16).
- Using digital satellite images to analyze physical changes and land use in these areas, and integrating this analysis with inventory data using a GIS (FAP 19).
- Conducting supplementary socioeconomic studies using rapid rural appraisal (RRA) methods in six river reaches (building on the Flood Response Study, FAP 14).
- Conducting detailed studies of flood losses and flood proofing potential in two areas along the Jamuna River (building on the Flood Proofing Study, FAP 23).
- Integrating the results of the above tasks into a comprehensive report.

This document is the report of the first stage of Phase 2 of the FAP 16/19 Charland Study: the Meghna charland inventory. It consists of analysis, maps, summary data tables, and lists dealing with population, land and resource use, and hazards for each mauza.[1] (Notes follow each chapter.) Satellite images and analysis of changes in the Meghna River course and chars are also included.

The study's primary product is a database derived from the field inventory returns that, when combined with data derived from Landsat imagery, forms an interactive GIS. Some of the more important results from the inventory and the GIS, particularly those concerning human population and resources, appear as figures in this report.

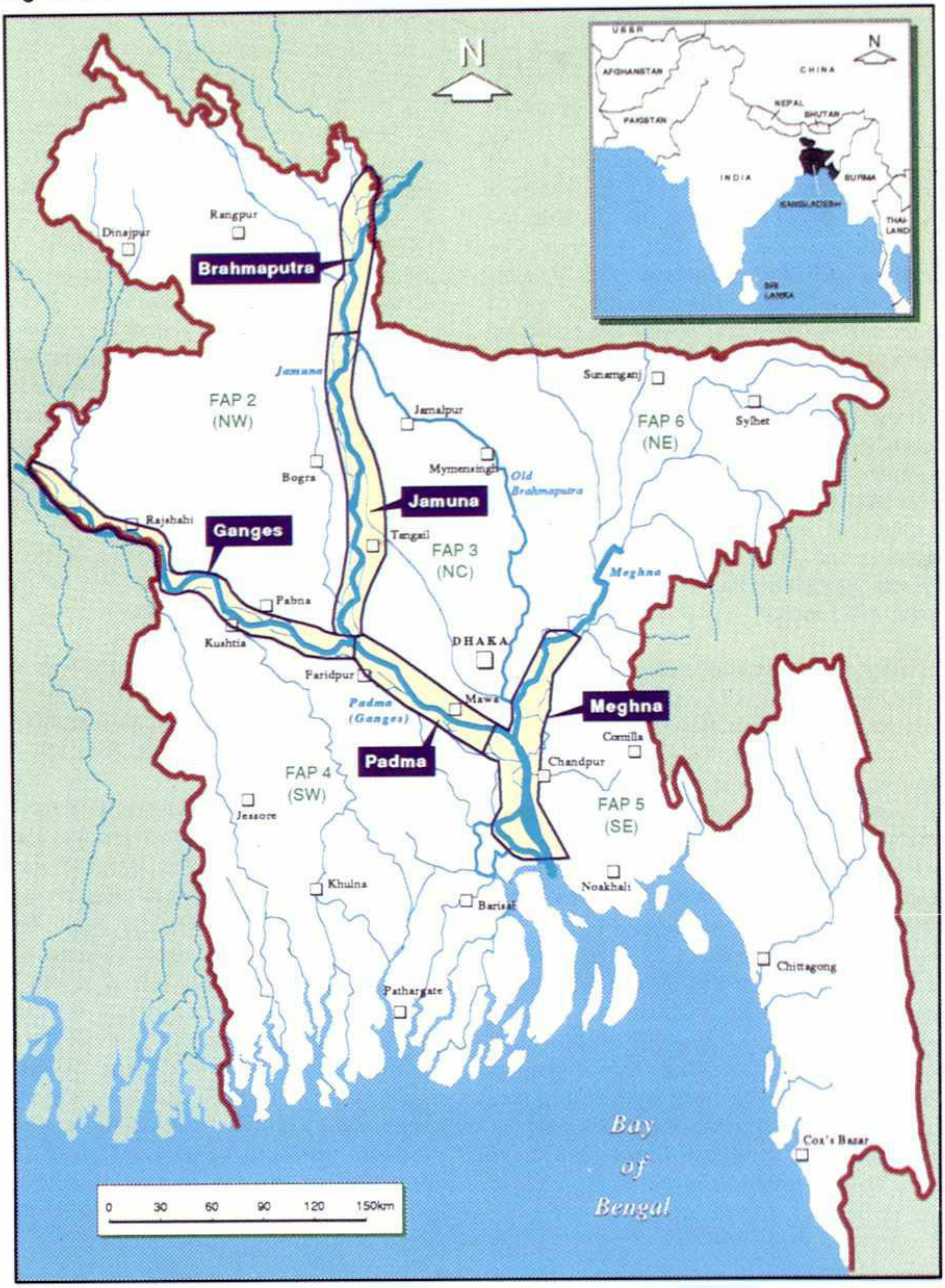
1.2 The Meghna Study Area

1.2.1 Delineation of Study Area

The Meghna River system (Figure 1.1) is the smallest component of the Ganges-Brahmaputra-Meghna delta. Unlike the other main delta rivers though, almost half of its catchment area (45 percent of the 8 million ha; Rogers, *et al.*, 1989) lies within the borders of Bangladesh. At the river's northernmost extremity it drains the Sylhet basin, one of the most deeply flooded parts of Bangladesh and the region that consistently gets the most rainfall in the country. The Meghna's flow is also fed by the adjacent Indian states of Tripura and Meghalaya, the hills of which have the highest annual rainfall in the world. The Meghna River starts at the confluence of the Baulai and Kushiyara rivers (FAP 6, 1993) in Greater Sylhet District. Southeast of Dhaka the river is joined by the Padma, which carries the combined flows of the Ganges and Brahmaputra. From there it continues south as the Lower Meghna and finally empties into the Bay of Bengal.

Figure 1.1

Charland Study Location



Map A in Historic Figure I shows the lower Ganges-Brahmaputra river system in about 1770. The Brahmaputra curved east through Bengal and joined the Upper Meghna northeast of Dhaka, while the Ganges travelled a separate course to reach the Bay of Bengal west of the Meghna mouth. A major change in the Brahmaputra course occurred between 1770 and 1830, and Map B shows that in the 1830s, while the old Brahmaputra course was still important, much of that river's flow went due south in the new Jamuna River to join the Ganges. The combined flow then joined the Lower Meghna in a wide delta some 65 km south of the present confluence (Rizvi, 1975). Between the 1830s and 1857-60, the Padma broke through the harder Chanida Alluvium to join the Meghna near its present confluence. Since then the river system has been adjusting to these major changes. Map C shows the late 20th century river system: the Old Brahmaputra is reduced to a flood distributary, and the combined Ganges-Jamuna flow passes through the Padma to join the Meghna just north of Chandpur.

In summary, in the past 200 years the main flow of the Brahmaputra moved 60 km west; the Upper Meghna lost much of its flow south of Bhairab Bazar; a major new river, the Jamuna, was created; and the Ganges and Brahmaputra-Jamuna joined to create the vast new river locally called the Padma. This river then moved northeast to capture the Meghna and form the present Lower Meghna. These changes resulted in the Madhupur Forest Tract being surrounded by rivers. The Dhaleswari flow was captured by overspill from the newly formed Jamuna, which effectively changed the Dhaleswari's origin as a distributary of the Ganges flowing northeast, to a distributary of the Jamuna flowing southeast. Throughout this period, the main flow of the Ganges moved progressively eastward, leaving moribund distributaries in the southwest region. Between 1830 and 1857, the Ganges ceased to have a direct outfall to the Bay of Bengal.

This study is primarily concerned with the riverine charland, the Bengali term for a "mid-channel island that periodically emerges from the riverbed as a result of accretion" (Elahi *et al.*, 1991), and more generally with the active floodplain, which is subject to erosion and accretion. Since the Meghna channel ranges from a relatively stable river in the northeast, through a very dynamic confluence, to estuarine formations near the Bay of Bengal (where there are many coastal chars), the Meghna study area had to be carefully delineated.

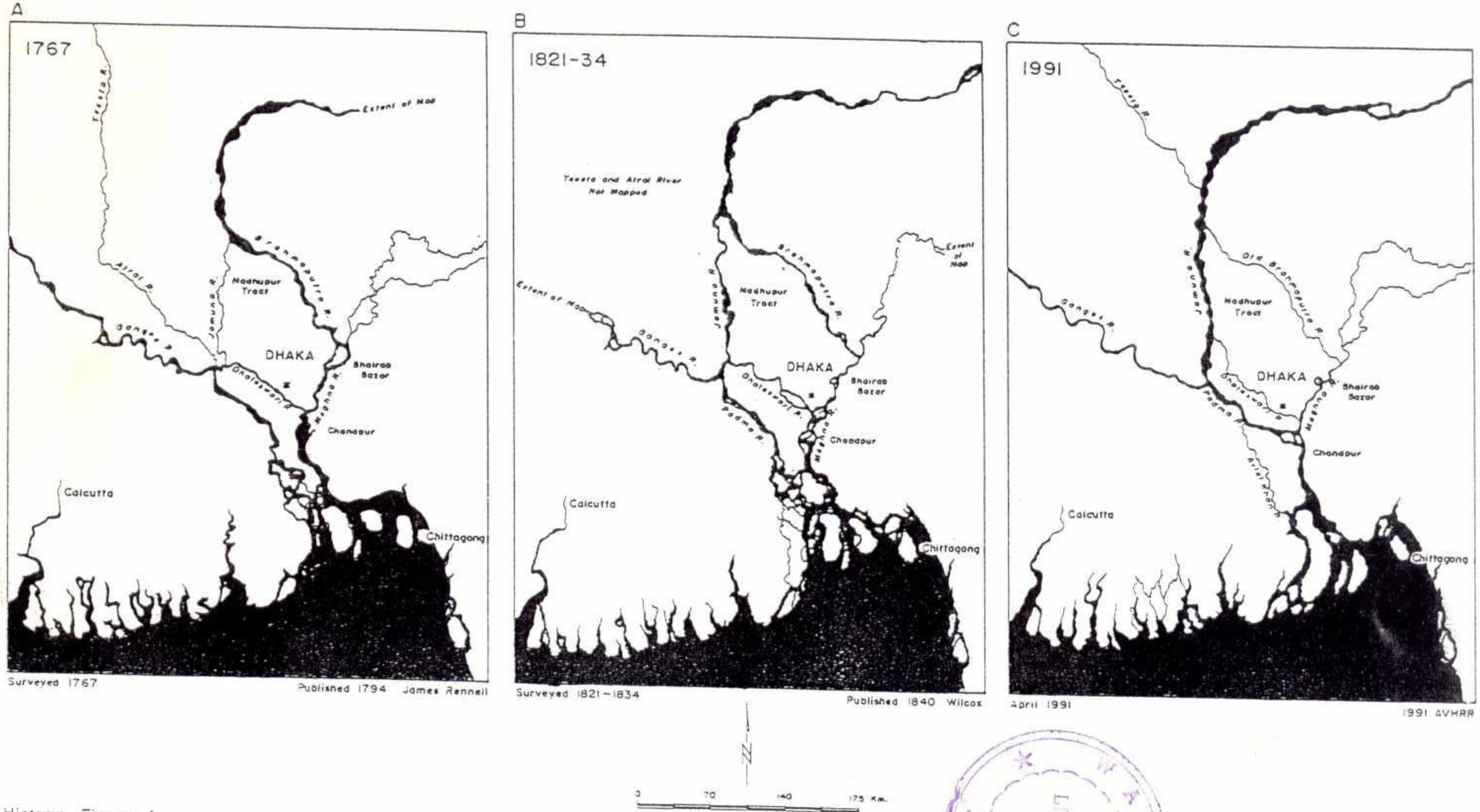
Preliminary analysis of the 1993 Landsat image, 1:50,000 scale 1989 SPOT satellite images, and Survey of Bangladesh maps from the 1960s found the Upper Meghna River course very stable, with little erosion and accretion along the banks; even island chars had been relatively stable during that period. There are some islands in the reach adjacent to the Meghna bridge that are typical sandy chars, but there are also large areas of old, established land surrounded by substantial side channels of the Meghna (mostly in Gazaria Thana). These islands, called "detached mainland" in the study, were inventoried because there are no plans to provide them with flood protection.

The northern limit of the study area was the first narrow single channel reach of the Meghna north of these islands, at the junction of Araihazar and Bancharampur thanas (Figure 1.2).

Below the Meghna's confluence with the Padma tidal influences gradually increase and the river widens into an estuary (in fact, water levels fluctuate with the tidal cycle even in the upper reach of the river). Much of the west side (right bank) of the lower reach consists of old charland accreted where the river previously flowed. From Barisal District southward, large distributaries on the west bank separate sizable islands from the main channel. The size of the Lower Meghna channel in this region makes it unlikely that mainland embankments could produce noticeable confinement effects, so people living in the unprotected active floodplain are unlikely to experience increased flood risks as a result of human interventions to protect mainland areas from flood.

Based on examination of satellite images it was decided to include in the study the large island

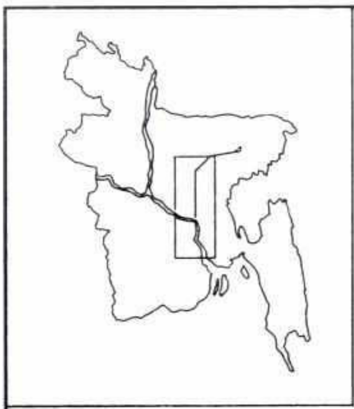
EVOLUTION OF THE RIVER SYSTEM OF BANGLADESH

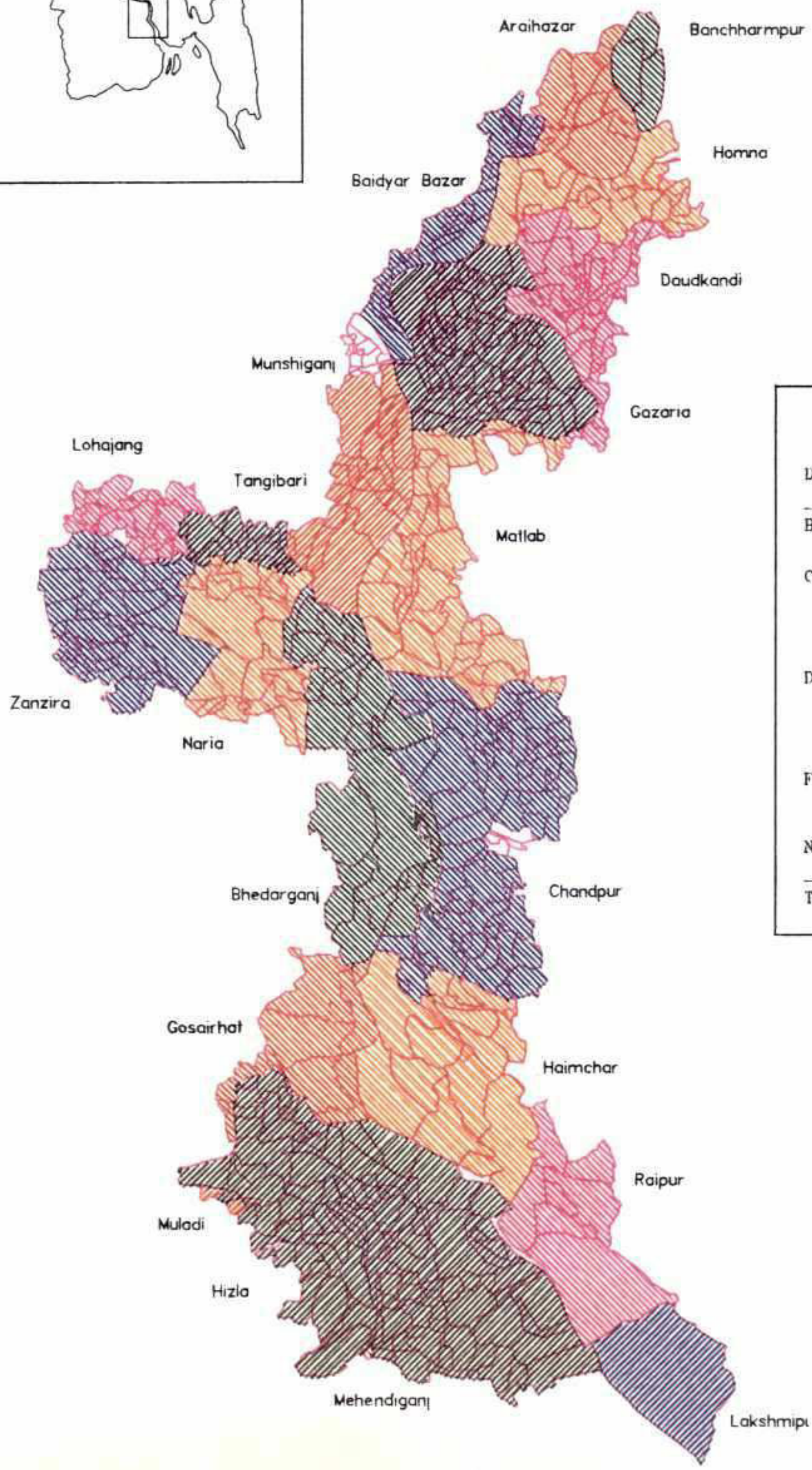


Historic Figure I

ISPAN FAP 19 , Geographic Information System

Meghna Thanas and Mauzas





NUMBER OF MAUZAS UNDER EACH THANA

District	Code	Thana	No of Mauza
Barisal	0536	Hizla	128
	0562	Mehendiganj	1
	0569	Muladi	2
Comilla	2504	Banchharampur	3
	2522	Chandpur	75
	2536	Daudkandi	48
	2547	Haimchar	17
	2554	Homna	24
	2576	Matlab	50
Dhaka	3002	Araihazar	12
	3004	Baidyar Bazar	45
	3024	Gazaria	117
	3044	Lohajang	27
	3056	Munshiganj	27
	3094	Tongibari	23
Faridpur	4014	Bhedarganj	29
	4036	Gosairhat	12
	4065	Naria	36
	4094	Zanzira	54
Noakhali	6543	Lakshmipur	1
	6558	Raipur	8
Total Mauza			739

ISPAN

Figure 12

FAP-19 Geographic Information System

forming most of Hizla Thana, since it is not normally regarded as part of the coastal estuary and has been subject to major erosion and accretion since 1973. The islands and estuary south of this point were not included; Bhola and the adjacent islands were considered part of the coastal delta system. The study area, then, ends with the southern limit of Hizla Thana and northwestern corner of Lakshmipur Thana.

This southern boundary skirts the edge of the main cyclone zone and is almost identical to the boundary of the Multipurpose Cyclone Shelter Program (BUET-BIDS, 1992), although the cyclone risk zone extends into part of Hizla that is covered by the Charland Study. The FAP 16/19 study concentrated on erosion, accretion, and flooding in riverine areas; a different questionnaire would have been needed to cover cyclone hazard. Although the scopes of the MCSP and charland studies are different, they are somewhat complementary and therefore a minimal overlap of coverage was appropriate.

The Padma charland inventory is covered in a separate report, but its confluence with the Meghna is included in this report. The area included extends as far as the first narrowing of the Padma to a single channel. This site was selected as the boundary because the complex of very mobile island chars that have formed at the confluence extend some distance upstream in the Padma.

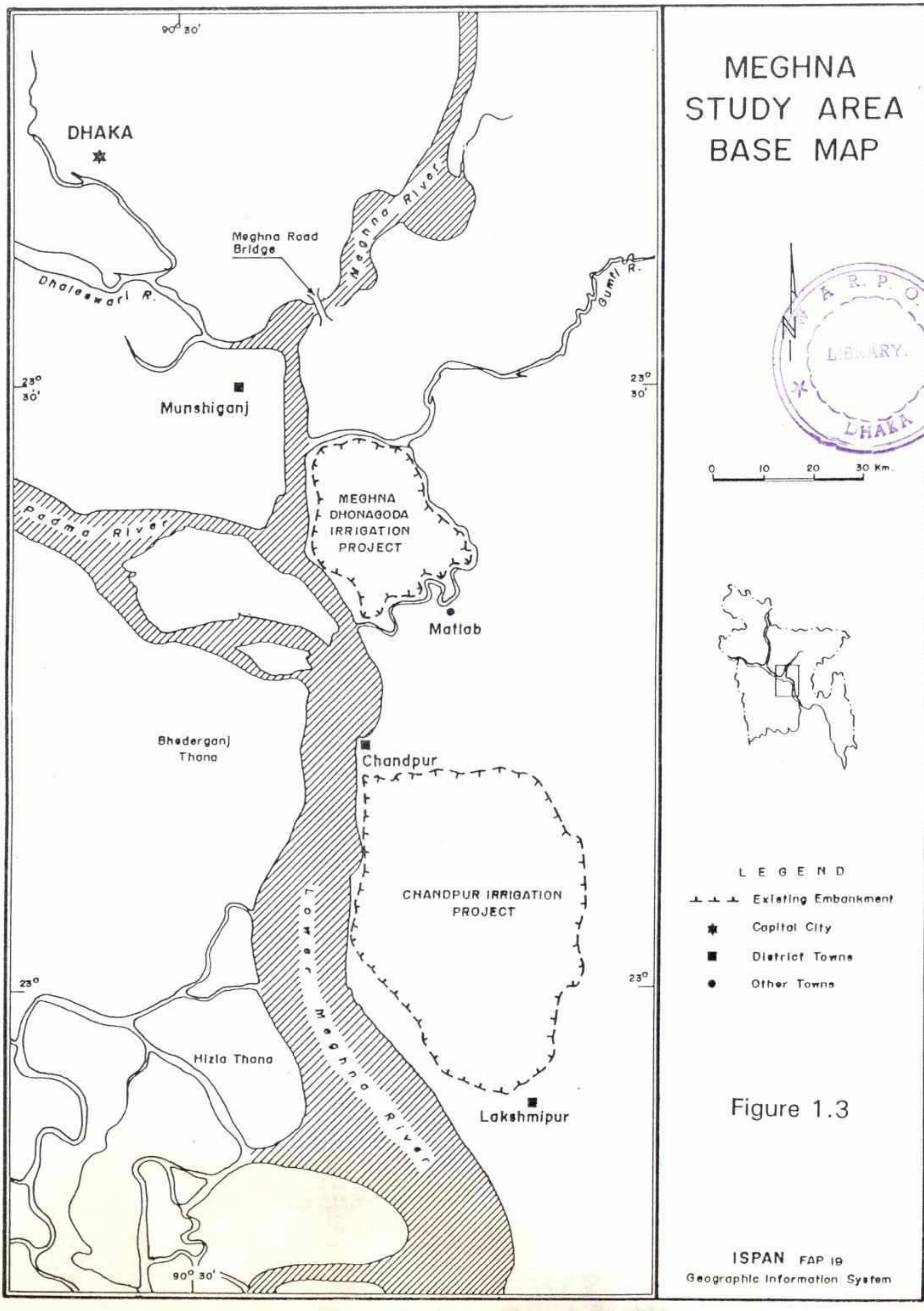
The 1993 charland surveys used the methodology developed for the Brahmaputra-Jamuna charland inventory. The study covered all land and water along the Meghna River up to existing or proposed embankments. Three main embankments border the study area. Northeast of the Padma-Meghna confluence, the embankment of the Meghna-Dhonagoda Irrigation Project constituted the study boundary. Along much of the east side of the lower reach, the boundary was the Chandpur Irrigation Project embankment (Figure 1.3). This boundary was adjusted to reflect recent retirement of the embankment due to bank erosion (SRP, 1993). The southwest boundary was the Hizla embankment. Where there were no embankments or proposals for them, other land features were used, particularly in a number of locations along the east side of the upper reach and west side of the lower reach. For example, the road between Matlab and Chandpur became a boundary since no embankment is proposed there and erosion is limited to the west side of the road.

Where there was no existing embankment the study area boundary was adjusted to follow mauza boundaries in order to simplify data collection for the Inventory Surveys. Flood modelling by FAP 5 (1993) indicates that water levels in the Upper Meghna are not the main determinant of flood levels in the adjacent floodplain to the southeast; local rainfall is the main factor. Consequently, only a limited confinement effect from embankments along this reach has been predicted. FAP 5, however, has raised the possibility that upstream embankments may change the timing and duration of floods in the area. For these reasons only a narrow band of mauzas along the eastern channel of the river was included in the study, but the large area of detached mainland was included (Section 1.3.2). Along the west bank of the Lower Meghna there is a large area of unprotected mainland and attached chars crossed and divided by small channels that connect with the Meghna. The long-accreted mainland fringe of this area, not subject to erosion or accretion in the past 20 years, was not studied. The study area has been divided into three reaches, upper, confluence, and lower, conforming with the morphology differences discussed here. For the sake of comparison with secondary sources and to simplify fieldwork, union parishad boundaries were followed.

1.2.2 Links with Other FAP Studies

The following FAP Regional Studies bound the Meghna charland study area. These studies have provided the FAP 16/19 study with the information indicated:

- North Central Regional Study (FAP 3)—proposed embankment alignments northwest of the Padma-Meghna confluence;



MEGHNA STUDY AREA BASE MAP

Figure 1.3

ISPAN FAP 19
Geographic Information System

- Southwest Regional Study (FAP 4)—survey of embankments along the south bank of the Padma, information on the west side of the Lower Meghna, assesment of morphological changes in the confluence, and historic maps and banklines;
- Southeast Regional Study (FAP 5)—flood regime and possible embankments east of the Meghna in the upper reach; and
- Northeast Regional Study (FAP 6)—embankment plans for the west bank of the Upper Meghna.

None of these FAP studies have proposed structures in the charland study area, and there has been relatively little discussion of alternative measures, such as flood proofing, for the Meghna charlands. The chars of the Meghna confluence and the Lower Meghna lie outside the investigations of the FAP regional studies. Discussions with FAP 5 about the Gumti Feasibility Study revealed that the Charland Study coverage of the Upper Meghna detached mainland areas would complement its regional and feasibility studies, which cover the floodplain but not the islands.

Potential further uses of the Meghna charland inventory data and GIS are discussed in Chapter 5.

1.3 Inventory Methodology

1.3.1 Overview

The FAP 16/19 study incorporates data generated from digital satellite imagery and field data (questionnaires) collected at the mauza level. These have been integrated using a database and GIS, which displays the field data as digital maps. The methodology for the mapping and field surveys evolved from the experience of the Brahmaputra-Jamuna Charland Study. The methodology followed is summarized in this chapter, as are specific issues raised in the Meghna charlands.

The inventory involved an iterative process of refinement using maps, images, field work, and questionnaire data, but generally the sequence was as follows:

- defining the study area (Section 1.2.1);
- digitizing mauza boundaries;
- correcting maps and images to common coordinates;
- combining and reconciling mauza and study area boundaries with the 1993 dry season Landsat image;
- designing the questionnaire;
- producing prints of the satellite image overlaid with mauza boundaries and mauza lists for field use;
- conducting the inventory questionnaire survey;
- entering and verifying data;
- adjusting the GIS database with revisions to study area boundaries and additional information from field teams; and
- tabulating, analyzing, and mapping data.

1.3.2 Charland Classification

Land and mauzas in the study area were classified into the following four main types (subdivided by left and right bank as appropriate):

- Island chars.
- Right and left bank attached charland.
- Right and left bank unprotected mainland.
- Detached mainland.

Figure 1.4 illustrates the basic classification system, which was developed for the Brahmaputra-Jamuna charland inventory.

For this classification, island chars are defined as land that, even in dry season, can only be reached by crossing a main channel of the river. Attached charland is accessible from the mainland without crossing a main channel during the dry season (although crossing lesser channels may be required), yet is inundated or surrounded by water during the peak of a "normal" flood (normal monsoon). Setback land is mainland on the river side of flood protection embankments, it differs from other unprotected mainland because the embankments may provide refuge during floods

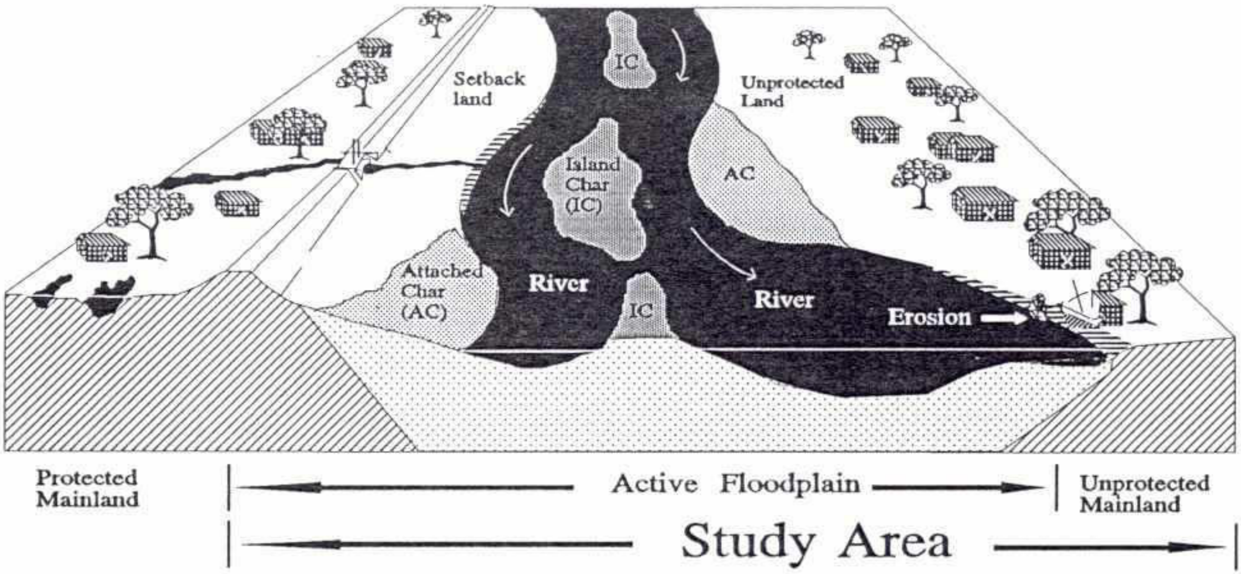


Figure 1.4 Charland Classification

but may also constrain flood water, thereby raising flood levels. Unprotected mainland has no embankment between it and the main river and is inundated during higher than normal floods. Unprotected mainland has been surveyed up to the extent of recent floods or features, such as roads, that restrict flooding.

This classification system has been modified slightly for the Meghna charland inventory. As noted in Section 1.2, an additional category called "detached mainland" was added. This long-established land differs from the nearby mainland only by being separated from it by a channel of the river. Areas meeting this description would otherwise have been grouped with the more recently accreted and dynamic island chars.

Also, since the area of setback land along the Meghna tends to be very small (because embankments are relatively close to the bank edge), there are few mauzas that are mainly setback land. In all the tables, therefore, the "unprotected mainland" category includes setback land.

Embankments rarely if ever follow mauza boundaries. Where mauzas were split by an embankment the respondents were asked to give inventory data only for the unprotected part of the mauza. This resulted in a more accurate assessment of the study area population, resources, and hazards and avoided the problem of estimating the proportion within the unprotected area. The 1981 population figures for those mauzas have been apportioned according to the area of the mauza's unprotected and protected land.

The breakdown of the study area into this classification system is shown in Chapter 3 (Figure 3.1), where it is compared with a land use classification derived from satellite image analysis.

1.3.3 Mauza Mapping

In order to collect and present the mauza inventory data, a suitable map base was required on which output maps from the GIS could be produced.

One existing set of maps, scaled 1 inch to 1 mile and known as Police Station maps, shows the location of mauza boundaries. Along the Meghna these maps were surveyed between 1910 and 1919, printed between 1923 and 1928, and last revised between 1935 and 1958. For this study, the mauza boundaries, including latitude and longitude marks, were traced from each of these maps onto separate acetate sheets. These maps were then compared with the relevant BBS Small Area Atlases to determine mauza "geocodes," which were used to identify mauzas, and any recent changes in mauza boundaries.[2] The tracings were then digitized. In the GIS the thanas were joined, and boundaries were matched. Small gaps and overlaps between mauzas along the edges of thanas were corrected by taking a middle line. The few larger areas that had not been allocated to a mauza at the time of the Police Station maps and were not shown as belonging to a mauza in the Small Area Atlas were then highlighted for field checking.

The locations of existing and proposed embankments were traced onto separate acetate sheets directly from the 1989 1:50,000 SPOT image sheets. The alignment of existing embankments was generally very clear on these images, but when there was any doubt about a location, Survey of Bangladesh 1:50,000 maps and maps from relevant FAP regional studies were consulted.[3] Maps of existing and proposed embankments provided by FAP 3 and FAP 6 (for the west bank of the Upper Meghna) and FAP 4 (for the Ganges-Padma right bank) also were used.

Where there was no embankment or proposed embankment, the physical boundary closest to the main river channel was used. The resulting study area boundary was digitized and overlaid on the mauza map, and the boundary where there was no embankment was revised to include mauzas intersected by the boundary line. The study area boundary, then, follows mauza boundaries except where there are existing embankments. The only exception to this is the northwest boundary in Araihazar Thana, where the bankline is very stable. Here data have been apportioned for the small area of land that would remain outside the proposed Narayanganj-Narsinghdi Irrigation Project embankment. Otherwise, data representing the whole of the mauzas would overstate the population expected to be at risk from flooding.

The mauza boundaries and study area boundary were then overlaid on the March 1993 Landsat image of the Meghna. A series of overlapping color prints of this combined map were made at 1:100,000 scale, and a transparent overlay, with the geocodes for each mauza, was added. A large plot of the mauza boundaries in the study area, also at 1:100,000 scale, and a copy of the relevant pages of the Small Area Atlases, with study area mauzas highlighted, completed the set of fieldwork information provided to the interview teams.

Field teams were given a color image of their areas, as well as black-and-white photocopies of the image and a mauza boundary map. The teams were required to visit each mauza in the study area, check on the status of areas not allocated to a mauza or where boundaries were uncertain, and complete additional questionnaires as appropriate. Relevant thana officials provided information on present administrative boundaries and recent changes.

1.3.4 Inventory Questionnaire

Field data collection used a key-informant interview method following a fixed questionnaire in each of the study area mauzas. First, the mauza was identified and located on the image, the name was checked, and key informants, or individuals who could speak for the entire mauza, were identified. If such informants could not be found, then separate returns were completed for the mauza's constituent villages. In the Meghna study area there were only 12 mauzas where two inventories were completed (split between island char and setback land).

The questionnaire was a modified version of the one used in the Brahmaputra-Jamuna inventory. Based on past experience some parts of the questionnaire were simplified, and more questions on hazards, including some on agriculture and others on flood and erosion impacts, were added. The questionnaire is reproduced in Appendix A.

The questionnaire was pre-coded and consisted of about 450 discrete pieces of information covering the following issues:

- Identification of the mauza.

- Physiography of the mauza.
- Mauza population, including seasonal and permanent in- and out-migration.
- Infrastructure and service provision.
- Broad socioeconomic parameters (occupations, agriculture, livestock).
- Environmental hazards.
- Social conflicts.

1.3.5 Fieldwork and Boundary Problems

The main problems arising during the inventory fieldwork involved disputes as to which mauza, union, thana, or even district a piece of land belongs. Since the confluence and Lower Meghna are so dynamic, detailed boundary surveys are needed in several places (including the boundary between Bhedarganj and Chandpur thanas and between Gosairhat and Haimchar thanas). Accurate maps, produced in conjunction with census data, are needed to ensure that the spatial content of census data is correct and that government officials and elected representatives have accurate information about their service areas and constituents.

Mauza boundaries and administration units in the study area were fixed between 1910 and 1919, and they have only been slightly modified since then, despite significant changes in the river channel. In a number of cases the mauza boundaries reflect the river channel alignment at the time of the cadastral survey, with the main district boundary typically following what was the center of the river. In the field maps used for the inventory, uncertain mauza boundaries were identified, but the field teams were neither set up nor equipped to carry out detailed mapping, so they were rarely able to accurately identify changes to these boundaries. In many cases the mauzas involved, virtually all of them in the Lower Meghna, are completely submerged, obviating the need for on-the-spot mapping. In some cases, however, field visits confirmed that there were ongoing disputes over accreted land along such boundaries. There are a few cases where the data recorded is for the area controlled by people of a given mauza, and that area may differ slightly from the area mapped.

In one of the more complex cases, a large area just inside Bhedarganj Thana, which had been river channel at the time the Police Station map was surveyed, is now island and attached char. The field work established that the people of three adjacent mauzas under Chandpur Thana are using this area. In this case, approximate boundaries for the enlarged mauzas were estimated so that the data collected was mapped in as close to the correct places as possible, even though this means that the boundaries shown in Figure 1.2 differ from the official boundaries. Similarly, an area of attached char on the border of Haimchar and Raipur thanas was found to be *khas* land, but the Union Parishad Chairman from the Haimchar side confirmed that it was occupied by farmers from the adjoining mauza of his union, and the GIS was adjusted accordingly.

Other cases were more straightforward. For example, mauzas that had been switched between unions or even thanas by the local administration since the BBS Small Area Atlas. Some inaccuracies were also found in the Small Area Atlases, among them: mauzas that appeared in the lists for more than one thana, mauzas that were not mapped, and mauzas in the same thana with the same geocode. With the help of the local thana officials, Union Parishad Chairmen, and local people as consistent a data set as was possible was prepared. Corrections were made to the digitized maps and to the geocodes to ensure that the inventory data was accurately plotted in the maps.

These uncertainties about the location and distribution of resources (land and people) relative to administrative units are a handicap to efficient development planning. More accurate official boundary demarcation is required in the areas where this study found uncertainties and disputes.

1.3.6 Satellite Image Interpretation

The Landsat imagery analysis on char physiography is detailed in Chapter 2 of this report. This analysis has been carried out by superimposing on the March 1993 image an image from the 1984 dry season. For the confluence area additional data on morphological changes was available from a 1973 Landsat image. The image analysis enabled the following to be mapped and quantified:

- Char persistence between 1984 and 1993.
- Erosion patterns over the past nine years.
- Current land use and cover.

Mauzas were categorized according to the charland types defined in Sections 1.2.1 and 1.3.2. Initially, the field teams determined for each mauza the proportions of mauza area in each category based on field observation, local information, and the 1993 satellite image. Mauzas were then categorized according to the dominant land type (excluding water areas). This was later cross-checked against the satellite images and questionnaires, corrections were made, and the category of detached mainland was added. It was particularly difficult to differentiate between attached char and unprotected mainland using GIS, so this was done manually.

In the Appendix B tables, which summarize the data by reach and char type, mauza data is aggregated according to the charland type of the maximum area of land within the mauza. The tables are analyzed and interpreted in Chapters 3 and 4.

NOTES

1. A mauza is the government's smallest revenue unit with a fixed cadastre.

2. The Police Station maps, which are more accurate, remained the primary source.

3. FAP 18 mapping of the Lower Meghna is scheduled to be completed by 1995; maps prepared so far are under the jurisdiction of Survey of Bangladesh.

Chapter 2

CHAR AND CHANNEL DYNAMICS

2.1 Summary

Seasonal and long-term changes in the geomorphic characteristics of the main river charlands affect the settlement patterns and social and economic activities of their inhabitants. To better understand the dynamic nature of the chars, FAP 19 undertook a study of satellite images. This data medium is the most effective means of monitoring present-day changes in the physical and morphological characteristics of these riparian environments.

Analysis of 1984 and 1993 satellite images confirmed the evidence of earlier maps, that although the Upper Meghna has changed very little, both the confluence and Lower Meghna reaches have been quite dynamic. Since 1984, the single channel in the Padma at the westernmost boundary of the confluence reach has narrowed and moved north, while at the juncture of the Padma and Meghna it has separated into two main channels and a stable cluster of chars there has "drifted" northward. Meanwhile, west bank erosion has widened the Lower Meghna at an average rate of 295 m per year between 1984 and 1993. The movement of dry season river channels and chars in the river is relatively simple to track since the Meghna is not braided except in the confluence area. In the unstable reaches the area of chars has increased in proportion to both channel bifurcation and widening. Moreover, existing chars have evolved at the confluence, and new chars have appeared in the lower reach.

Over the long term the confluence and Lower Meghna have shown a tendency toward east bank erosion (FAP 4, 1993), rather than the west bank erosion found between 1984 and 1993. Natural stabilization of the alignment is unlikely until the eastward movement brings the left bank to another outcrop of resistant Chandina Alluvium east of Chandpur. Analysis of a longer time series of images is needed to make reliable quantitative predictions of future bank retreat. Nonetheless, the width of the lower channel apparently will continue to increase as mainland is destroyed. Consequently, sedimentation will enlarge existing islands and continue to create new island chars.

In the confluence, the Padma flow will continue to switch between north and south channels around the island char complex. This will occur on about a 15-year cycle, with the river sometimes occupying only the northern channel, and at other times both channels. The large bend where the Padma flow is turned southward is likely to continue to erode. If the bank is stabilized at Chandpur, the trend found between 1984 and 1993 could continue. The flow of the Lower Meghna could become more directed into the network of channels along the lower west bank, converting existing smaller secondary channels into a major off-take rather than the present single channel.

2.2 Background

Three great rivers drain through Bangladesh and have been responsible for building the vast alluvial fan that forms its landscape. The Ganges and Brahmaputra are the larger, both ranking among the top 10 rivers in the world. The Upper Meghna, which is the Bangladesh portion of the Meghna-Barak Basin is much smaller, but just north of

Chandpur it is joined by the Padma (the combined Ganges and Bramaputra flow). The Lower Meghna carries most of the flow of these great rivers into the Bay of Bengal. When considering the present hydrology and geomorphology of these rivers and the alluvial fan they continue to build, it is important to bear in mind their dynamic nature over both the geological time scale and the recent past.

The Ganges rises in India on the southern flanks of the Himalayas and flows southeastward into Bangladesh. Until about 500 years ago it followed a course well to the west of its present position in Bangladesh, building a delta in the area of Jessore and reaching the Bay of Bengal along the course of the present Hoogly River. In the 15th or 16th century it began to swing eastward to follow a course close to that of the present day Gorai River, and the Hoogly became a right bank distributary. It then continued to migrate eastward, and by the mid-18th century Renell's map shows it flowing along what is now the Arial Khan River. Until that time, there had been no confluence of the Ganges with either the Brahmaputra or the Meghna rivers, but this situation was to change radically in the next few years.

The Brahmaputra rises on the northern flanks of the Himalayas, its source only a short distance from that of the Ganges. It flows almost due east through China as the Tsangpo before turning south and entering India. It then flows southwest through Assam as the Brahmaputra before turning almost due south as it enters Bangladesh. Until the late 18th century the curve of the river continued, producing a southeasterly course that took the Brahmaputra to the east of the Madhupur Forest Tract and into the southern end of the Sylhet Basin, where it joined the Upper Meghna River. The combined flow entered the Bay of Bengal along the present course of the Meghna Estuary.

Eventually, the Brahmaputra broke through the higher ground along its southern flank around Gaibanda to shift 60 km and adopt a new course to the west of the Madhupur Forest Tract. In Bangladesh the reach of river this shift created is called the Jamuna, the name Brahmaputra being retained by the former course, which has dwindled to little more than a high-flow distributary. There is evidence that this change did not occur catastrophically, but took place gradually over a period of perhaps 30 years between 1790 and 1830.

As a result of this shift, the Brahmaputra-Jamuna formed a new confluence with the Ganges, creating a very large river called the Padma. In the 1830s, Wilcox's map shows the Padma following the old course of the Ganges, along the Arial Khan, but soon the great increase in the volume of flow led to a major avulsive shift, and by 1857-60, as Gastrell's map shows, the Padma had broken through a neck of higher terrace land separating it from the Meghna. A remnant of this terrace of consolidated silt/clay sediments (Chandina Alluvium) appears as an arrow-shaped vegetation pattern on the southwest side of the present confluence in the satellite images. For the first time the three large rivers met north of Chandpur, the situation which still prevails today.

The Upper Meghna has followed a stable course in recent times. Before the Brahmaputra shifted to its present Jamuna course, the Meghna reach covered in this study carried virtually the entire flow of the Brahmaputra. Today the Meghna has a stable main channel with a few island chars and large areas of relict chars, "detached mainland" that is separated from the mainland by secondary channels of the river. The dominant discharge in the Upper Meghna just north of the study area at Bhairab Bazaar has been estimated to be 9,000 cumecs. Only 45 percent of the Meghna-Barak Basin lies within Bangladesh, where it drains the Sylhet Basin, and 54 percent of the flow comes from high-rainfall areas across the Indian border.

The Lower Meghna is tidal throughout its length. The daily range of the tide is from 0.4 m at the Padma-Meghna confluence to 1 m at Chandpur and more than 2.5 m on the Bay of Bengal. The discharge ranges from a low flow of about 10,000 cumecs to a 1-in-100-year flood of about 160,000 cumecs (FAP 4, 1993). The dominant flow is the sum of the Padma and Upper Meghna flows: about 80,000 cumecs. The large and variable flow, coupled with a high sediment load (estimated to be on the order of one billion metric tons a year), tidal regime, and the transition from fresh to saline water (the extent of which shifts between monsoon and dry seasons), result in a highly dynamic system in which there is constant creation and destruction of land along and in the channel.

2.3 Methodology

2.3.1 Satellite Image Selection

A pair of dry season satellite images from 1984 and 1993 were selected to study changes in river dynamics, charland geometry, and vegetation distribution. The river banks, as well as the chars, could be mapped with a precision and consistency that enabled local characterization in greater detail than could be compiled from available map sources. The images selected for the study were obtained from satellite image archives in the United States and Thailand (Table 2.1).

Table 2.1 Satellite Imagery Used for the Meghna Char Study

Date	Path/Row	Sensor
March 19, 1984	137/44	MSS
March 11, 1993	137/44	TM

Data from two Landsat satellite sensors were used: the Multi-Spectral Scanner (MSS) derived data for 1984 and the Thematic Mapper (TM) for 1993. The 1984 data were a subset of an MSS image mosaic of Bangladesh that had been generalized from 80 m to 100 m ground resolution.[1] The TM data were used for 1993 because that sensor provides high-resolution images (30 m) and is more suitable for analyzing current conditions.

2.3.2 Image Preprocessing and Rectification

The images listed in Table 2.1 were acquired on nine-track computer tape, read into FAP 19's ERDAS image processing system, rectified to geographic coordinates, and fixed to the Bangladesh Transverse Mercator (BTM) projection using control points selected from 1989 SPOT image prints. The prints, at 1:50,000 scale, were supplied to FAP 19 by the FPCO. Each satellite scene was then clipped to a precise rectangular region covering major portions of the Upper and Lower Meghna rivers and the Padma River confluence, an area approximately 110 km north-south by 53 km east-west (Figures 2.1 and 2.2)

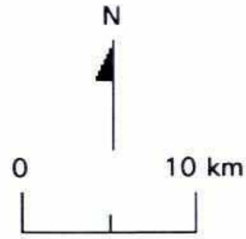
2.3.3 Satellite Image Classification

To create precise, comparable maps of river channel features, each digital satellite image grid cell, or pixel, was classified according to its image brightness and color. This multispectral image classification methodology evolved through a series of tests using standard classification techniques described in Richards (1986) and used for similar analyses in the Jamuna study. Generally speaking, similar surfaces or types of ground cover produce a distinct range of spectral responses known as a signature. Digital algorithms were used to recognize and statistically define these spectral patterns in the image data. Next, the pixels were sorted into one of the proposed classes (signatures) through the use of a mathematically-based decision rule (maximum likelihood). Finally, the land cover features to which each proposed class corresponded were identified, and analogous categories were combined. The final product was an image composed of four classes: water, sand, cultivated/bare soil, and natural vegetation. This method and classification had already been used for the Jamuna charlands.

2.3.4 Accuracy Assessment of Image Classification

The accuracy of the March 1993 digital image classification was checked in the field in April 1993. Waterways, land cover, and agronomic practices were observed and compared with spectral signatures on color prints of the original satellite image.

1984 DRY SEASON SATELLITE IMAGE



Source: ISPAN, Landsat TM image.

Figure 2.1

1993 DRY SEASON SATELLITE IMAGE

N

0 10 km

Source: ISPAN, Landsat MSS image.

Figure 2.2

82

The evaluation compared actual ground conditions with those interpreted from the image ("ground truthing") at 24 sites on the river banks and chars of the confluence and lower reach. For each site a polygon was overlaid on the satellite image. The polygons were selected for image areas with relatively uniform spectral characteristics and for ground areas of about 10 to 20 ha. After locations were verified using a hand-held global positioning system (GPS) receiver, land cover and conditions were noted, and local people were questioned about conditions at the time the image was taken.

Table 2.2 Comparison of 1993 Image Classification with Verified Land Type

	Area Verified in the Field		Classified Correctly		Classified Incorrectly	
Land Type	Area (ha)	%	Area (ha)	%	Area (ha)	%
Water	409	50	399	98	10	2
Sand	24	3	23	96	1	4
Cultivated	262	32	244	93	18	7
Vegetated	120	15	63	53	57	47
Total	815	100	729	89	86	11

Source: FAP 19 ground truthing

Field information was used to assign a class to the polygon for each field ground truth site. There were a total of six classes corresponding to types of cultivated land (cropped and emerging crop or fallow), natural vegetation (homestead and catkin grass), and one class each for sand and water. Using a computer cross-referencing program, coincident pixels, each representing a ground area of 0.09 ha on the 1993 classified Landsat image, were compared with the polygon classes for the ground sample sites.

Accuracy was determined according to the percentage of ground truth sites correctly classified. Table 2.2 summarizes the results and shows that overall classification accuracy was 89 percent.

The two most accurate classes were water, for which the image classification was 98 percent accurate, and sand, which was 96 percent accurate. The relatively small area used for verifying sandy regions is consistent with the proportion of sand area in the image. The lower accuracy for the cultivated/vegetated land category is thought to be attributable to two types of misclassification. In some cases natural homestead vegetation was classified as cultivated (cropped) or vice versa, and sandy areas were sometimes classified as cultivated land (cropped). In addition, some errors may be attributed to the time lapse of more than one month between the time the image was taken and the formal ground truthing observations, to inaccurate responses from interviews, or to variability in sample areas. Cultivated and natural vegetation classes were subsequently combined since they have similar meanings in the context of this study and were not clearly distinguishable. As a result, the simple three-category classification used in the remainder of this study had an accuracy of 99 percent.

Since the satellite image processing was initiated in 1993, it was impossible to perform an accuracy assessment of the 1984 image. It is expected, though, that assessment of the 1984 image would yield similar accuracies since it was also recorded during the dry season and was subjected to the same image classification procedures.

Finally, the classified 1984 (MSS) and 1993 (TM) images were resampled to a common pixel size of 80 by 80 m to provide a consistent foundation for analysis. The classified 1993 image formed the basis of the analysis in Chapters 2 and 3 and is shown in Figure 3.2.

2.3.5 Bankline Delineation

The criteria for bankline interpretation of the satellite images were determined during the Jamuna study after discussions with various experts, including river morphologists and engineers from FAPs 1, 21/22, and 25. Images were displayed at full resolution on large-format, high-resolution computer monitors, and the river bankline and char boundaries were digitized and saved as BTM map coordinates. After review and finalization, maps of both years' river channel area were created. The advantage of these maps was that bankline and char features could be distinguished and quantified, which allowed temporal comparison of spatial patterns. Detailed analysis of these changes over the period is described below.

2.4 Riverbank Erosion and Accretion

2.4.1 Context

There is considerable anecdotal evidence of severe bank erosion and very rapid rates of bankline retreat along the Brahmaputra-Ganges-Meghna river systems. Most of it lacks a sound factual basis, and much of the evidence used to document rapid retreat may, in fact, relate to exceptions rather than the overall pattern. This study attempted to quantify the actual rates of bank erosion along the river based on satellite images. This analysis was undertaken using the FAP 19 GIS.

Products of the analysis include bank erosion rates, estimates of the loss of mainland area to erosion, and estimates of the population affected (Chapter 4). Some estimates of future erosion patterns are made, but there are many uncertainties about the movements of rivers like the Meghna.

2.4.2 Channel Morphology

The Upper and Lower Meghna river systems must be treated separately in terms of channel history and morphology. Although the Upper Meghna has maintained its present general position for many years, the Lower Meghna has undergone significant changes in the recent past.

Until the mid-19th century, as previously noted, the Meghna-Padma confluence was about 65 km south of its current location. After the Padma broke through to join the Meghna at the present confluence, the Lower Meghna had to enlarge to carry the combined discharge of all three rivers, but its orientation was no longer adjusted to the approach alignment of the dominant flow. The approach previously had been almost due north-south from the Sylhet basin. But after the Padma broke through, the flow had to turn almost 90 degrees as it exited the gap in the Chandina Alluvium. The bend this produced is still in evidence today. Its tendency to migrate eastward—by eroding the outer (left) bank along the reach between Eklashpur and Chandpur—is a consequence of the immense change in momentum associated with turning many thousands of cumecs of water flowing at high speed around a comparatively tight corner. Since the thrust of the water is concentrated on attacking the outer bankline, it will be difficult to slow erosion in the short to medium term in this area. On a longer, geologic, time scale, continued eastward migration of the Lower Meghna is probably unstoppable.

The Upper Meghna appears to have a stable, mature course, while the Lower Meghna channel continues to adjust to accommodate the range of flows and sediment loads from the Jamuna and Ganges via the Padma. In addition, tidal effects, seasonal changes in salinity, possible increases in relative sea levels, and seismic hazard, mean that the lower river channel is expected to continue in a process of unsteady adjustment, with the three-dimensional geometry of the channel evolving to cope with the changing conditions. Nevertheless, the characteristics of past and present channel evolution should give a reasonable indication of future trends—at least over short time scales.

The three-dimensional geometry of the channel is defined by its long-profile, cross-section, and planform pattern. The FAP 19 GIS analysis shows that the positions of the banks and low flow channels have changed notably over the past nine years. The maps produced have allowed an examination of recent patterns of planform evolution. These image-based maps provide reliable, quantitative data on distributions and rates of channel adjustment. The results, described in detail in the following sections, show that the Lower Meghna River has been widening westward since at least 1984. The analysis also shows that the river is continuing to evolve actively through changes in its centerline, width, and char distribution.

2.4.3 Channel Migration

The Meghna River, in sharp contrast to the intensively braided Brahmaputra-Jamuna River, consists of one, and sometimes two, predominant channels. In the upper reach it has remained essentially static, while in the confluence and lower reach since 1984 it has bifurcated and migrated westward, respectively (see Figures 2.5 and 2.6 and Section 2.4.5). Moreover, there has been considerable charland formation concurrent with substantial bank erosion. Bankline accretion was limited mainly to the right bank of the confluence reach (see Figure 2.7 and Section 2.4.5).

The maximum movement of the west (right) bankline during the nine years is about 7.5 km west some 35 km south of Chandpur. The banks of the upper reach have experienced a net accretion rate of 1 m per year. In the confluence and lower reach, on the other hand, there have been net annual erosion rates of 57 m and 171 m, respectively. Moreover, the centerline of the lower reach moved westward at approximately 121 m per year for the nine-year period.

Figure 2.3 summarizes and simplifies channel migration, irrespective of channel width, by plotting centerlines calculated from banklines derived from the satellite images. Centerline movement has been calculated at 5 km intervals in an east-west direction for the Meghna and in a north-south direction for the Padma. This illustrates the westward movement of the lower reach channel since 1984.

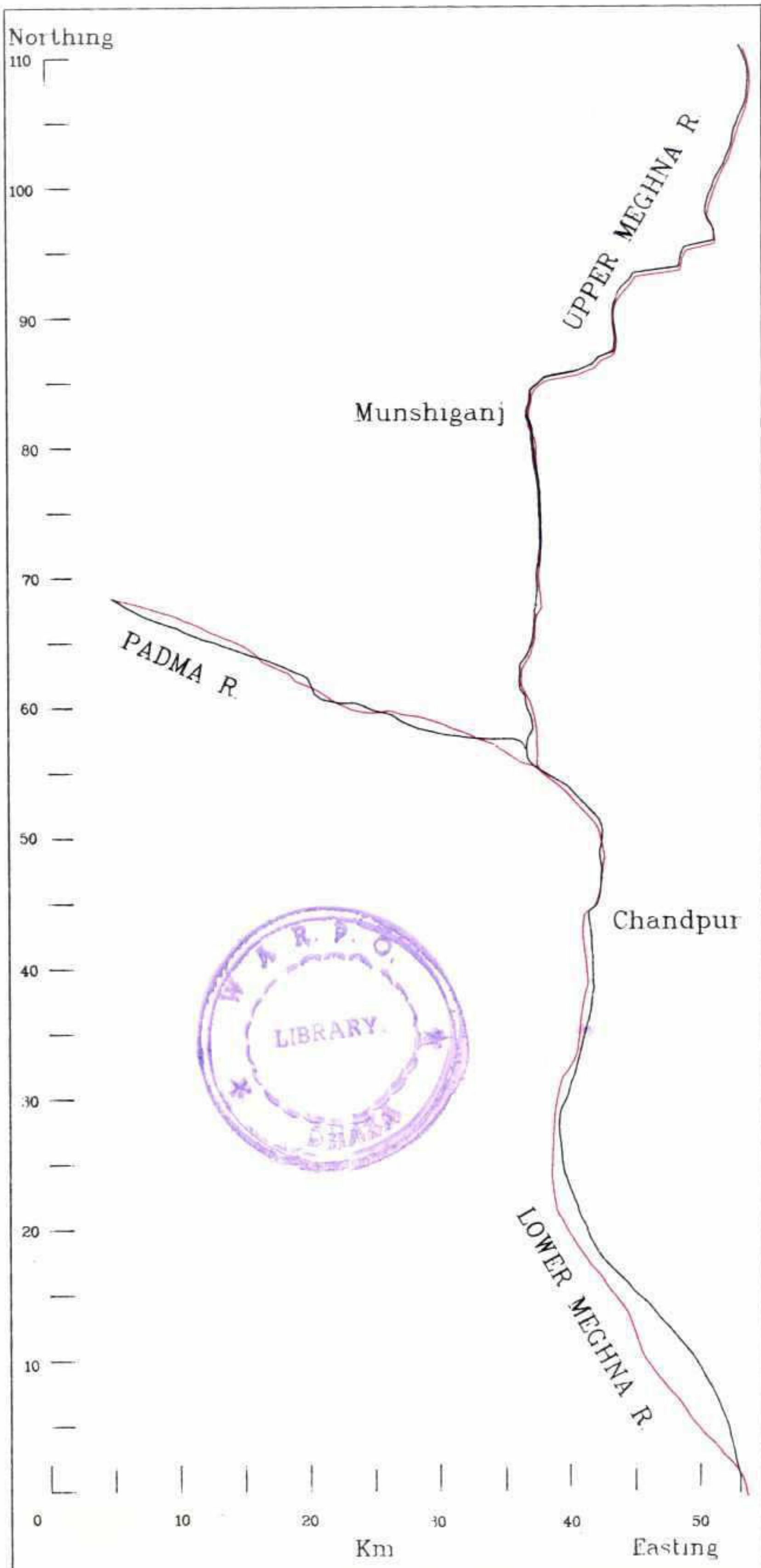
Although the part of the Meghna within the study area has moved westward on average by 466 m, centerline migration for 11 cross-sections in the upper reach (north of northing 60 in Figure 2.3) ranged from 438 m east to 94 m west (negative numbers in the figure), an average eastward movement of 11 m per year. In the lower reach (from northing 55 south), the centerline moved west by up to 3.7 km at all cross-sections except for the southern limit of the study area, giving an average westward movement of 111 m per year. By comparison, the Padma, as it approaches its confluence with the Meghna, has mainly moved northward during the nine-year period. Figure 2.3 gives a maximum movement of the centerline 1.1 km north and an average of 359 m north (positive numbers), implying an annual northward movement of 40 m.

These erosion trends contradict earlier studies showing eastward movement of the Lower Meghna. This suggests that erosion patterns in the reach do not persist in one direction for long periods. FAP 4 (1993), for example, refers to an eastward erosion rate between 1963 and 1973 of 100 m per year at Hajimara (near the southern limit of the study area on the east bank); and at Haimchar (middle of the lower reach east bank) the east bank reportedly eroded some 600 m in a short time around 1974 when peak flood flows cut through a bend in the channel.

Holding the bankline at Chandpur may cause the main current of the Lower Meghna to swing to the west downstream of Chandpur, which will become a hard point. FAP 9B (1990) recognized this and noted that some accretion of the left bank south of Chandpur might be expected. This implies that the Meghna may re-occupy the large west bank meander opposite Haimchar and that erosion of the west (right) bank could recur. This would involve loss of land in the south central region and could cause changes in the hydrodynamics and morphology of the area's large right bank spill channels.[2] The image analysis suggests that these changes are, in fact, taking place.

2.4.4 Channel Widening

Channel widening is as significant as the westward migration of the lower reach centerline in understanding overall changes in the Meghna reaches. There are considerable differences in width along



Center Line Migration (1984–1993)

Migration from 1984 Center Line (m)
Upper and Lower Meghna

Northing (Km)	1993
110	224
105	120
100	110
95	88
90	-44
85	-94
80	201
75	-56
70	63
65	52
60	439
55	152
50	-117
45	-280
40	-481
35	-478
30	-808
25	-884
20	-1526
15	-1789
10	-3751
5	-2325
0	456
Mean	-466

Migration from 1984 Center Line (m)
Padma at Confluence

Easting (Km)	1993
5	271
10	1112
15	797
20	-158
25	113
30	1083
35	-701
Mean	360

1984

1993

Figure 2.3

ISPAN
FAP19 Geographic Information System

Table 2.3 Average Width (km) of the Meghna 1984-1993

Reach	Year	Average	Maximum	Minimum
Upper	1984	3.41	11.52	1.01
	1993	3.39	11.34	0.98
Change		-0.02	-0.18	-0.03
Confluence	1984	7.98	12.94	3.79
	1993	9.01	14.42	4.33
Change		+1.03	+1.48	+0.54
Lower	1984	5.74	7.87	3.82
	1993	8.82	12.99	5.03
Change		+3.08	+5.12	+1.21

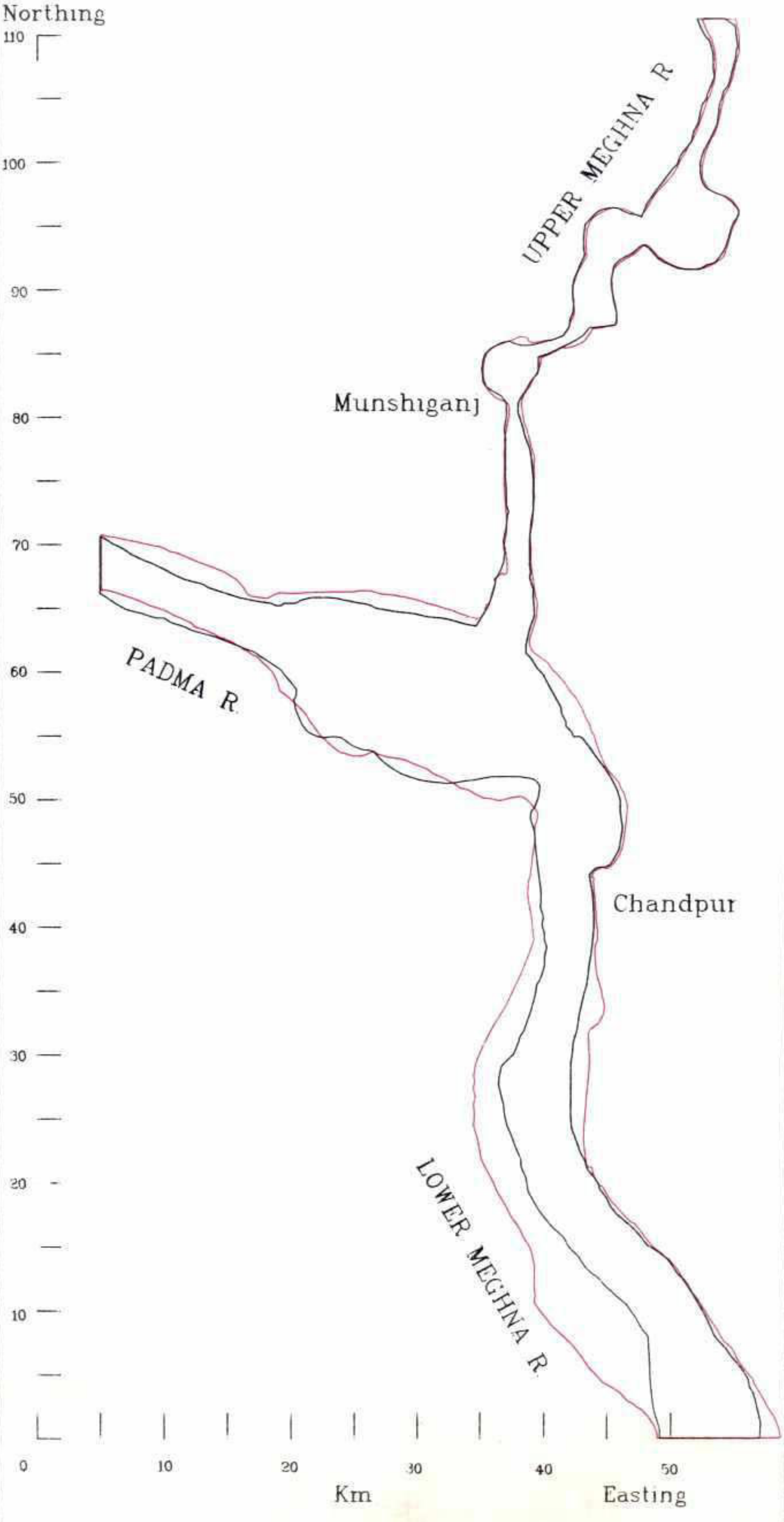
Sources: 1984 and 1993, Landsat images

the Lower Meghna, but at most cross-sections the river has also markedly changed width. Figure 2.4 shows width variation to have been relatively less around the confluence and in the upper reach. In 1984, the average width of the upper reach was 3.4 km, the confluence was about 8.0 km wide, and the lower reach approximately 5.7 km wide. By 1993 the average width in the upper reach had increased by 10 m, in the confluence by 1 km, and in the lower reach by 3 km (Figure 2.4 and Table 2.3). The most rapid width change occurred in the lower reach, where the river widened at an average rate of 339 m per year. The figure also shows a maximum rate of widening in excess of 800 m per year in the vicinity of Hizla Thana at northing 10 km.

2.4.5 Overview of Channel Changes

Figure 2.5 shows the successive low flow channels of 1984 and 1993, which reveals some of the within-channel changes underlying the bankline erosion discussed above. The division of the Padma flow to the north and south of the large island char complex in the confluence is evident in the figure. This phenomenon reflects the complex interplay of the dynamics of the Padma channel, the presence of the stable Upper Meghna flow, and the bend where the Padma flow is redirected from east to south. Figures 2.1 and 2.2 show that the erosion-resistant Chandina Alluvium sediments (the arrow-shaped vegetation pattern southwest of the confluence) have checked bankline erosion. In the Lower Meghna there has been erosion of some attached charland near and opposite Chandpur, but this stretch of the river has remained relatively narrow. Farther south, bank erosion and widening has been associated with the emergence of island chars in the east side of the channel.

A dominant feature of the study area is the large bend in the Padma-Meghna confluence. It has a radius of about 15 km and an arc angle of around 90 degrees. The main channel width is reduced at the bend to about 2.5 to 4 km (FAP 9B, 1990). The main channel switches alternately between a northern outer bank and a southern (chute) channel around a large mid-channel char complex that periodically forms just upstream of the bend, depending on the approach flow configuration and upstream meander bend, and on the char pattern. In some years both channels are open (as in 1993), but in this divided reach, while the southern channel can sometimes be completely blocked, the northern channel is always kept open by the flow of the Upper Meghna. When flow is predominantly in the southern channel, extreme bank erosion occurs on the opposite bank (near Eklashpur). When the northern channel predominates, erosion is concentrated farther around the bend at Chandpur. The configuration of the approach flow, then, has a direct impact on the pattern of flow and distribution of erosive attack on the outer bank of the bend.



Bankline Positions and Width (1984–1993)

UPPER MEGHNA

North -ing	Channel Width (m) 1984	1993	Change	Rate m/year
110	2492	2331	-161	-17.9
105	1207	1213	6	0.7
100	1744	1825	81	9.0
95	11515	11344	-171	-19.0
90	2975	2989	14	1.6
85	5087	5030	-57	-6.3
80	1014	975	-39	-4.3
75	2222	2276	54	6.0
70	2058	1922	-136	-15.1
65	3748	4006	258	28.7
Mean	3406	3391	-15	-1.7

PADMA AT CONFLUENCE

East -ing	Channel Width (m) 1984	1993	Change	Rate m/year
5	4563	4328	-235	-26.1
10	3889	4838	949	105.4
15	3792	5125	1333	148.1
20	6384	8497	2113	234.8
25	11357	12923	1566	174.0
30	12944	12933	-11	-1.2
35	12937	14417	1480	164.4
Mean	7981	9009	1028	114.2

LOWER MEGHNA

North -ing	Channel Width (m) 1984	1993	Change	Rate m/year
50	6481	7833	1352	150.2
45	5796	6448	652	72.4
40	4054	5032	978	108.7
35	3822	7003	3181	353.4
30	4655	8802	4147	460.8
25	5174	8896	3722	413.6
20	5591	8333	2742	304.7
15	6430	9769	3339	371.0
10	5654	12990	7336	815.1
5	7576	12093	4517	501.9
0	7870	9807	1937	215.2
Mean	5737	8819	3082	342.4

— 1984

— 1993

Figure 2.4

FAP19 Geographic Information System

FAP 9B (1990) reports that the east bank at Eklashpur eroded 3.25 km during 1952-1990 (40 m per year), compared with 2.7 km at Chandpur, where the bank appears to have stabilized in recent years (Figure 2.4). The erosion rate has a 15-year cycle coinciding with the periodicity of channel switching in the Padma upstream of the bend. When migrating chars from the Padma reach the Meghna confluence they are eroded rather than rounding the bend, and the sediment load merges into the mobile char complex at the inner bank.[3]

These attributes of the Padma-Meghna confluence bend are consistent with the behavior of curved channels in general. On this basis, it can be predicted that, without heavy and continuous efforts to stabilize the right bank around Eklashpur and Chandpur, the bend will migrate downstream through sustained erosion of the outer bank from the apex of the bend downstream to its exit. Conversely, success in stabilizing the outer bank by creating one or more hard points would result in distortion of the outer bankline as the river attempts to outflank the protection. This could lead to large-scale changes in channel configuration, both at the bend and farther downstream.

Figure 2.6 compares the two Landsat images and shows the banklines that were digitized from them. The complexity of the west bank of the lower reach—where there has been char consolidation outside of the bank of the main channel—is apparent, as is the relatively stable west bank at the far south of the image.

By concentrating on bank changes in the main channel, the complex changes in this reach are simplified. Figure 2.7, which was developed by digitally comparing bankline delineations, shows the net change in river banklines between 1984 and 1993. There has been an overall widening of the river through consistent erosion along both the left and right banks of the Padma section of the confluence and along the lower reach. The right bank of the Padma near the confluence is the only part of the Meghna study area where a significant amount of accretion took place. Table 2.4 shows that the area of net accretion was only 7 percent of the area of mainland lost to erosion.

Figure 2.7 also gives some indication of the complexity of changes that have taken place during the nine years. For example, some places have changed from mainland to char, which may involve land breaking away from the mainland, or erosion followed by later accretion. Images taken within the nine-year period would reveal the sequence of changes in such areas.

Analysis of a series of satellite images at three- to four-year intervals would help to understand the complex changes that have occurred. Only one rate of change could be calculated for the years 1984-1993. This effectively generalizes an intangible amount of physical change in river morphology and rates of change for the period. Since those years included the floods of 1987 and 1988, bank erosion rates in those years, on the basis of the Jamuna study, would have been much higher.

2.4.6 Bankline Erosion and Accretion Trends

The data used to derive Figure 2.4 were analyzed by FAP 19 to determine bank erosion rates between 1984 and 1993. Without an extensive satellite image time series it was not possible accurately to predict future bank erosion patterns and duration of erosion rates.

Table 2.4 Bankline Erosion/Accretion by Reach 1984-1993*

Reach	Eroded Area (Ha)	Accreted Area (Ha)
Upper	460	439
Confluence	5,017	789
Lower	14,425	131
Total	19,902	1,359

Source: FAP 19 Satellite image analysis
*Summed on a mauza basis resulting in small differences from the estimated increase in within-bankline area.

LOW FLOW CHANNEL MIGRATION

N

0 10 km

1984 Channel
1984 & 1993 Channel
1993 Channel

Source: ISPAN, Landsat images of 1984 and 1993.

Figure 2.5

Bankline Movement 1984-1993

1984 Landsat Image

1993 Landsat Image

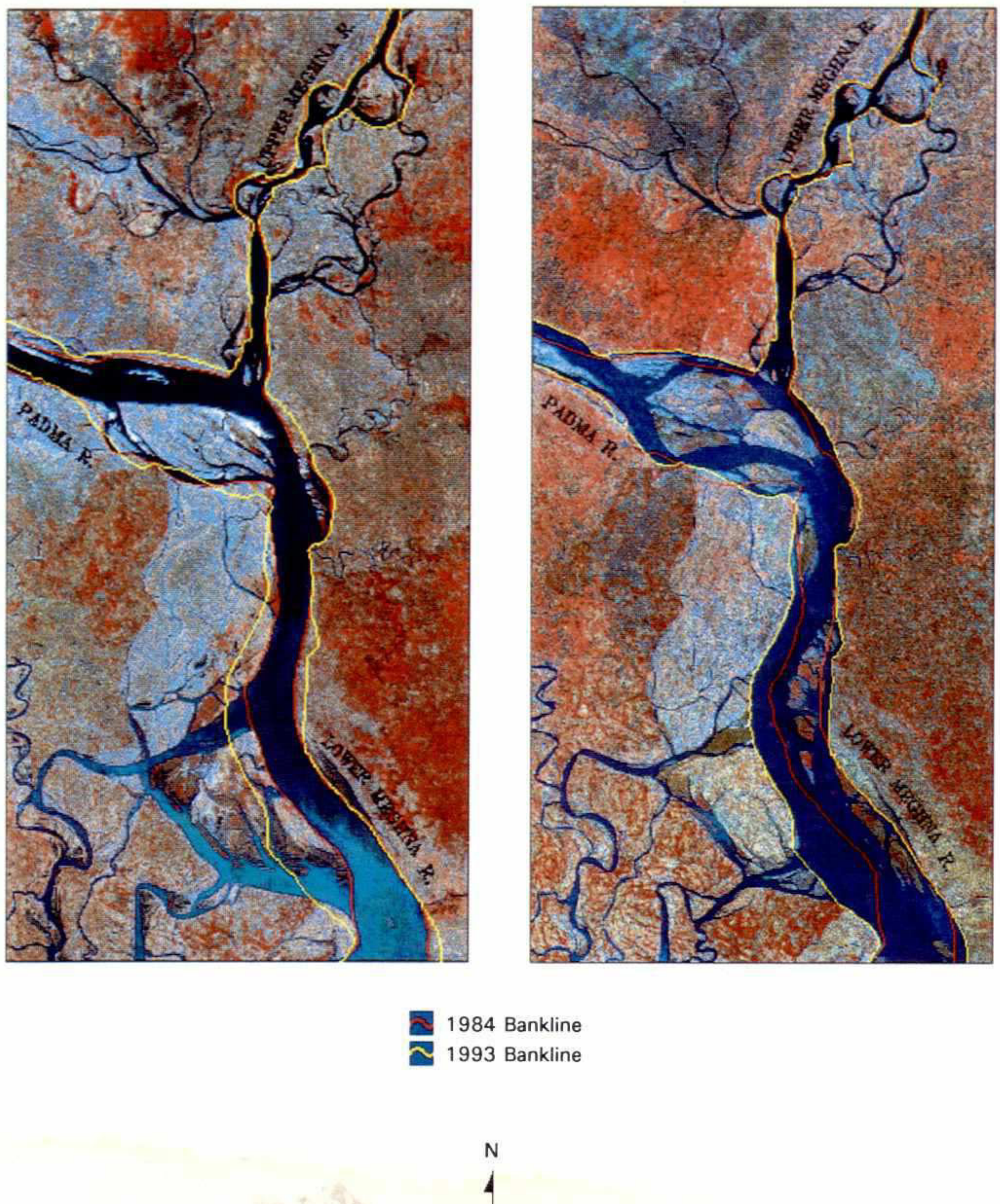
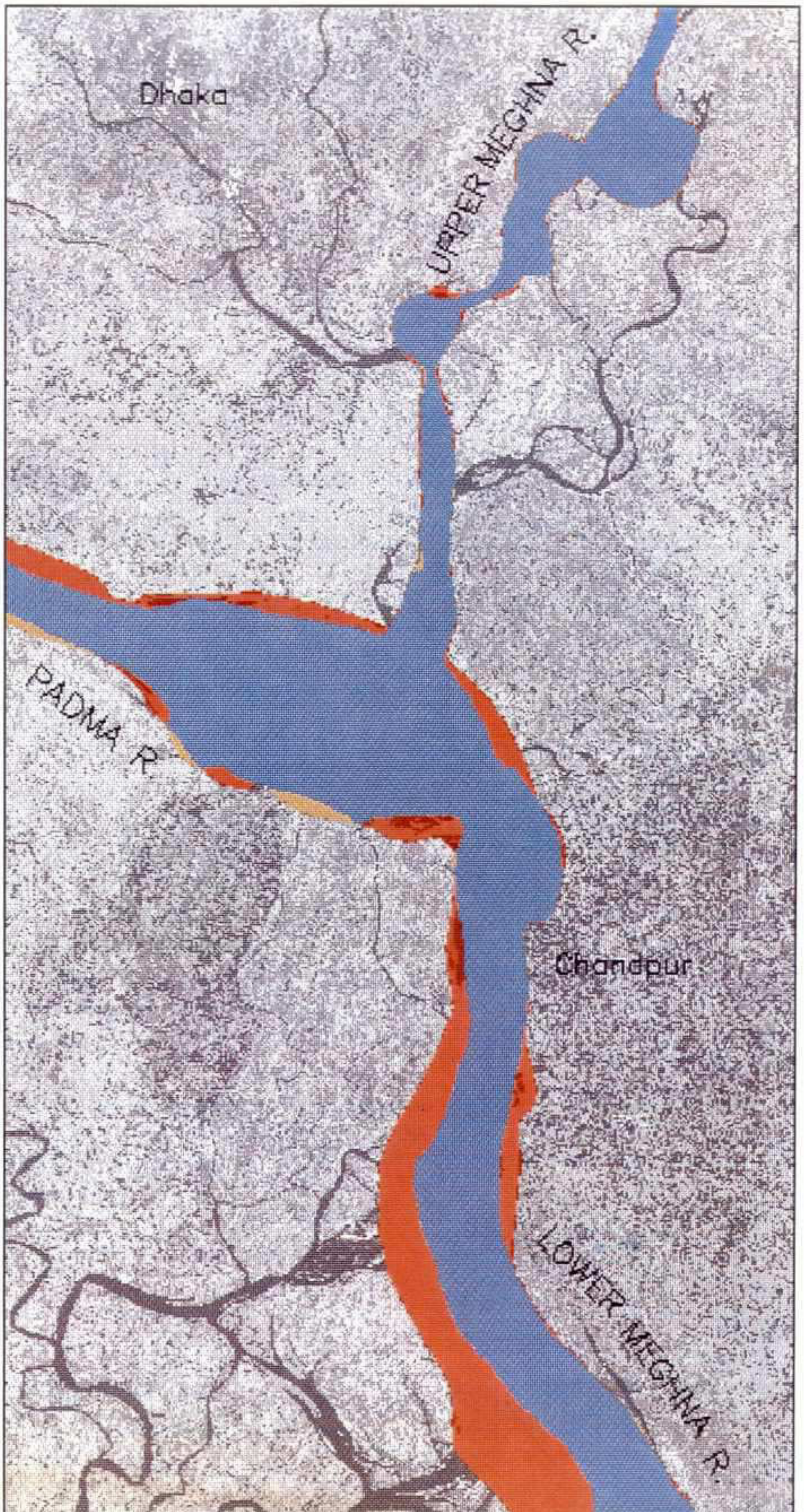


Figure 2.6

Source: ISPAN, Landsat images.



River Bank Erosion and Accretion 1984-93

N

0 10 km

Channel

BANK EROSION

Mainland to Channel

Mainland to Charland

BANK ACCRETION

Channel to Mainland

Charland to Mainland

Source: ISPAN, Landsat images of 1984 and 1993.

Figure 2.7

For each cross-section used in Figures 2.3 and 2.4,[4] the amount of bank erosion or accretion between 1984 and 1993 was calculated. Table 2.5 summarizes the mean net bankline changes in the three reaches. The confluence and lower reach both had net erosion. The maximum nine-year erosion rate was 824 m per year, and the average rate for the right (west) bank of the lower reach—just under 300 m per year—was more than six times higher than for the left (east) bank. Although the median of all bankline change rates across all three reaches was only 15.1 m per year of erosion, in general, the confluence and lower reach show some of the most rapid erosion found in the riverine charlands.

Erosion and channel migration trends in the confluence area are most critical since large areas of high-value land use are threatened by east bank erosion, among them Chandpur town and two FCD/I projects: Meghna-Dhonagoda Irrigation Project and Chandpur Irrigation Project. FAP 9B (1990) assessed erosion trends in this area and the following discussion is based on this work.

FAP 9B (1990) found that, in the confluence, erosion (and channel movement) is continually eastward, based on maps and images for a series of years from 1952 to 1990.[5] While predictions for the future evolution of the confluence are necessarily subjective and speculative, the fairly orderly behavior and natural constraints on planform changes, particularly the limits imposed by the outcrops of Chandina Alluvium north and south of the Padma just upstream of the confluence, make such predictions possible in this case.

On that basis, and assuming that no bank protection is undertaken, left bank erosion around Eklashpur can be expected to average about 40 m per year, but in a 15-year cycle ranging from 200 m per year (when flow is concentrated in the north channel of the Padma) to only 20 m per year (when it is mostly in the south channel). Around Chandpur, where there is naturally slower bank attack and existing bank protection, slower erosion can be expected, averaging 20 m per year. This could rise to 30 m per year in adjacent unprotected areas. If the embayment around Eklashpur continues to erode and town protection at Chandpur is successful, east bank deposition could occur just downstream of Chandpur as the channel swings westward across its present course (as happened to a limited extent between 1984 and 1993).

Table 2.5 Mean Bankline Erosion/Accretion Rates; 1984-1993*

Bank	Change	Upper	Confluence	Lower
Right	Shift 84-93 (m)	78	-183	-2657
	Rate (m/yr)	9	-20	-295
Left	Shift 84-93 (m)	-63	-845	-423
	Rate (m/yr)	-7	-94	-47
Total	Shift 84-93 (m)	8	-514	-1540
	Rate (m/yr)	1	-57	-171

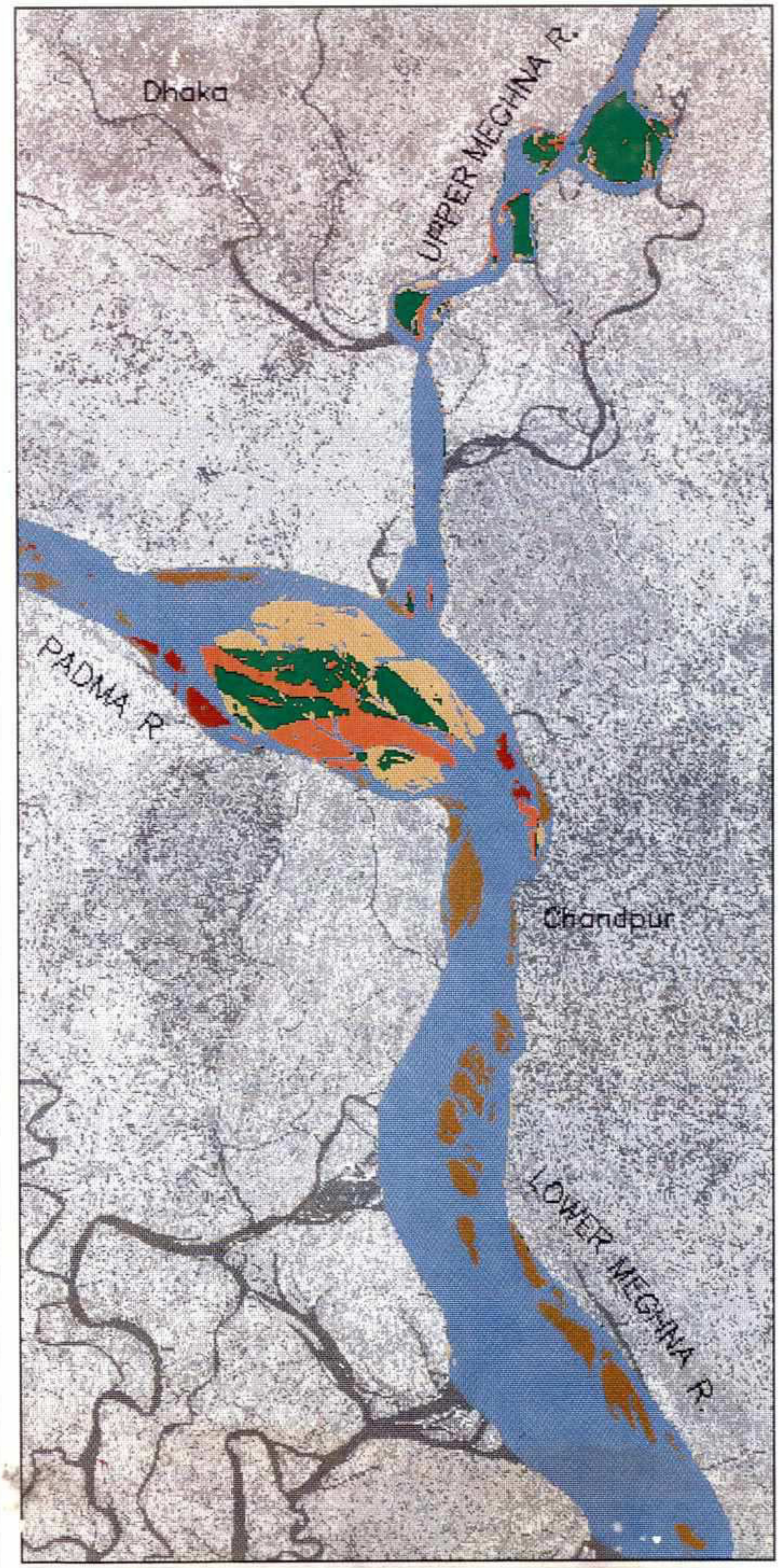
Source: FAP 19 satellite image analysis
*Negative = net erosion; positive = net accretion

2.5 Within-Bank Dynamics

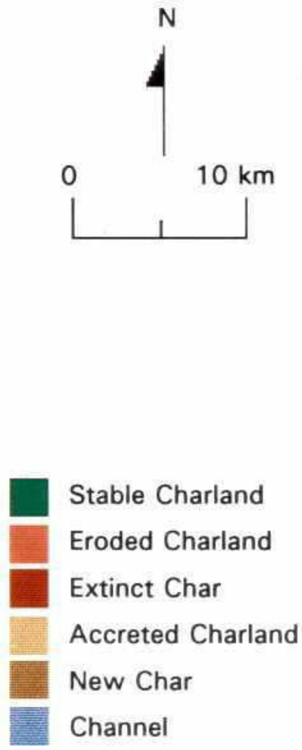
2.5.1 Summary of Char Morphology

Although the degree of braiding in the Meghna is very low, there is a major char cluster at the confluence, and during the study period chars have emerged in the lower reach.

The geomorphology of wandering rivers in transition between meandering and braiding is poorly understood. The mechanics of meandering can be reasonably well explained and channel changes are somewhat predictable, but although the basic processes of braid bar formation, flow detection, and bank erosion have been described for braided rivers, they are less well understood. Leopold and Wolman (1957) established the basic mechanics of braiding through the deposition of a medial bar (char), which then deflects the flow to each side of it, producing erosional bays in each bank. Flow



Charland Erosion and Accretion 1984-1993



Source: ISPAN, Landsat images of 1984 and 1993.

Figure 2.8

Table 2.6 Trends in Within-Bank Area 1984-1993

Area	1984	1993	1993 as % of 1984
Total (ha)	69,674	88,826	127
Water/Sand (ha)	53,559	66,124	123
Char (ha)	16,115	22,702	141
% Water/Sand	77	74	—
% Char	23	26	—

Source: FAP 19 satellite image analysis

diverges as it approaches a medial bar and then converges toward the tail of the bar. As the bays grow, the increasing channel width creates space for the medial bar to grow, while the sediment from bank erosion fuels continued bar-building and produces clusters of bars that eventually merge to form larger and more permanent island clusters.

In a wandering river, elements of both patterns and associated flow processes are present at all times and at all locations to a greater or lesser degree. At any given time, though, different sections may be dominated by meandering tendencies, so that adjacent river reaches may display contrasting channel planform characteristics. These changes may not be evolutionary or have any particular cause; they may be cyclical and inherent to a wandering pattern in quasi-stable equilibrium. The interpretation and prediction of detailed channel planform changes within the outer banklines defining the active geomorphic corridor is particularly difficult in wandering rivers.

These processes appear to apply in the Meghna. As the river has widened, island chars have increased in number and total area, especially in the lower reach. Yet channel movements in the Lower Meghna since 1984 are somewhat contrary to past experience. Tables 2.4 and 2.6 show there has been a net loss of about 18,500-19,000 ha of mainland in the whole study area, and a gain of only 6,587 ha of vegetated char within the banklines. In the confluence, this trend will most likely persist since the expanded islands and new island clusters help to deflect the channel flow toward the banks, causing rapid erosion, while the bend in the river results in deposition of sediments in the char complex. The Chandina Alluvium on the southeast side of the confluence has resisted bank erosion and may have deflected the channel flow since 1984, thereby eroding a sizable swath of charland (Figures 2.1, 2.2, and 2.5). In the lower reach the trend is less certain because of the influence of tidal flows. The trend of the past nine years needs to be monitored since it is the opposite of the general pattern of eastward migration observed in previous decades.

Assessment of the 1993 dry season Landsat image shows that on March 11, 1993, the Meghna study area had a total of 18 island chars longer than 3.5 km (large). There were an additional 36 island chars of between 0.35-3.5 km length (small); this includes both chars that were pure sand (and are categorized as sand in the following sections) and ones that were vegetated. Very small islands (under 350 m long) have not been counted, but appeared invariably to consist of sand. Categorization was complicated by the presence of large islands that have been stable for many years and are located adjacent to the main channel rather than within the banklines (as noted in Chapter 1). These have been excluded from the island char totals. There were also four distinct large areas of attached charland (more than 3.5 km long), and seven smaller areas of attached charland (up to 3.5 km long).

2.5.2 Image Analysis of Within-Bank Changes

The within-bank area on each of the images was classified as explained in Section 2.3.4. Char[6] areas are distinct from the other predominant landscape components of water, including saturated zones along water edges, and sand, including areas of sparse grass cover. The classifications are in grid-cell format and are the result of digital image processing as described in Section 2.3. The classified image data made mapping and quantification of within-channel changes possible, and resulted in an improved understanding of channel and char evolution.

Changes in water, sand, char, and total area were measured for each of the three reaches. Table 2.6 summarizes this data and not only confirms the overall widening, but also shows that the proportion of within-bank area that is water or sand in the dry season (approximately the normal monsoon channel area) remained almost constant (77 percent in 1984, 74 percent in 1993). Hence, the area of vegetated (productive) island chars has increased more or less proportionally with the widening of the river, although the area of new charland is much less than the area of mainland lost.

Changes in the river channel over short time spans are very complex. Figure 2.8 illustrates the patterns of erosion and accretion taken from the classified dry season satellite images. The map represents the changes in char land area and position within the river channel. Green indicates char areas that have persisted throughout the study period, light red signifies eroded char areas, and tan indicates char areas that were accreted. Chars that have completely disappeared (extinct chars) are colored dark red, and new island chars that have appeared since 1984 are shown in dark brown. This highlights the morphological changes behind the population and resource data that are mapped and discussed in Chapters 3 and 4. Especially in the confluence chars, many inhabitants must have been forced to move as the char cluster eroded and accreted.

There are considerable differences between reaches in the composition of within-bank area. The proportion of vegetated charland within the banklines is much higher in the upper and confluence reaches, where it was respectively 39 percent and 30 percent of the within-bank area in 1984 (Table 2.7). In both cases, though, it fell (to 35 percent and 25 percent) by 1993. The lower reach, where widening has been greatest over the nine-year period, showed an increase in char area, but from a very low proportion of only 2.5 percent in 1984.

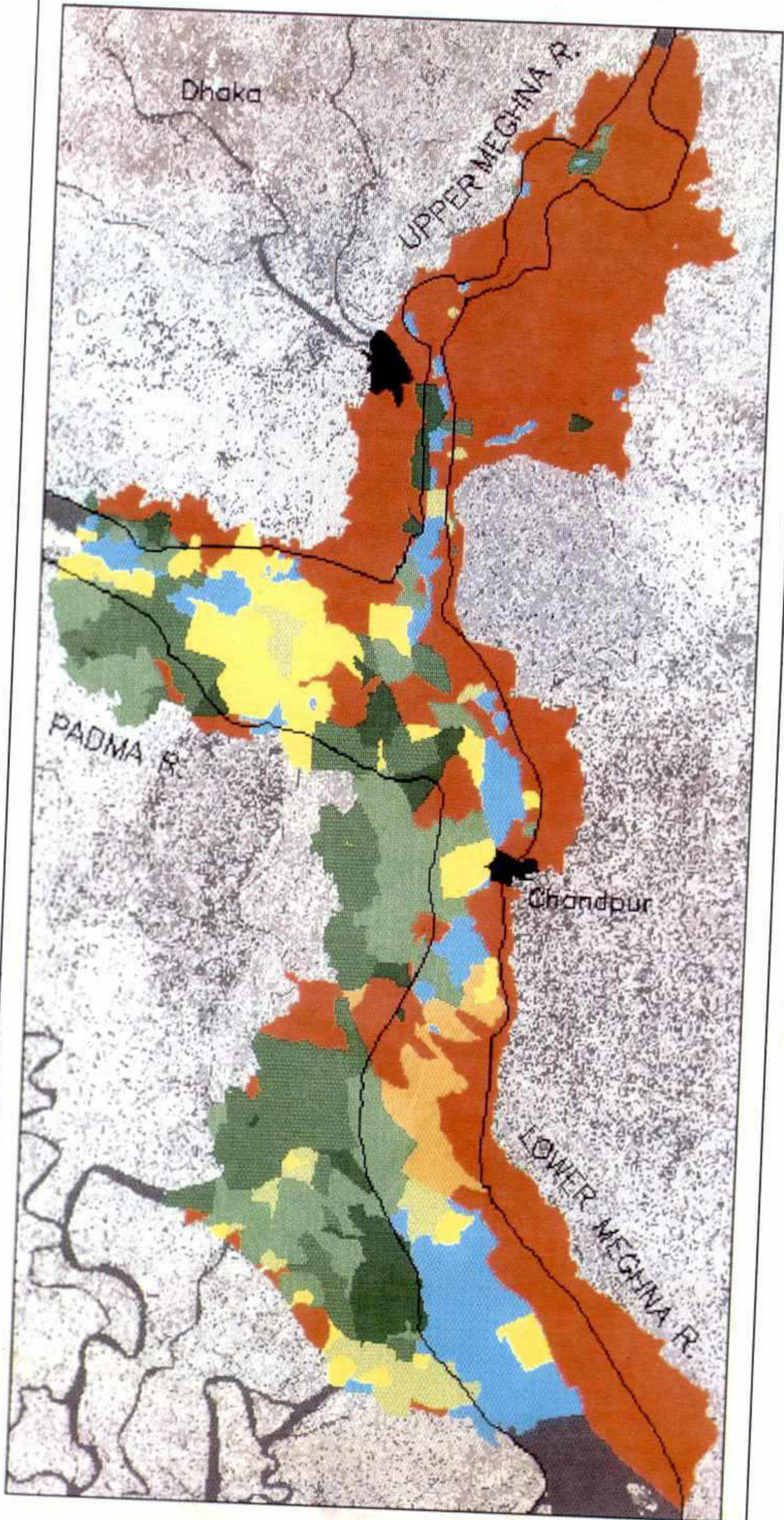
2.5.3 Char Ages and Erosion

The approximate ages of mainland and charland were determined from key informants as part of the inventory survey. These data, detailed in Chapter 3, were collected on a mauza basis and therefore do not have the spatial accuracy of the image-derived data. Figure 2.9 illustrates the results of this analysis, which corresponds remarkably well with the recent satellite image data and with more general information from historical maps regarding erosion and accretion, and channel migration and widening. The stability and old age of land in the upper reach and along the east bank of the whole study area is confirmed (in many cases informants could not recall when these areas were settled but referred to several generations or said they had been "always settled"). It is also apparent that some mauzas in the confluence char complex have been above water for a long time. The map shows the west bank south of the conflu-

Table 2.7 Trends in Within-Bank Areas by Reach 1984-1992

Reach	1984	1993	1993 as % of 1984
Upper			
Total (ha)	12,997	13,067	101
Water/Sand (ha)	7,951	8,440	106
Char (ha)	5,046	4,627	92
% Char	39	35	—
Confluence			
Total (ha)	35,528	40,011	113
Water/Sand (ha)	24,997	26,538	106
Char (ha)	10,531	13,473	128
% Char	30	25	—
Lower			
Total (ha)	21,149	35,748	169
Water/Sand (ha)	20,611	31,146	151
Char (ha)	538	4,602	855
% Char	3	5	—

Source: FAP 19 satellite image analysis



AGE OF LAND

N

0 10 km

YEARS

Stable Charland
Submerged
1-5
6-10
11-20
21-30
31-70
GT 70
No Data Recorded
Bankline, 1993

Source: ISPAN, Landsat images of 1984 and 1993.

Figure 2.9

ence as having accreted within living memory, and the age and soil types of this land are likely the reason for the area's population trends, which are discussed in Chapter 3.

If it is assumed that past persistence implies that chars will continue unbroken existence here, then interventions such as flood shelters and more permanent settlements might be viable.

These flood- and erosion-prone chars are home to substantial numbers of people. Chapter 3 presents the results of the inventory of people and resources within the banklines and in unprotected mainland along the river, and concludes with information on hazards and floods. Chapter 4 discusses the recent erosion experience reported from these mauzas, and links the bankline analysis of this chapter with population changes in the study area.

NOTES

1. A resolution of 80 meters means that anything smaller than this size cannot be detected; in practice, an object or site may have to be larger to ensure appearance in any one pixel. A pixel is the rectangular area on the earth's surface for which a singe spectral response is given; pixel size nominally is 80 x 80 m for Landsat MSS and 30 x 30 m for Landsat TM.

2. These include the Layontia-Swarnplati-Baleswas system, which is a major fresh water supply for the south central region.

3. This behavior is consistent with bend flow theory as demonstrated by Seminara's (1988) theory of bed wave propagation, which explains why chars are absorbed by the point bar in the big bend.

4. Cross-sections were taken at 5 km intervals.

5. For the years: 1952, 1960, 1973, 1976, 1977, 1980, 1984, 1987, 1988, 1990.

6. Throughout the remainder of this section the term "char" refers to the same landscape component: a surface within the banklines that is either vegetated or under cultivation.

94

Chapter 3

RESULTS OF THE POPULATION AND RESOURCE INVENTORY

3.1 Introduction

This chapter presents results of the Inventory Survey, which has been linked to the satellite image analysis using a geographic information system (GIS). Land resources in the study area are assessed in Section 3.2.1 based on an analysis of the 1993 Landsat image (Figures 3.1 and 3.2). Thereafter, the results of the inventory analyses are mapped and interpreted for the following subjects:

- population of the study area in 1981 (census) and 1993 (inventory), changes in population, and availability of cultivable land (Section 3.2.2; Figures 3.3-3.6);
- migration into and out of the study area mauzas in 1992 (Section 3.3; Figures 3.7-3.10);
- infrastructure, primarily education and health facilities (Section 3.4; Figures 3.11-3.14);
- household occupations (Section 3.5.1);
- agriculture (Section 3.5.2; Figures 3.15-3.22);
- livestock relative to land and people (Section 3.5.3; Figures 3.23-3.26);
- boat availability (Section 3.5.4; Figures 3.27 and 3.28);
- land disputes (Section 3.5.5);
- loss of life in the 1988 flood and from other hazards (Section 3.6.1; Figures 3.29 and 3.30);
- flood experience and risk (Sections 3.6.2 and 3.6.4; Figures 3.31-3.36); and
- flood impacts on housing (Section 3.6.3; Figures 3.37-3.44).

In order to interpret the maps and tables correctly, it is necessary to understand some conventions in the maps, and some limitations to the methodology of the Inventory Survey.

The inventory-derived maps show mauzas that were uninhabited in 1993 as a separate category (pale blue in the relevant figures). In general, the uninhabited mauzas are either completely eroded or have only sand and natural vegetation above water during the dry season and are generally submerged in the monsoon. Some uninhabited mauzas in the confluence and Lower Meghna are cultivated in the dry season by temporary settlers and then abandoned in the monsoon when they are submerged. Submergence was verified by superimposing mauza boundaries on the land use classification map derived from satellite imagery. The survey interviews were conducted in May 1993 some two months after the satellite image was taken but before the monsoon, and these temporary settlements on newly accreted chars were present during the Inventory Survey.

The urban (*pourashava*) areas of Chandpur and Munshiganj were not surveyed. The inventory questionnaire was designed for rural areas and the methodology used was unsuited to these densely populated areas (see Section 1.3.2). Moreover, both towns were included in the Meghna Left Bank Protection Project (FAP 9B), which studied their bank protection needs. The two towns, therefore, are excluded from the analysis and colored black in the maps.

Data for some questions are missing from the survey because respondents in the mauza were unsure of information.[1] Missing data has been colored pale green on the maps. Except that in the flood-related maps missing data is colored sandy fawn.

Forty-four study area mauzas are split by the Meghna-Dhonagoda Irrigation Project, the Chandpur Irrigation Project, or the Hizla embankments. The GIS was used to estimate the unprotected area in these mauzas; this estimate has been used to calculate the 1981 population in the study area. The inventory survey only covered the unprotected part of these mauzas. Respondents generally were familiar with the embankment alignment and appeared to make reasonable estimates of population and resources in the unprotected portion, but any data from officials had to be apportioned based on their local knowledge. Reliance on local respondents, in this case, is believed to have provided more accurate data than collecting data for whole mauzas from officials. The 1991 census data, therefore, is not directly comparable with the inventory data.

Although Figure 1.2 shows whole mauzas, including the unprotected parts, the maps in this chapter show only the unprotected part of mauzas. These maps, then, accurately represent the study area.

The questionnaire data, presented according to river reach and predominant charland type (defined in Section 1.3.2 and shown in Figure 3.1), is summarized in output tables in Appendix B. The "unprotected mainland" category in the tables includes both setback land and open floodplain adjoining the river where there are neither existing nor proposed embankments. "Detached mainland," established land surrounded by Meghna channels, is only found in the upper reach, as previously mentioned.

Interpretation of the maps is aided by the tables summarizing the data by reach and char type. Discerning general patterns in the maps can otherwise be difficult because of the highly variable size and irregular shape of the mauzas. Although the key informant survey method results in some data uncertainty, cross-checks were used to minimize its effect. The census and inventory data are a 100 percent survey rather than samples, so statistical tests are inappropriate; any differences between char types and reaches are actual differences.

LAND AND POPULATION

3.2 Land and Population

3.2.1 Land Area

Based on the digitized thana maps and embankment alignments, the Meghna Charland Study area constitutes 195,660 ha, including submerged mauzas. As discussed in Section 1.3.6, mauzas were categorized according to their dominant land type. Figure 3.1 and Table 3.1 combine the setback and unprotected mainland categories into one category—unprotected mainland.

Table 3.1 Study Area Size by Category (total = 195,660 ha)

Category	Area (ha)	Percent
Submerged	17,186	9
Island Char	72,550	37
Attached Char	51,039	26
Detached Mainland	14,133	7
Unprotected Mainland	40,753	21
Upper Reach	50,572	26
Confluence	68,294	35
Lower Reach	76,794	39

Source: Table B.1

The gross areas in Table 3.1 include areas under water in the 1993 dry season. Since water area in the dry season is greater in the island char mauzas than in other areas, those mauzas comprise the highest percent of the study area. The gross areas for mauzas were obtained from the digitized Police Station maps (Figure 1.3).

In most cases, the total gross areas of mauzas not totally submerged were used to calculate density figures; exceptions have been specifically noted. Gross areas do not change over time, and although it underestimates population density on dry season land, this calculation method, the national standard used by the Bangladesh Bureau of Statistics (BBS), makes analysis of these data consistent with sources such as national censuses.

Mauza areas calculated from the digitized boundaries of the Police Station maps, which were adjusted using the BBS Small Area Atlases or information collected from the thanas, were compared with the areas in the atlases. The digitized areas generally were larger than the BBS areas, suggesting that the latter may have excluded water from the land area. The GIS estimates could be used to revise the official areas of mauzas.

The digital land type classification, derived from the 1993 Landsat imagery and shown in Figure 3.2, was correlated with the mauza data and digitized mauza map. The three land categories used were: water, sand, and cultivated or vegetated, which included land recently cultivated or vegetated.

The percentages shown in Table 3.2 were cross-checked with the cultivation percentages collected in the inventory questionnaire (Table B.5); this is interpreted in Section 3.3.2.

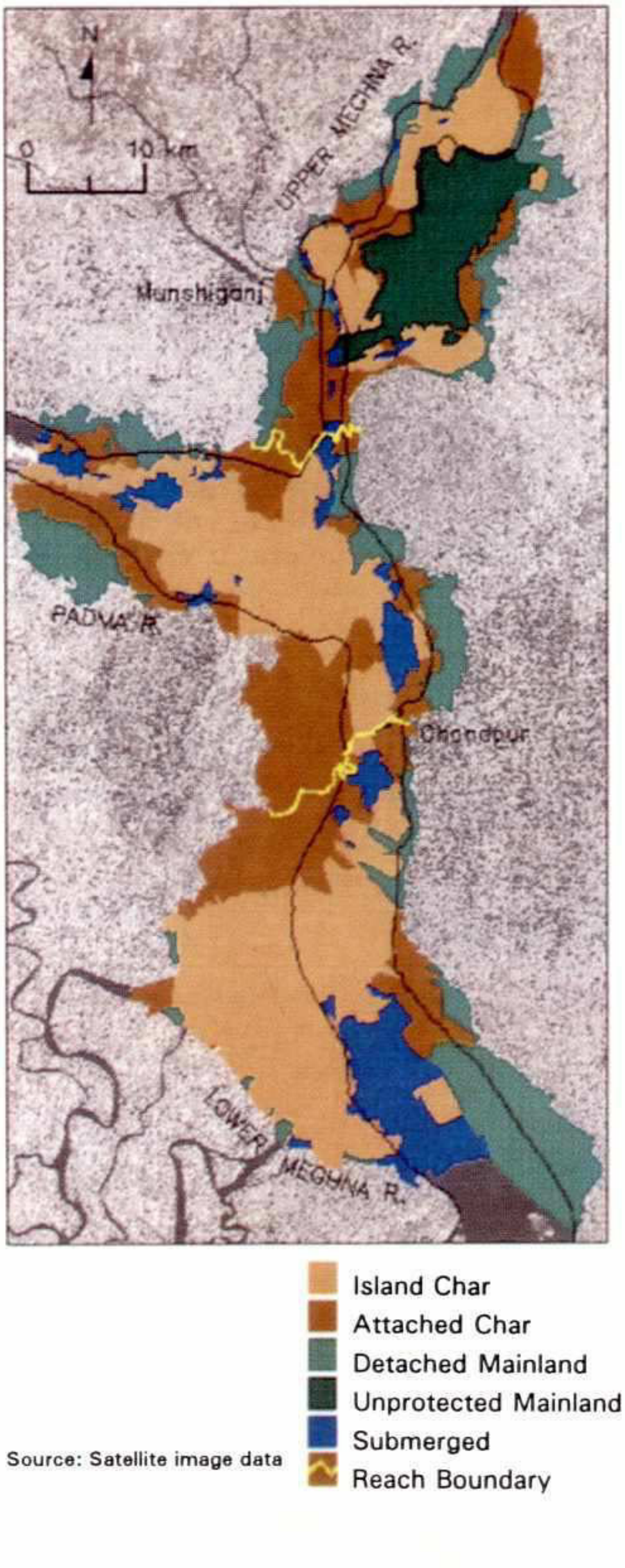
Completely inundated mauzas, and others with a high percentage of water are concentrated in the Lower Meghna, where 47 percent of total area is water. Tables B.2, B.3, and B.4 are breakdowns of water, sand, and vegetated areas, respectively. Only 3 percent of the study area is sand in the dry season satellite image (mostly in island chars).

Table 3.2 Study Area Land Type (percent)

GIS Interpretation of Surface Type	Land Categorization: Island Char	Attached Char	Detached Mainland	Unprotected Mainland	All Areas*
Water	39	29	7	24	36
Sand	5	2	1	1	3
Cultivated/Vegetated	56	69	92	75	61

Source: Tables B.1, B.2, B.3, B.4
*Includes submerged mauzas

CHARLAND
CLASSIFICATION



Source: Satellite image data

Figure 3.1

LAND COVER
CLASSIFICATION
11 MARCH 1993

Source: Satellite image data

Figure 3.2

There is much less sand visible in the Meghna image than in that of the Jamuna. Confluence and Lower Meghna chars that are vegetated, and even cultivated, in the dry season are inundated in the monsoon and form part of the normal monsoon river channel. There is very little unproductive land, especially in the detached mainland, which is almost entirely vegetated or cultivated.

3.2.2 Mauza Population Data

The 1981 population, mapped in Figure 3.3 and summarized in Tables 3.3 and B.6, is taken from the BBS National Census data (BBS Small Area Atlases) and apportioned to the mauzas lying partly in the study area (see Section 3.1). There were just over 0.97 million people living in the area in 1981, mostly in unprotected mainland.

Figures 3.3 and 3.4 show population density in 1981 and 1992, respectively, relative to mauza extent, not land. Of a total of 737 mauzas, the number of uninhabited mauzas (blue) increased from 193 in 1981 to 229 in 1993.

The upper reach had the largest population in 1981 but has the smallest area, although the amount of vegetated land in each reach is about the same. Figure 3.3 shows that the upper reach and unprotected mainland on the north and east banks of the confluence had the highest population densities in 1981. Population densities were higher in the unprotected mainland than in the island chars, and the highest populations were concentrated on setback land, particularly on the east bank at the confluence. This is apparent adjacent to and south of the Meghna-Dhonagoda Irrigation Project, where there had been bank erosion (which had presumably forced people onto the nearby mainland).

The 1981 population density was 496 people per km^2 (including sand and water; Table 3.4), considerably lower than the Bangladesh average of 605 people per km^2. Because some presently submerged island char mauzas were above water and inhabited in 1981, these mauzas are included in the island char category. In the island char mauzas that are not submerged in 1993 the population density was 303 people per km^2 in 1981 and 449 people per km^2 in 1993.

Figure 3.3 clearly shows low population densities (1 to 200 people per km^2; yellow in the figure) concentrated between the two banklines (on island chars) in the confluence and lower reach. In addition, on the west side of the lower reach there are uninhabited and thinly populated mauzas where a new island char was forming alongside the main channel. The scatter of uninhabited mauzas in the eastern part of the upper reach channel (detached charland) reflects the small size of mauzas in that area and a complex network of channels flowing parallel with the main Meghna channel.

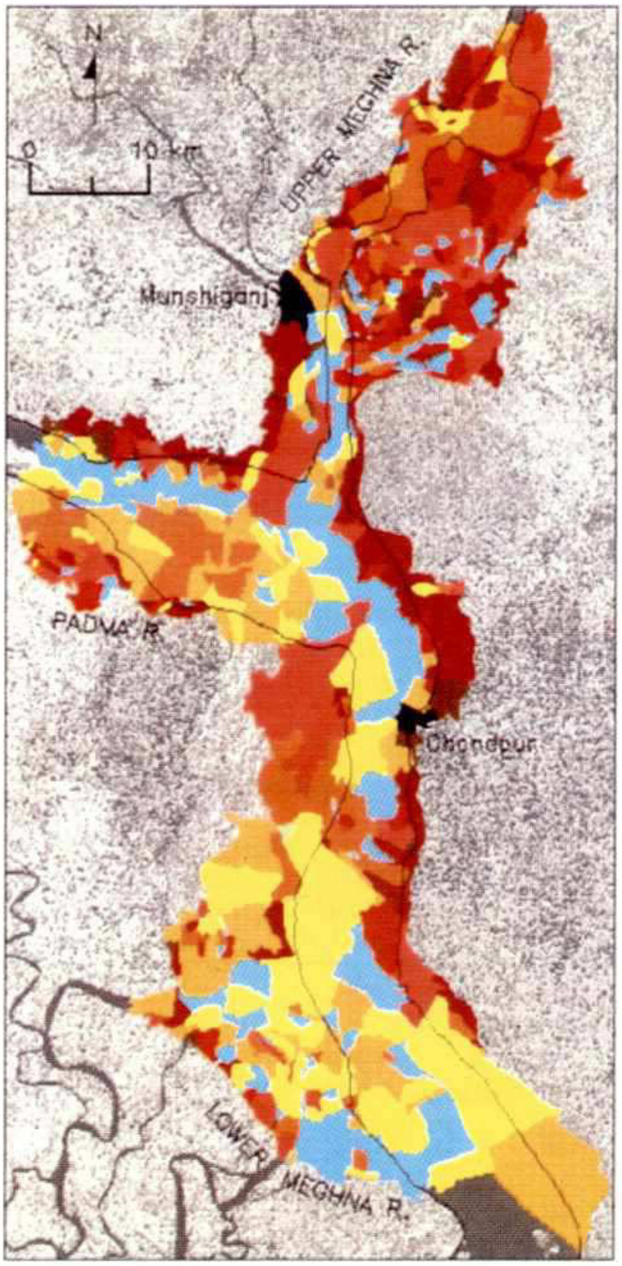
The study area population, based on the 1993 inventory,[2] is estimated to be 1,165,787. Table 3.3 shows this population broken down by char type and reach based on Table B.7. In the unpro-

Table 3.3 Study Area Population in 1981 and 1993

Category	1981 Population	1981 Percent	1993 Population	1993 Percent
	Total = 971,325		Total = 1,165,787	
Island Char*	243,634	25	325,485	28
Attached Char	269,445	28	260,635	22
Detached Mainland	129,169	13	169,248	15
Unprotected Mainland	329,077	34	410,419	35
Upper Reach	380,148	39	508,031	44
Confluence	364,369	38	418,055	36
Lower Reach	226,808	23	239,701	20

Source: Tables B.6, B.7; BBS Small Area Atlases and Charland Study Field Survey
*Includes mauzas populated in 1981 but submerged in 1993.

1981 POPULATION DENSITY BY MAUZA



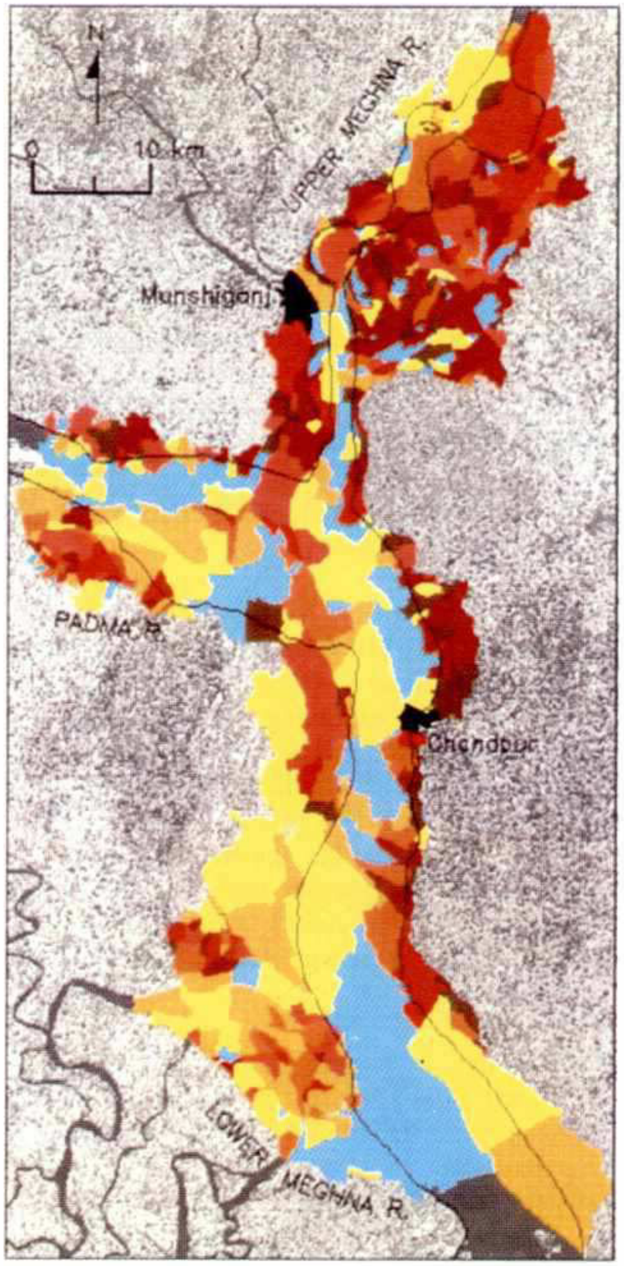
POPULATION PER SQ. KM IN 1981

- Uninhabited
- 1-200
- 201-400
- 401-600
- 601-800
- 801-1000
- 1001-2000
- GT 2000
- No Data recorded
- Bankline, 1993

Source: Bangladesh Bureau of Statistics, 1981 census data

Figure 3.3

1993 POPULATION DENSITY BY MAUZA



POPULATION PER SQ. KM IN 1993

- Uninhabited
- 1-200
- 201-400
- 401-600
- 601-800
- 801-1000
- 1001-2000
- GT 2000
- No Data recorded
- Bankline, 1993

Source: ISPAN, 1993 Field data

Figure 3.4

tected mainland most of the lower reach population is on the east bank as the west bank of the reach was mostly categorized as attached char.

The 1993 population density in the study area was still below the Bangladesh average of 763 people per km², but it was more than 1,000 people per km² in 28 percent of mauzas. The highest average population density (1,005 people per km²) was in the upper reach, where even the island and attached chars have more than 850 people per km². Population density was also locally high in unprotected mainland areas, and it was exceptionally high on east bank unprotected mainland at the confluence (brown and dark red in Figure 3.4), where the area of setback land outside the embankments and near Chandpur town has been eroding and is densely populated. If submerged mauzas are excluded, the 1993 population density was 653 people per km² (Table D.8).

Very low population densities (fewer than 200 people per km²; yellow in the figure) are concentrated in the island chars (which average only 449 people per km², excluding submerged mauzas), and in the attached chars of the lower reach. Average densities in the attached chars are mostly 200 to 400 people per km² (pale orange), except in the upper reach where there are 850 people per km². Variation in population density appears to be linked with land productivity, recent erosion experience, and flood risks.

The change in population density between 1981 and 1993 is shown in Figure 3.5 and summarized in Tables 3.4 and B.9. The study area has experienced a population increase of 20 percent in that period, a simple average of 1.67 percent per year (Tables B.7, B.8, and B.9). The population of Bangladesh, on the other hand, increased 26 percent between the 1981 census and 1991 census (BBS, 1993). Although population in the study area has grown less than the national average, it has experienced a complex pattern of declines and increases that appear to be related to the morphological changes shown in Chapter 2.

In Figure 3.5, yellow represents no change in population and therefore highlights the small number of mauzas that remained uninhabited between 1981 and 1993. Figure 3.5 shows that areas where there has been a population decline since 1981 (blue) include:

- island chars and within-channel mauzas in the lower reach, where some islands have submerged and the channel has widened;
- west bank attached chars in the lower reach (the reason for which is unclear, there have been no morphological changes in that area since 1984);
- the confluence and start of the Padma, where bank changes have been small but island char configurations have shown large changes; and
- a few mauzas along channels in the Upper Meghna.

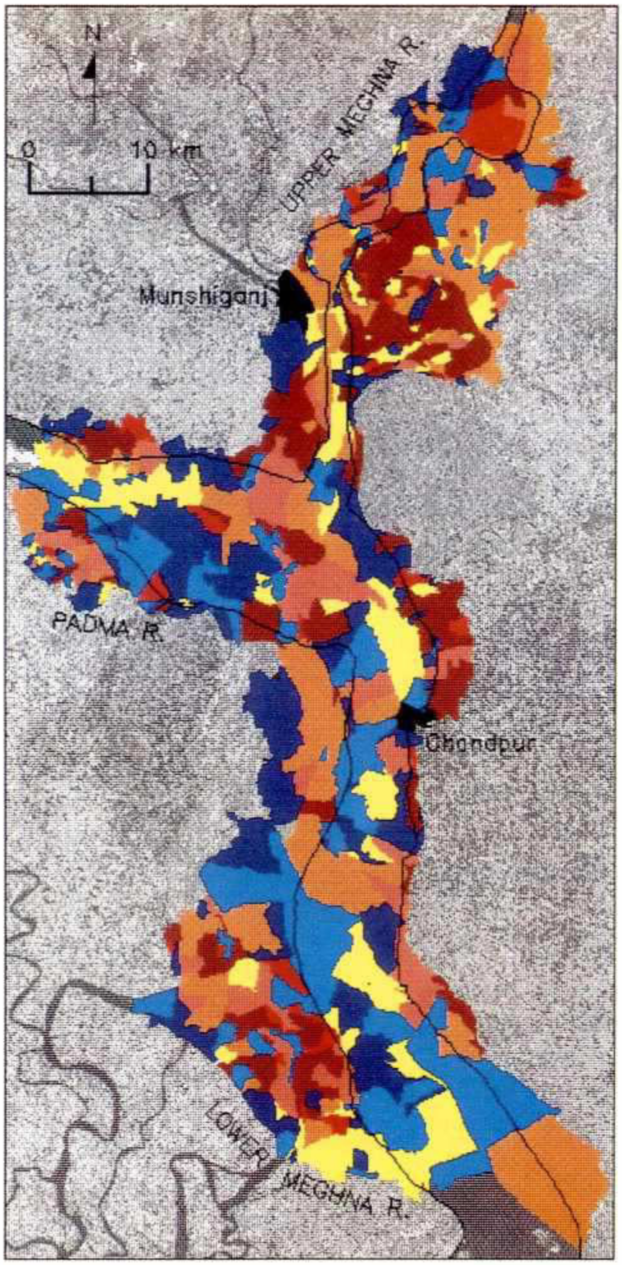
In the confluence and lower reach, population on west bank unprotected mainland and attached chars declined, while it increased in island chars in the

Table 3.4 **Population Density and Growth 1981-1993**

Category	1981 People per km²	1991/3* People per km²	Percent Change, 1981-93
Island Char	272	363	+33
Attached Char	528	511	-3
Detached Mainland	914	1,198	+31
Unprotected Mainland	807	1,007	+25
Upper Reach	752	1,005	+34
Confluence	534	612	+15
Lower Reach	295	312	+6
Study Area Average	496	596	+20
Bangladesh Average	605	763	+26

Source: BBS Small Area Atlases; BBS (1993); FAP 16/19 Inventory.
*1991 population density is for the whole of Bangladesh; 1993 is for the Meghna charland study area. Areas are whole mauzas including water and submerged mauzas, which accounts for the low population densities.

CHANGE IN POPULATION DENSITY 1981-1993



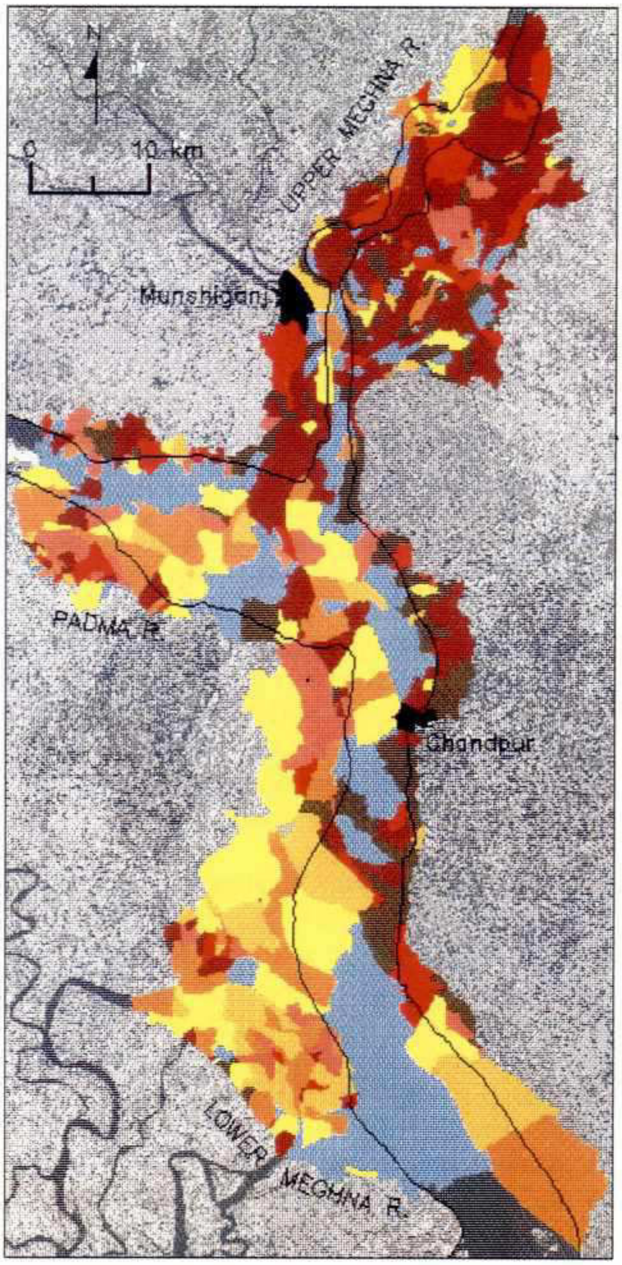
CHANGE IN POPULATION PER SQ. KM

- < -200
- -200 to 0
- No Change
- 0 to 100
- 101 to 200
- 201 to 300
- GT 300
- No Data recorded
- Bankline, 1993

Source: ISPAN, 1993 Field data and Bangladesh Bureau of Statistics, 1981 census data

Figure 3.5

HUMAN POPULATION TO CULTIVATED/VEGETATED LAND 1993



POPULATION PER SQ. KM IN 1993

- Uninhabited
- 1-200
- 201-400
- 401-600
- 601-800
- 801-1000
- 1001-2000
- GT 2000
- No Data recorded
- Bankline, 1993

Source: ISPAN, 1993 Field data and Satellite image data

Figure 3.6

confluence. This appears to be associated with channel widening and consequent bank erosion.

There are three concentrations of areas that gained the most population between 1981 and 1993 (dark red):

- stable land in the upper reach—mostly detached mainland;
- unprotected mainland on the east bank north of Chandpur that was stable during this period but is close to areas of bank and island erosion; and
- the remnants of the island char of Hizla on the west side of the lower reach, where land stabilized during this period but where adjacent mauzas experienced erosion.

Moderate population gains (around 200 people per km^2; dark orange and pale red) mostly occurred in areas unaffected by bank erosion: in some of the island chars and the detached mainland of the upper reach, in island chars at the confluence, and in a band of attached charland on the west bank opposite Chandpur. The areas with population trends similar to the rest of Bangladesh, then, are the most stable in the study area.

Table 3.4 shows that the Meghna charlands had low populations in 1981, and that population has grown since then at a rate less than in Bangladesh as a whole. There are large differences in the trend over the study area, which covers only about 110 km from north to south. Population density in the upper reach was higher than the national average in 1981 and has grown faster than the national growth rate. In the confluence, population density has remained below the national average and grew more slowly. The population density in the lower reach is much below the national average (because of the large area of water) and appears to have fallen between 1981 and 1993 as the Meghna widened. While population growth in the island chars generally was the same as the national average, and the stable unprotected mainland and detached mainland both have higher than average population densities, it is the small population drop in eroding attached chars that has depressed the growth rate over the 12-year period. These trends appear closely related to erosion incidence (Chapter 2). The relationship between population changes and bankline changes is explored in more detail in Chapter 4.

Population densities also can be related to available dry season vegetated/cultivated land (Figure 3.6; Tables B.10 and B.11). Relating population to land use rather than gross mauza area avoids complications introduced by the extent of dry season water area, which is higher for island chars (Table 3.2). Although land availability is known to vary from season to season, monsoon season land areas are unknown. Rapid rural appraisals found that much of the agricultural and livestock economy of the study area depends on dry season land and the extent of monsoon inundation. Figure 3.6 compares population to the dry season vegetated area. This is mainly cultivated land with some additional useful natural vegetation, which consists of catkin and *hogla* grasses in the confluence and lower reach chars and of trees in the mainland areas.

Table 3.5 **Population Relative to Cultivable Land; 1991/93**

Land Type	Hectares Per Person	People Per km^2
Island Char	0.12	801
Attached Char	0.13	742
Detached Mainland	0.08	1,303
Unprotected Mainland	0.07	1,334
Study Area*	0.10	975
FAP 14 Char Villages‡	0.06	1,667
Bangladesh Average	0.09	1,111

Sources: Charland Study; FAP 14 (1992); BBS (1993)
*Averages for vegetated and cultivated land based on satellite image interpretation.
‡Data are from five villages, one of which was in the Meghna study area, and may underestimate absentee landownership.

The 1993 population relative to productive land is lower (yellow and pale orange in Figure 3.6) on average in the main river channel and attached chars in the confluence and lower reach (where it is rarely above 600 people per km^2). Table 3.5 shows that there is more usable land available per capita in the attached and island chars. Yet overall population densities are almost the same as the Bangladesh average because of very high densities in the detached and unprotected mainland, which are concentrated in the upper reach.

That population density on vegetated charland is lower than the Bangladesh average presumably reflects lower land productivity, recent settlement, and the risks of flood and erosion in the main river channel, especially in the lower reach. The few within-channel mauzas south of Chandpur that have high population densities are primarily mauzas that, although they are mostly water, encompass part of the river bank (the maps do not show population relative to land but relative to mauza extent). Island chars in the upper reach nonetheless are able to support similar numbers of people per vegetated ha as the mainland in that reach (more than 800 people per vegetated km^2; red and brown in Figure 3.6). These islands are very stable, but the finding also implies that these chars and the channel are as productive as the mainland. The very high concentrations of people on the east bank of the confluence (over 2,000 per km^2) may be due to past bank erosion and the availability of work in Chandpur; continued bank erosion threatens these mauzas.

There is little sand in the area, so there was little difference between the population density on dry season non-flooded land (vegetated plus sand; Table B.11) and that of vegetated land.

There were a total of 182,494 households in the study area in 1993 (Table B.12). Mean household size is six people, but there is a north-to-south trend from 7.0 people per household in the upper reach to 6.6 in the confluence and 5.2 in the lower reach (Table B.13). Household size was larger on the island chars (7.3 people per household) than in other land types (5.7 in attached chars and 6.1 in unprotected mainland). These sizes are higher than the Bangladesh average of 5.44 people per household in 1991 (BBS, 1993). It may be that in the more dynamic southern areas there are more new settlers with smaller families and that households break up as a result of erosion. Further analysis would require more detailed data at the household level, either from the 1991 BBS census, when it becomes available, or from household surveys.

MIGRATION

3.3 Migration

Just as the land areas of the charlands are dynamic, so to is the human population of these areas. To assess the dynamism of the charlands' human population, data on in- and out-migration were collected in each mauza for 1992. Migration, of course, can be either permanent or temporary. Permanent moves following erosion of homesteads and land are made either to take advantage of newly accreted land or to find work in other areas. Erosion may also prompt a temporary move to find work, and when the household's land reemerges they return. Temporary movements also are made to take advantage of seasonal economic opportunities, which may be outside the charlands (out-migration to work in urban areas, for example), or on the chars, where people can use land that is only available in the dry season (in-migration).

3.3.1 Permanent Migration

Permanent out- or in-migration (Figures 3.7 and 3.8) in the surveyed mauzas appears to be closely associated with past patterns of erosion and accretion. In the lower reach, on the large island char in Hizla, there was both moderate in- and out-migration, which informants said was associated with consolidation of the island and resumption of land by landowners who were previously absent from the area. In the confluence there was some localized out-migration and considerable in-migration among the constantly changing island chars (shown in the satellite images in Chapter 2), and whole villages moved to newly accreted land in 1992. Population is continuously adjusting to these morphological changes. The movements may well have been local—between adjacent mauzas—as households moved to take residence where their land had accreted. Such movements were found to be a common response to submergence and accretion of island chars in Shibsen and the confluence area (Charland Study RRA).

Only 1.6 percent (just over 3,000 households) of the study area population permanently moved out of mauzas in 1992 (Tables B.14 and B.15). This migration was localized, and in one small upper reach mauza on a branch of the Meghna all the inhabitants left in 1992. Permanent out-migration, though, was concentrated in the confluence and lower reach, where it occurred in mainland and attached chars to the same degree as it did in island chars (Figure 3.7). On the mainland a few mauzas along the west bank of the upper reach experienced out-migration, but the main concentration was in the confluence, especially in Zanzira and Naria thanas. A few mauzas in the east bank of the lower reach experienced out-migration and are shown in Chapters 2 and 4 to have experienced recent bank erosion. The out-migration in Hizla Thana, which is not concentrated in bankline mauzas, does not appear to have been clearly associated with bank erosion and the area has also attracted in-migrants (Figure 3.8), who may have displaced temporary settlers.

For 1992 study area mauzas reported 139 percent more permanent in-migrations than out-migrations (Table B.16). Four percent of households present in 1993 had moved into their mauzas in the previous year (Table B.17). Permanent migration, therefore, is estimated to have resulted in 2.3 percent more households in 1992. In-migration was concentrated in the island chars: 8 percent of households had moved there in the previous year (1992) compared with 4 percent in attached chars and 3 percent in unprotected mainland. It appears, therefore, that people are moving to take advantage of newly accreted chars as they reemerge and stabilize (possibly following widespread char erosion during 1987-88). They may also be moving in from overcrowded mainland where there has been bank erosion.

Permanent in-migration is strongly concentrated in the confluence (Figure 3.8), where 26 percent of households on island chars moved into their mauzas during 1992. Even on the west bank of this reach (along the Padma) in-migration was high: 9 percent of households on unprotected mainland were in-migrants in 1992, as were 6 percent on attached chars. As char and bankline erosion takes place households move either to the remaining mainland or to newly accreted chars.

PERMANENT OUT-MIGRATION

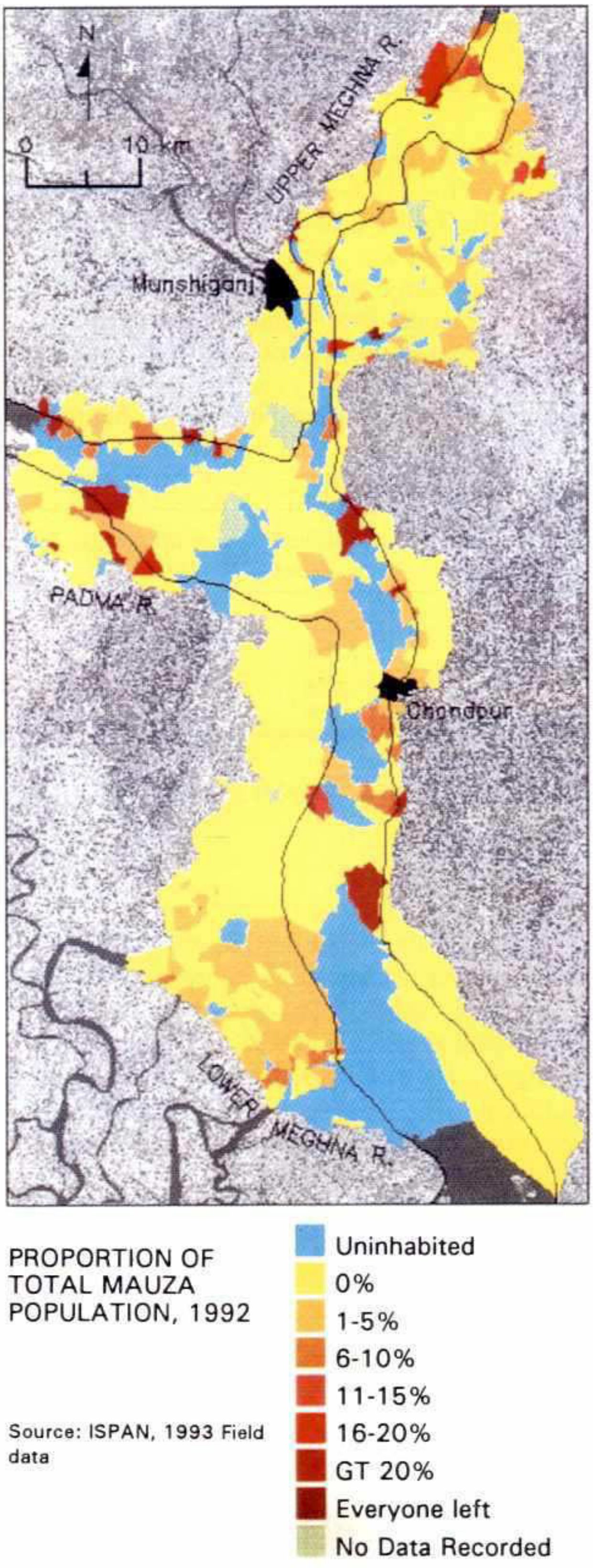


Figure 3.7

PERMANENT IN-MIGRATION

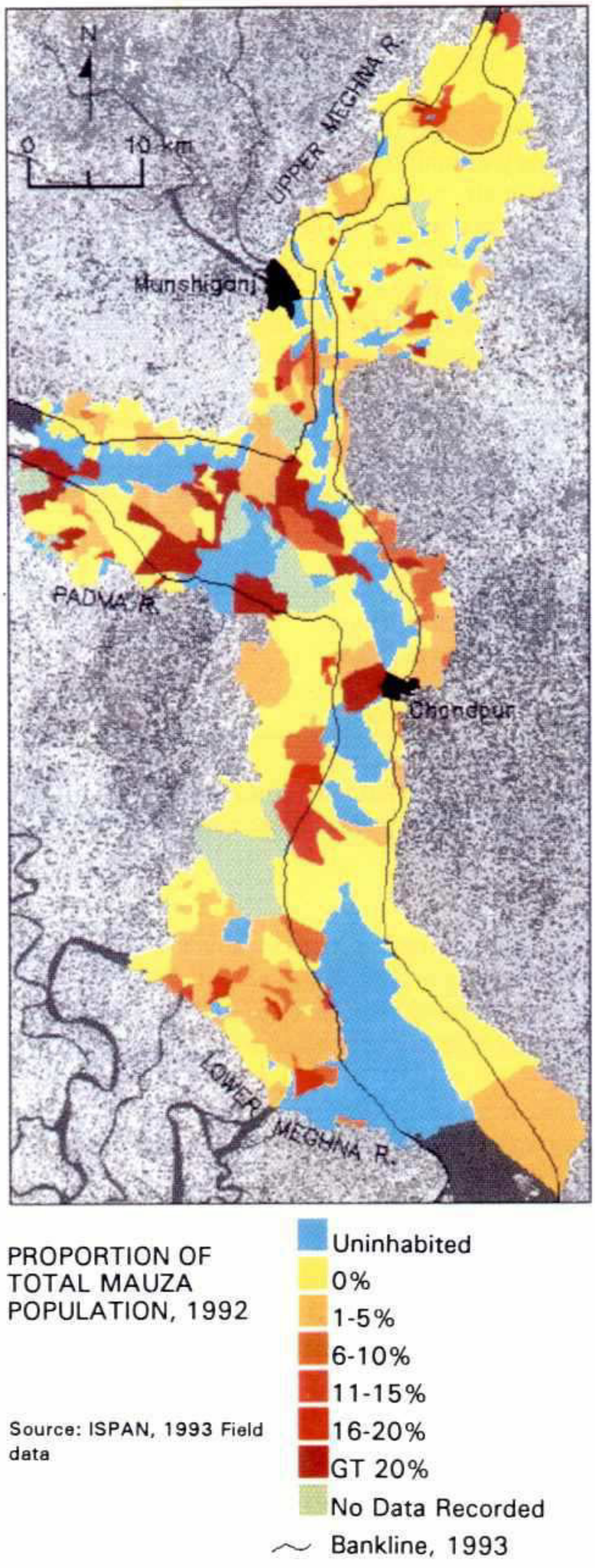


Figure 3.8

The RRA in this reach indicated that the 1992 pattern is not an isolated occurrence, and that char formations in the confluence frequently change forcing their inhabitants to move.

3.3.2 Seasonal Migration

Data were also collected on the total number of people seasonally leaving the mauza (out-migrating from their mauza of residence) or seasonally visiting the mauza (in-migrating to a temporary abode). A total of just under 4,000 people, about 0.3 percent of the 1993 population (Tables 3.6, B.18, and B.19), were reported to have temporarily migrated out of their mauzas. Seasonal migration often involves only some male household members, so if only one person per household migrated, it implies that in about 2 percent of households someone migrated out. This is probably an underestimate since the RRAs found temporary out-migration for work to be more common.

Most mauzas did not report any seasonal out-migrants, and there were very few migrants in the upper reach or confluence. Figure 3.9 indicates concentrations in the lower reach, where 6 percent of households may have sent someone to work outside the mauza, particularly in the island chars and west bank mainland and attached chars. This area is also attracting permanent in-migrants, but the reason for the large number of seasonal migrants may be that as the large char ages more people move there, but the char is not able to support them throughout the year. There also are nearby island chars where land can only be cultivated for part of the year. Alternatively, people may move back to their own land but retain jobs and businesses elsewhere that they return to periodically, these people would also have been recorded as seasonal migrants.

There were only slightly more seasonal in-migrants than out-migrants in the study area in 1992 (Figure 3.10; Tables 3.6, B.20, and B.21). Patterns of in-migration and out-migration were similar except for a higher incidence of in-migrants in the confluence (almost exclusively on island chars). In most cases it appears that seasonal migrants move into newly accreted island chars that are too low for permanent settlement, but that can be cultivated during the dry season. This is the case in the lower reach mauzas colored red-brown in Figure 3.10, which, although not permanently inhabited (and therefore colored pale blue in the other maps), are cultivated in the dry season by temporary settlers (seasonally out-migrating from nearby mauzas). In the remaining lower reach island char mauzas seasonal in-migrants may work transplanting and harvesting paddy (boro and T. aman are major crops in this area, see Section 3.5.2), when there is a seasonal peak in labor demand.

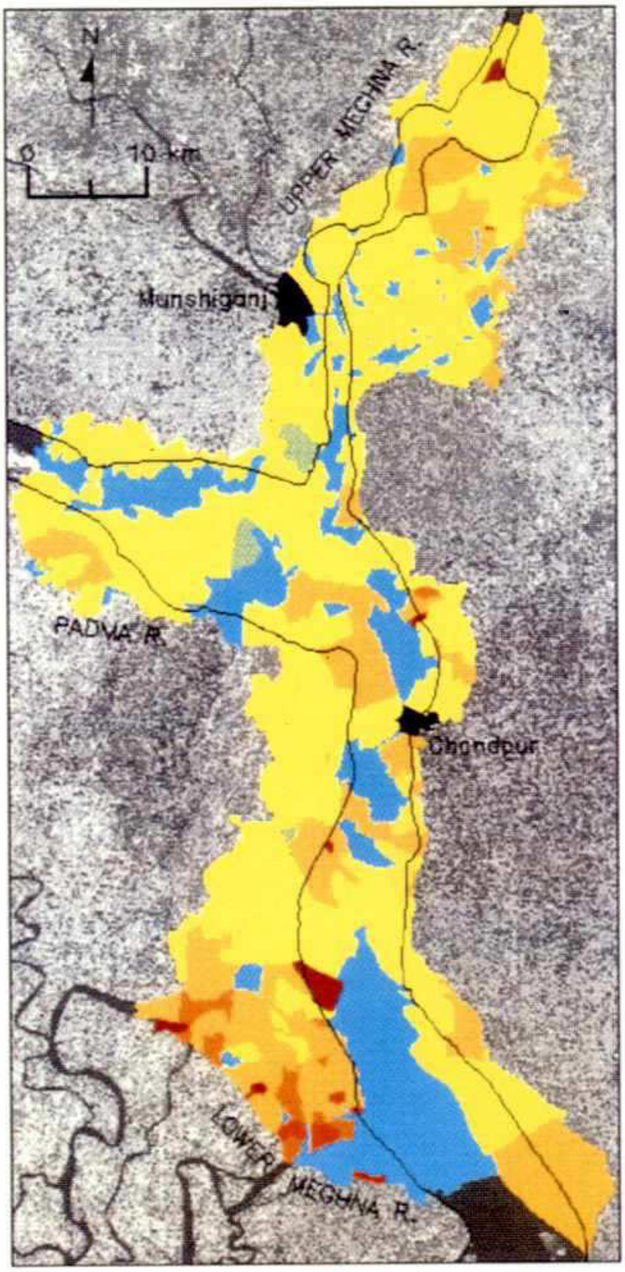
Table 3.6 Incidence of Migration in 1992 (percent of total households)

Type of Migration*	Island Chars	Attached Chars	Detached Mainland	Unprotected Mainland
Permanent Out-migration	2.0	2.0	0.2	1.7
Permanent In-migration	7.9	3.7	0.5	3.0
Seasonal Out-migration	5.2	1.2	0.4	1.6
Seasonal In-migration	6.1	2.5	0.0	1.0

Source: Tables B.14 to B.21.

*Permanent migrants are a percentage of households in mauzas with available data; seasonal migrants are individuals expressed as a percentage of households.

SEASONAL OUT-MIGRATION



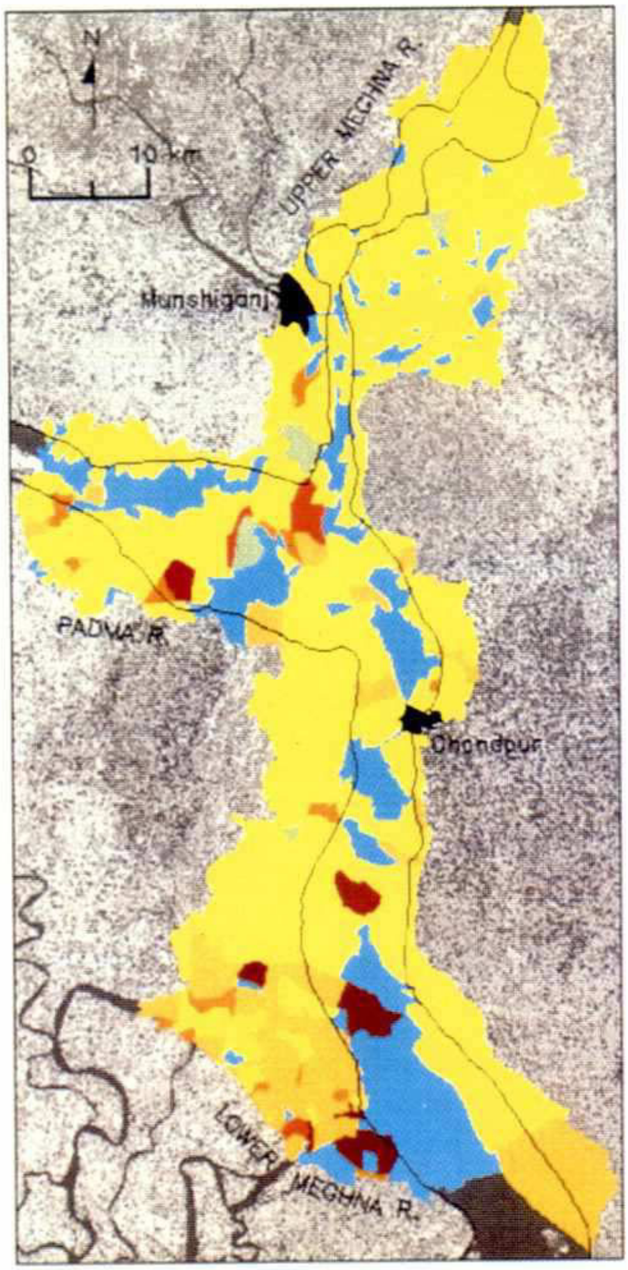
PROPORTION OF TOTAL MAUZA POPULATION, 1992

- Uninhabited
- 0%
- 1-5%
- 6-10%
- 11-15%
- 16-20%
- GT 20%
- No Data Recorded
- Bankline, 1993

Source: ISPAN, 1993 Field data

Figure 3.9

SEASONAL IN-MIGRATION



PROPORTION OF TOTAL MAUZA POPULATION, 1992

- Uninhabited
- 0%
- 1-5%
- 6-10%
- 11-15%
- 16-20%
- GT 20%
- Seasonally Occupied
- No Data Recorded
- Bankline, 1993

Source: ISPAN, 1993 Field data

Figure 3.10

SERVICE AND INFRASTRUCTURE PROVISION

3.4 Service and Infrastructure Provision

Among the inventory data collected was information on the type and level of services provided to people. Only education and health services are mapped since these are the most important government service issues in the charlands, according to case studies conducted by FAP 14 and FAP 3.1. No attempt was made to obtain size details of the education and health facilities. The distribution patterns of school and health facilities are expressed as the number of people in the mauza theoretically served by the facility. The maps disregard the fact that government health facilities are intended to have cross-mauza catchments. Moreover, access to many facilities is likely to be uneven due to communications difficulties in both dry and wet seasons. The RRA case studies show that transport problems limit the achieved charland catchments of high schools and health facilities.

3.4.1 Schools

A total of 284 mauzas (55 percent of inhabited mauzas) were reported to have primary schools (Tables 3.7 and B.22). Figure 3.11 shows that they are widely spread across the study area. Although attached chars and detached mainland appear to have the highest school coverage, many of these are orange in Figure 3.11, indicating that they are larger mauzas with high populations. The coverage, therefore, may be no better in attached chars than in some areas of unprotected mainland. In the latter, fewer mauzas have schools but the mauzas are much smaller, so children may actually travel a shorter distance to a school than do children in an attached char that has a school. Coverage of island chars is poor: more than 50 percent of mauzas have no primary school (yellow).

There are, the survey found, many fewer secondary education opportunities (high schools) in the Meghna charlands. Figure 3.12 shows only 67 high schools in the study area (Table B.23). There are the least number of high schools in the island chars, particularly in the lower reach. In the Upper Meghna and confluence there are 16,000 people per high school, but there are 24,000 per school in the Lower Meghna. Many potential students in the chars are separated from high schools by main river channels and distances of 10 km or more.

The age range for primary school children is six to 10 and for high school children, 10 to 15. The 1981 census of Bangladesh found that 16.3 percent of the country's population was between the ages of five and nine (the age range closest to that of primary schools) and 13.4 percent was between 10 and 14 years old (the age group closest to that of high schools). Assuming that these percentages still apply to the study area—and to Bangladesh—implies that in 1993 the study area had 190,000 children between five and nine years old

Table 3.7 Health and Education Services Provided to Inhabited Mauzas*

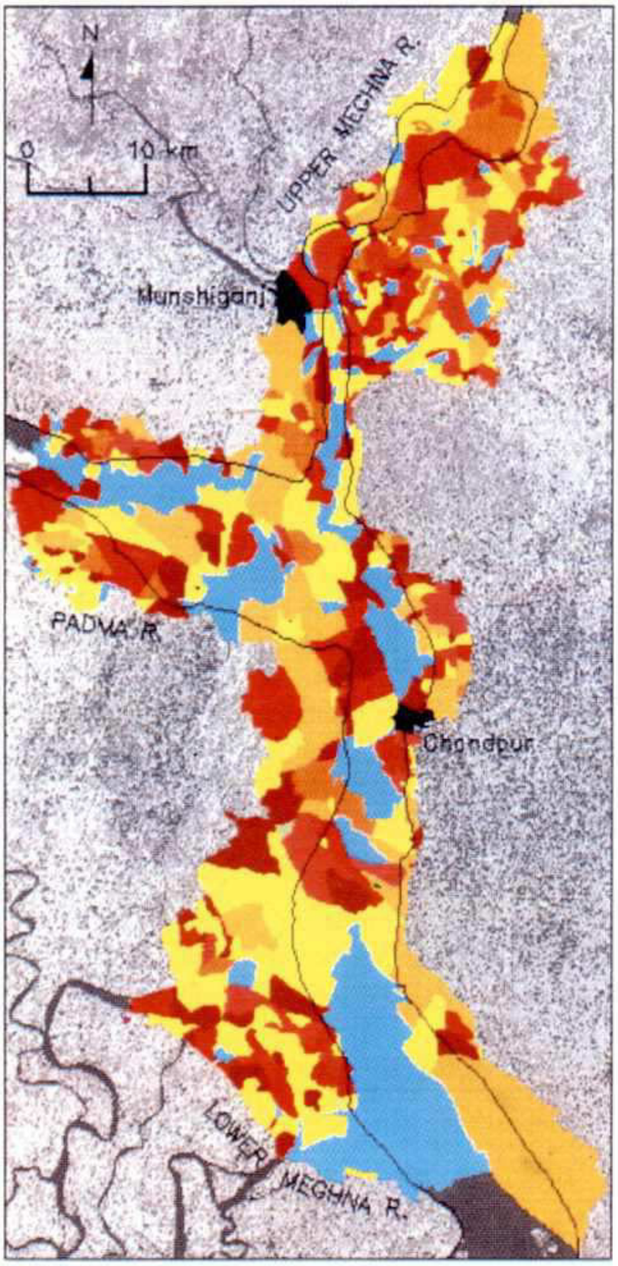
Charland Type	Number of Mauzas	Inhabited Mauzas	Primary School (%)	High School (%)	Health Facility (%)
Island Char	350	173	47	6	6
Attached Char	132	111	64	19	9
Detached Mainland	82	71	65	14	14
Unprotected Mainland	173	157	54	16	17
Total	737	512	55	13	11
Bangladesh†			74	13	4

Source: Tables B.22 to B.24; BBS (1993)

*Excludes mauzas for which no service provision data were obtained.

†All mauzas

PRIMARY SCHOOLS BY MAUZA



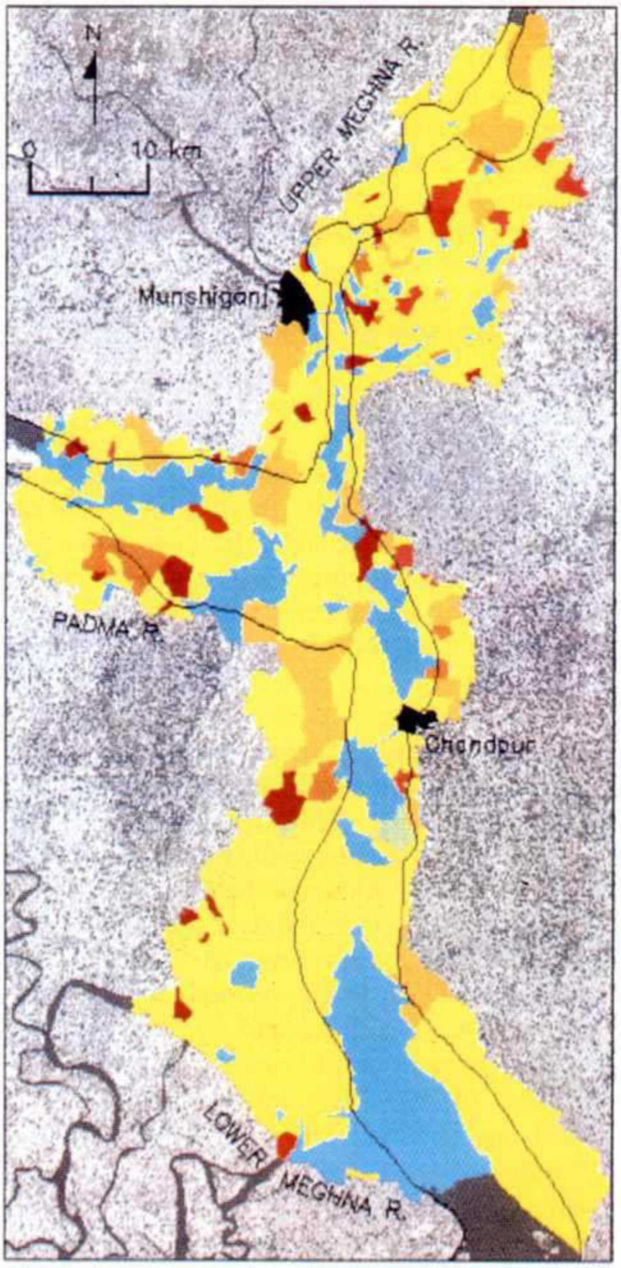
TOTAL POPULATION PER SCHOOL

- Uninhabited
- 1-1000
- 1001-2000
- 2001-3000
- 3001-4000
- GT 4000
- No School
- No Data Recorded
- Bankline, 1993

Source: ISPAN, 1993 Field data

Figure 3.11

HIGH SCHOOLS BY MAUZA



TOTAL POPULATION PER SCHOOL

- Uninhabited
- 1-1000
- 1001-2000
- 2001-3000
- 3001-4000
- GT 4000
- No School
- No Data Recorded
- Bankline, 1993

Source: ISPAN, 1993 Field data

Figure 3.12

and 156,200 in the 10-to-14 age range. For the study area this amounts to an average of 669 children per primary school (compared with 372 per school for all of Bangladesh) and 2,330 children per high school (compared with a Bangladesh average of 1,513). There is considerably less education infrastructure in the Meghna charlands, therefore, than the national average, or indeed than the Jamuna charlands. Moreover, the existence of a school does not ensure that education is available; in many char schools in the middle Jamuna teachers were absent or had not been posted (FAP 3.1, 1993), and the same problem is presumed to arise in the Meghna charlands.

3.4.2 Health Care

Figure 3.13 shows there are only 57 mauzas (11 percent; Tables 3.7 and B.24) with health care facilities in the study area. Health facilities were defined as physical infrastructure (either a government hospital, health care center, or family planning center or an NGO health care facility) present in the mauza.

Provision, the survey found, is biased toward the more stable upper reach, where there are about 17,000 people per facility compared with more than 26,000 per facility in the lower reach (Tables 3.7 and B.24). Although there are more than 20,000 people per hospital or health care center in the study area, this appears to be considerably better than the national average. In 1991 there were 2,819 government and non-government health care facilities (BBS, 1993)—only about one facility for every 38,980 people. Despite appearances, however, many people in island and attached chars live 10 km or more from the nearest medical facility and must travel long distances by foot and boat in the dry season or by boat in the monsoon season to take advantage of the service.

Key informants were also asked when their mauza had last been visited by a health worker (Figure 3.14). Of all inhabited mauzas, 57 percent were visited in the first half of 1993 prior to the field survey (red), and an additional 25 percent had been visited in 1992 (pink). Only 8 percent of inhabited mauzas were never visited (or informants do not remember when they were last visited; yellow on the map). Coverage appears to be slightly worse in the upper reach, yet these mauzas are no less accessible than other parts of the study area; some of them can be approached by road, and mechanized boats are widely available in the area (Section 3.5.5).

3.4.3 Water Supply

One fundamental means of preventing illness is to have a secure and pure source of drinking water. Under normal monsoon conditions, 79 percent of households in the study area reportedly use hand tubewells (HTW) for drinking water, 19 percent use the river, and 2 percent use ponds. Table 3.8 shows, though, that there is room to improve water supplies in the island chars; in those areas, even under normal conditions, 29 percent of households drink river water. This problem is greatest in the lower reach, where 34 percent drink river water.

Table 3.8 shows a complete reversal of drinking water sources during the 1988 flood, when 70 percent of study area households drank river or

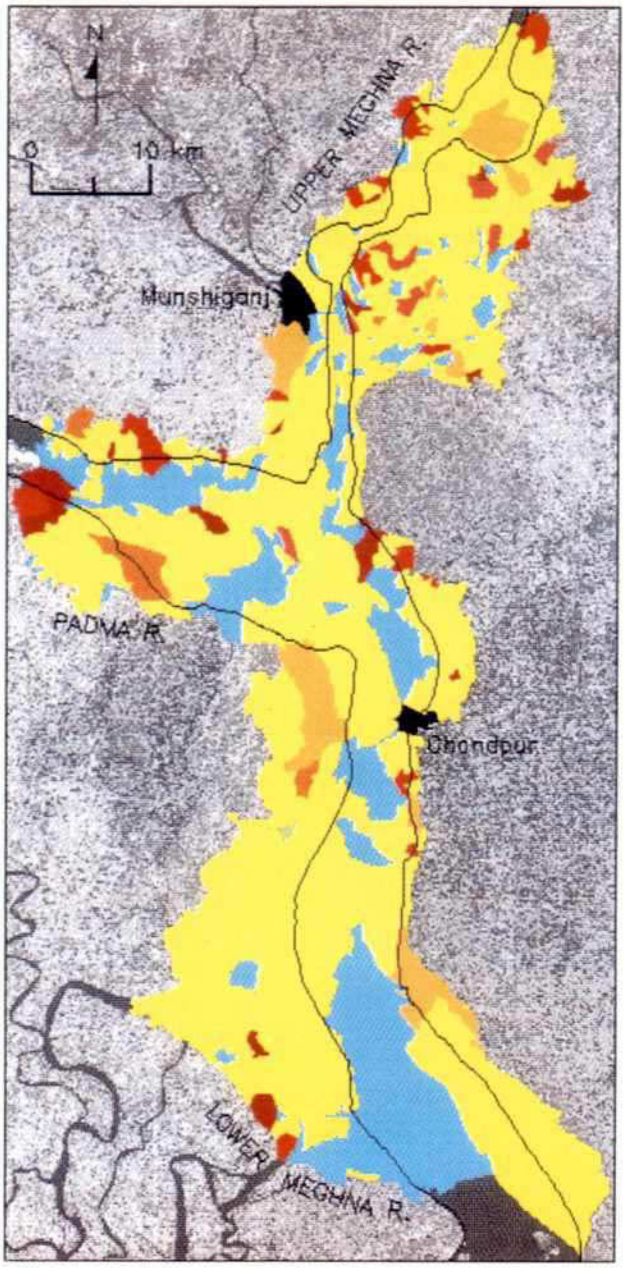
Table 3.8 Drinking Water Source (percent of households)

	Normal Monsoon		1988 Flood	
Land Category	HTW	River	HTW	River
Island Char	70	29	37	60
Attached Char	79	19	17	81
Detached Mainland	82	15	30	68
Unprotected Mainland	84	14	23	76
All Areas*	79	19	28	70

Source: FAP 16/19 Field Survey
*The remaining households (less than 2 percent before rounding) used pond water.

9r

HEALTH FACILITIES BY MAUZA



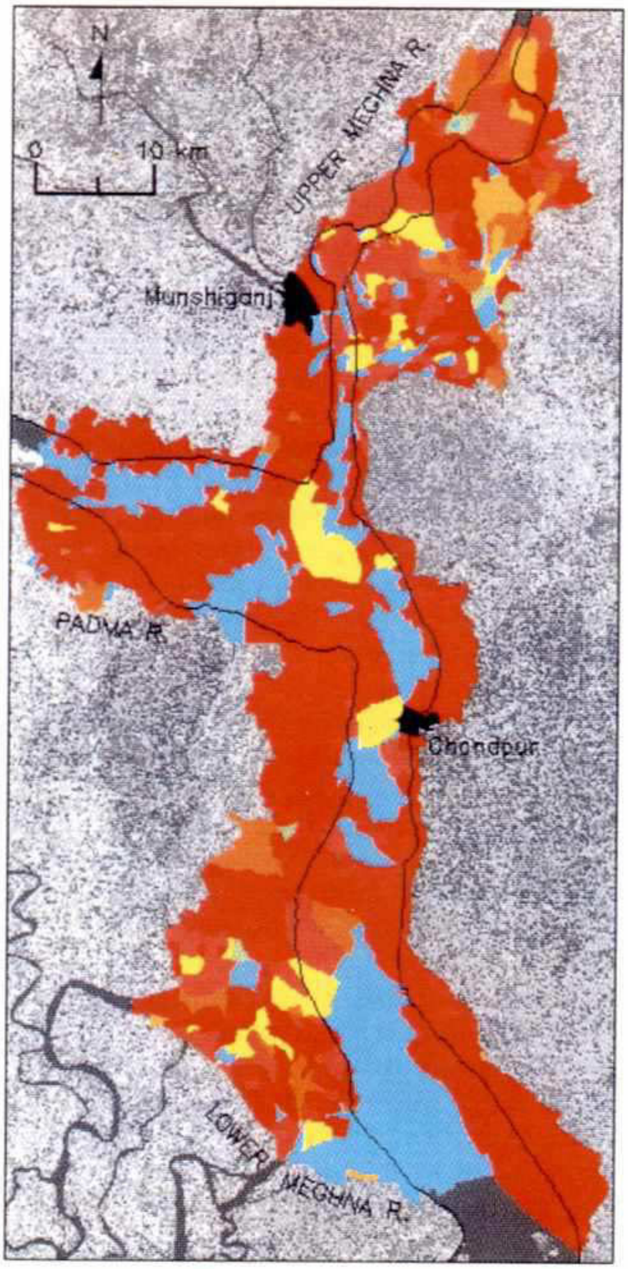
TOTAL POPULATION PER HEALTH FACILITY

- Uninhabited
- 1-1000
- 1001-2000
- 2001-3000
- 3001-4000
- GT 4000
- No Health Facility
- No Data Recorded
- Bankline, 1993

Source: ISPAN, 1993 Field data

Figure 3.13

LAST VISIT BY HEALTH WORKER



YEAR OF VISIT

- Uninhabited
- 1993
- 1992
- 1991
- 1990
- No Visit
- No Data Recorded
- Bankline, 1993

Source: ISPAN, 1993 Field data

Figure 3.14

flood water. Thirty-seven percent of households in the island chars still used HTW water during the flood, but this is probably because Lower Meghna island chars were less severely flooded than the remainder of the study area (Section 3.6.2).

3.4.4 Other Infrastructure

The distribution of markets in the study area was also investigated. There are a total of 113 mauzas (22 percent of inhabited mauzas) with periodic markets (*hats*). Most of those mauzas also have a bazaar with some permanent shops. *Hats* and bazaars were very evenly distributed between the three reaches: just over one in five mauzas has one of the markets. Thirty-six mauzas had major markets. These market centers are concentrated in the confluence, where 58 percent of the major markets serve 36 percent of the study area population. The lack of larger markets in the lower reach, which has only four, could limit development potential, although boat transport is plentiful in that area.

Rural electricity supplies are scarce in the Meghna charlands. Only 60 mauzas (12 percent of inhabited mauzas) have electricity, and these are concentrated in the unprotected mainland and attached chars. The few island char mauzas that have electricity include small areas of mainland; the islands themselves do not have electricity.

Other inventory data on infrastructure will be useful in planning improved access to facilities and designing income-generating programs for the char people in specific areas. At present most of the mauzas do not have any NGO activities—only 16 percent of all inhabited mauzas were reported to have any NGO presence or activity.

Access to the local power structure is important as a means of directing infrastructure and services, including relief during floods, to a particular mauza. In that connection, the study found that only 11.5 percent of inhabited mauzas within the study area are reported to be home to the relevant Union Parishad Chairman. Since there are an average of 13 mauzas per union in Bangladesh, the norm is for 7.7 percent of mauzas to have their chairman resident.[3] On that basis, there is no evidence that the Meghna island chars are particularly badly represented in union parishads (although the distribution of ward members was not assessed). The east bank attached chars and unprotected mainland have fairly high numbers of chairmen present in the study area (15 to 18 percent of mauzas with a chairman living there); either because unions are smaller or the population centers of eroding unions are close to the bankline.

60

RESOURCE AVAILABILITY AND USE

3.5 Resource Availability and Use

3.5.1 Occupations and Overall Resource Base

This section documents a high dependence on cultivation, particularly paddy, in the Meghna chars. Livestock are also a key part of this economy, which reflects the charlands' abundant grazing, although as will be seen, this does not result in higher densities of animals per hectare. The Meghna is particularly important for commercial fishing, as national statistics (BBS, 1993) show, and the inventory revealed that many households earn a living from fishing. Many people own boats, river transport being an important resource both for normal communications and for evacuation, when erosion and floods force people to leave their homes. The pattern of competition and social conflict for the changing land resource is complex, and these issues have been further studied during rapid rural appraisals (RRAs) in 1993.

Forty-five percent of households reported agriculture as their primary occupation (Table 3.9). Dependence on agriculture was highest in the upper reach (detached and unprotected mainland) and lowest in the lower reach (Tables B.25 and B.26). In the latter area fishing is almost as important as agriculture, with 34 percent of households mainly fishing and 40 percent mainly farming. In the detached mainland few households reported either laboring or fishing. Instead, these households mainly cultivate their own land and more (7 percent) are involved in service (possibly because the area is nearer to Dhaka).

Compared with the Jamuna charlands fewer households are dependent on day labor, which is primarily agricultural work, and there is little variation between land types. The FAP 14 data, from a wider range of flood environments, shows even greater involvement in business and service, and much lower dependence on fishing than in the Meghna charlands. Low involvement in business (Tables 3.9 and B.30) in the study area may reflect the isolation of some of the confluence and lower reach charlands from trading centers, although two towns border the study area.

The surveys concentrated on land-based resources because the methodology was inappropriate for a detailed investigation of fisheries. Nevertheless, fishing is the main occupation of 19 percent of households, and another 16 percent fish as a

Table 3.9 Main Occupations of Charland Households (percent)

Occupation	Island Char	Attached Char	Detached Mainland	Unprotected Mainland	Study Area	FAP 14 Average
Farming	45	44	54	43	45	38
Day Labor	23	22	19	24	23	30
Fishing	22	21	11	19	19	6
Business	4	6	5	6	5	8
Service	2	1	7	2	3	7
Other*	4	6	4	6	5	12
Total Households	43,286	45,574	26,038	67,596	182,494	7,723
Percent Fishing for Second Income	24	15	7	16	16	na

Source: Table B.30; FAP 14 Final Report

*Consists mainly of households engaged in paid domestic work or receiving remittances from abroad. Other households that report no income may receive remittances from people working away from home.

secondary income source (Tables B.27, B.28, and B.29). In the Lower Meghna dependence on fishing is much higher: 34 percent of all households fish as a primary occupation and 30 percent do so as a secondary occupation. In this reach, since the mainland areas border the main channel, fishing is equally important regardless of land type. In the confluence, on the other hand, fishermen are concentrated on the island chars. In the upper reach, people in the detached mainland do not have direct access to the river, so only 18 percent fish commercially. But the RRAs in the upper reach and confluence found more professional fishermen than the inventory did. It may be that the inventory underestimates the number of households fishing seasonally or with members employed as laborers or working on a share basis for fishing gear owners.

These figures are much higher than the 6 percent of households mainly found fishing in five char villages studied by FAP 14 (FAP 14, 1992), which included one village in the Padma-Meghna confluence. The pattern of high dependence on fish is also consistent with national statistics (BBS, 1993), which show that in 1988-89 the Meghna contributed 93 percent of the total main river catch (although this includes areas of the Upper and Lower Meghna that were not included in the Charland Study).

3.5.2 Agriculture

As Section 3.2.1 explains, cultivated areas were mapped using the mauza questionnaire returns (Figure 3.15; Table B.5) and interpretation of satellite imagery (Figure 3.2). The Meghna inventory questionnaire tried to improve respondent's accuracy in estimating cultivated area by calculating land area separately, and having them estimate the total percentage of dry season land area cultivated at any time during the year. Comparison of the two estimates (Tables B.4 and B.5) shows that the inventory estimates of cultivated area were a constant 82 percent of the image analysis estimate of vegetated area for all three reaches, and there was little variation from this figure between char types. There are locally sizeable variations, but the consistency suggests that the estimates are somewhat reliable and that the remaining 18 percent of vegetated land is probably homestead land with trees (especially in the mainland) and grasses (in the chars).

Figure 3.15 shows that a high percentage of study area land is cultivated. Most of the 110 uncultivated mauzas (blue) are uninhabited (pale blue in the previous figures), and were completely submerged during the 1993 dry season. Pressure to use land resources is high and most of the remaining uninhabited mauzas are reported to be seasonally cultivated; only 4 percent of mauzas that are not submerged have no cultivated land. The other uninhabited mauzas mostly show up as having less than 50 percent of land cultivated (pale green), are within the channel, and correlate with areas of seasonal in-migration.

In 52 percent of cultivated mauzas more than 80 percent of land is cultivated (dark green in Figure 3.15). Cultivation is particularly extensive in the detached mainland, the confluence (including island chars), and the mainland and attached chars of the lower reach, particularly the east bank.

Cropping intensity measures the extent to which land is multiple cropped within a year. A 100 percent intensity means that all cultivable land grows an average of one crop per year, and a 200 percent intensity means that an average of two crops a year are grown.[4] Most cultivable land grows at least one crop a year in Bangladesh, and the study area is no exception. In the 19 percent of cultivated mauzas with intensities up to 100 percent (pale brown in Figure 3.16) almost all were in the 95-100 percent range indicating single cropping with small areas of fallow in any one year. These areas are concentrated in the island chars of the Padma side of the confluence and in the west bank attached chars in the lower reach.

Average cropping intensities are 145 to 150 percent for all three reaches (Table 3.10) and are similar for all the land types, but this masks some high local cropping intensities (Table B.31).

Table 3.10 Cropping Intensity

Land Type	Cropping Intensity* (percent)
Island Char	147
Attached Char	143
Detached Mainland	147
Unprotected Mainland	159
All Land	150
Bangladesh Average	172

Source: Table B.31; BBS (1993)
*1990-91 for Bangladesh; 1992-93 for inventory

Figure 3.16 shows that mauzas with a cropping intensity of more than 200 percent (darker green) are concentrated in the unprotected mainland of the northwest side of the confluence, and spread through the attached chars south of Munshiganj to the east bank unprotected mainland bordering the Meghna-Dhonagoda Irrigation Project, and toward Chandpur. This is the older, more established side of the confluence where land, while subject to some bank erosion in recent years, has been stable (Chapter 2). By comparison, there are lower cropping intensities in the more dynamic confluence chars. Lower reach island chars also are locally intensively cultivated, which may be associated with lower flood risk (Section 3.6.2). Upper reach detached mainland shows only moder-

68

PROPORTION OF LAND CULTIVATED BY MAUZA

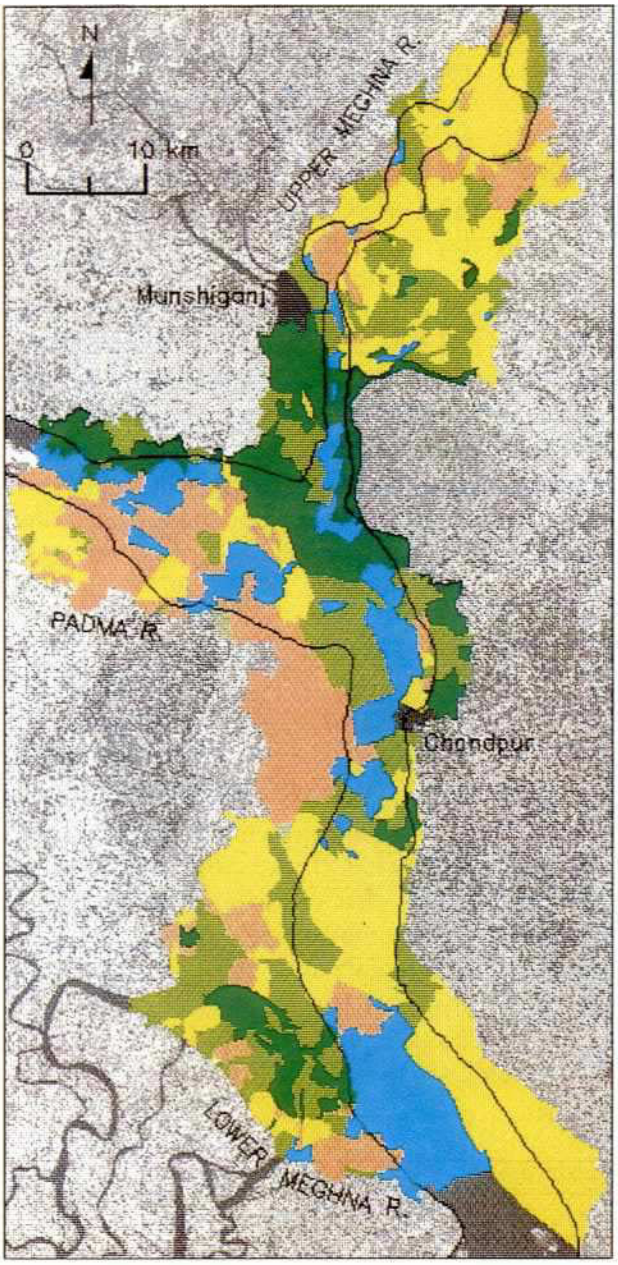
PROPORTION CULTIVATED IN 1992

- Submerged
- 0%
- 1-50%
- 51-60%
- 61-70%
- 71-80%
- 81-100%
- No Data recorded
- Bankline, 1993

Source: ISPAN, 1993 Field data

Figure 3.15

CROPPING INTENSITY



PROPORTION OF CULTIVABLE LAND CULTIVATED IN A YEAR

- No Cult
- 70-100%
- 101-150%
- 151-200%
- 201-250%
- 250%
- No Data Recorded
- Bankline, 1993

Source: ISPAN, 1993 Field data

Figure 3.16

ate cropping intensity, which may be because the area is deeply flooded during the monsoon.

Land stability, monsoon water levels, and flood risks are among the factors determining a farmer's choice of crops and, therefore, the intensity of cultivation, but in the Jamuna chars sand and dry-land cropping were also found to be important. The Meghna inventory obtained estimates of the percentage of land that is sandy (*bele*), loam (*doas*), or clay (*etel*) in each mauza. Figure 3.17 shows that only in the large island char in Hizla was sandy soil virtually absent, but in much of the study area less than 25 percent of soil was sandy. There are concentrations of sandy land in the main channel of the Upper Meghna, in much of the channel of the confluence, and in the west bank attached chars of the lower reach. The confluence island chars average 61 percent sandy soil (Table B.32), but the attached chars in all reaches average 28 percent sandy soil.

The influence of sandy soil on cultivation should be most apparent in the extent to which dry-land crops (millets, groundnuts, or sweet potatoes) are grown. Figure 3.18 shows a generally low coverage of these crops, in 60 percent of all cultivated mauzas these crops are grown on only 1-25 percent of cultivable land. These crops are absent on most of the island char of Hizla, just where most of the soil has a minimal sand content. Likewise, in the detached mainland of the upper reach the old, established land has a low sand content. An explanation for the apparent lack of dry-land crops in reportedly sandy areas of the confluence would require more detailed agronomic study.

The main concentration of dry-land crops is in the island chars of the upper reach. This finding is consistent with the RRA of this area, which found that groundnuts, sweet potatoes, and watermelons, were important crops. Unlike the Jamuna char-lands, millets are not important crops in the Meghna. Table 3.11 shows that even in the upper reach only 15 percent of cultivable land is under these dry-land crops. There is no apparent advantage in the island chars for cultivating these crops, although Table B.33 suggests that groundnut yields are higher in the island chars.

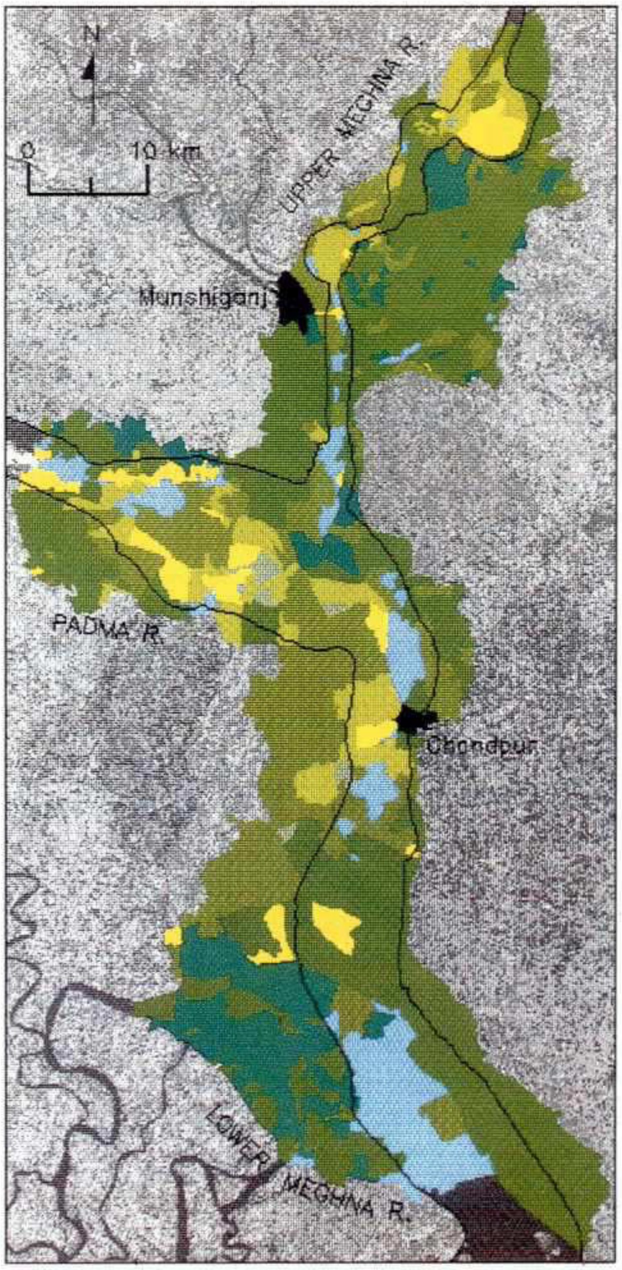
A wide range of other crops are also grown during the winter, or rabi, season including wheat and other dry-land crops, as well as winter-sown boro paddy. Figure 3.19 shows that boro cultivation is concentrated in the island chars of the lower reach, and Tables 3.11 and B.33 indicate that this is mainly local boro, which tends to be grown on newly accreted chars within the main channel and particularly in low-lying silty areas around the periphery of the large island char in Hizla (shown dark green in Figure 3.19). There is also a concentration of boro cultivation in the chain of island chars along the main Meghna channel that skirts the sandier areas shown in Figure 3.17. HYV boro, which requires irrigation, also is grown to a limited extent. It is mainly concentrated in the detached mainland of the upper reach, which is the most stable part of the study area. Yields of both types of boro are reported to be higher in the island chars then on other land types (Table B.34).

Table 3.11 Rabi/Boro Cropping Pattern (percent of cultivable land under main crops)

Crop	Island Char	Attached Char	Detached Mainland	Unprotected Mainland	Upper	Conflu-ence	Lower	Total
Dry-land Crops	8	8	10	12	15	7	7	9
Wheat	5	10	10	9	8	11	4	8
Other Rabi Crops	21	32	38	33	32	34	19	30
L Boro	30	15	5	9	7	10	34	17
HYV Boro	17	11	20	14	21	6	18	15
Total	81	76	83	77	83	68	82	79

Source: Table B.33

EXTENT OF SANDY SOIL



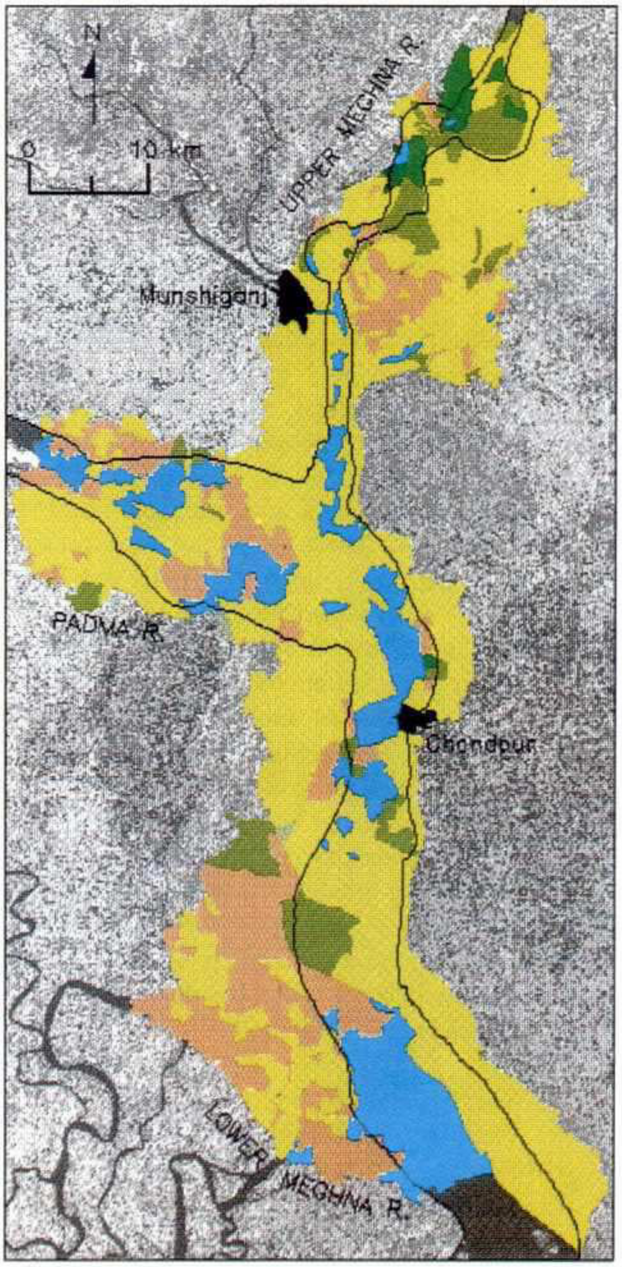
PROPORTION OF SOIL REPORTED SANDY

- Submerged
- 0%
- 1-25%
- 26-50%
- 51-75%
- 75 + %
- No Data recorded
- Bankline, 1993

Source: ISPAN, 1993 Field data

Figure 3.17

DRYLAND CROP COVER



PROPORTION OF CULTIVABLE LAND UNDER DRYLAND CROPS

- No Cult
- 0%
- 1-25%
- 26-50%
- 51-75%
- 75 + %
- No Data recorded
- Bankline, 1993

Source: ISPAN, 1993 Field data

Figure 3.18

Table 3.12 Monsoon Cropping Pattern (percent of cultivable land under main crops)

Crop	Island Char	Attached Char	Detached Mainland	Unprotected Mainland	Upper	Conflu-ence	Lower	Total
Aus	14	22	9	24	11	30	13	18
Jute	5	8	10	12	12	8	5	8
B Aman	19	23	35	27	28	28	17	24
TL Aman	24	8	4	6	6	5	26	12
HYV Aman	4	2	1	5	4	2	4	3
Total	66	63	59	74	61	73	65	65

Source: Table B.33

Table 3.11 shows that the remaining rabi crops are the most widely grown in the study area. In addition to wheat, "other rabi crops" comprise pulses, chilies, potatoes, oilseeds (mainly mustard and *til*), and onions; there also are very small areas producing a wide range of other spices and vegetables. These crops are widespread but concentrated in the upper reach and confluence where less boro is grown (Figure 3.20 shows a reversal of the pattern in Figure 3.19). There are more sandy soils at the confluence, and it is less extensively cultivated in the winter season than the other reaches. In this reach, more detailed investigation of the constraints on farming are warranted. There appears to be more dry season irrigation in the Meghna charlands than in the Jamuna. The area under irrigated crops is still low, however, and it may be possible to increase coverage—provided the equipment used is portable (to cope with erosion and floods) and returns are high enough.

There is no reason to believe that land in the confluence is less productive than other areas, since winter cropping is balanced by a higher percentage of land cultivated in the monsoon (Table 3.12). In particular, early monsoon (aus) paddy is commonly grown in this reach implying that some areas are less prone to early monsoon floods. This area also has less boro cultivation, and since the boro and aus seasons overlap, this may explain the limited aus cultivation in other reaches (as aus has considerably lower yields; Table B.34). Jute, which is grown in the same season, is not a major crop in the area. In terms of flood damage there seems to be little comparative advantage between reaches in the early monsoon. These two crops tend to be the most vulnerable to flood damage, and Table 3.13 shows that in general aus and jute have been badly damaged more than once in the five years 1988-92, and can be expected to be damaged almost three years in 10.

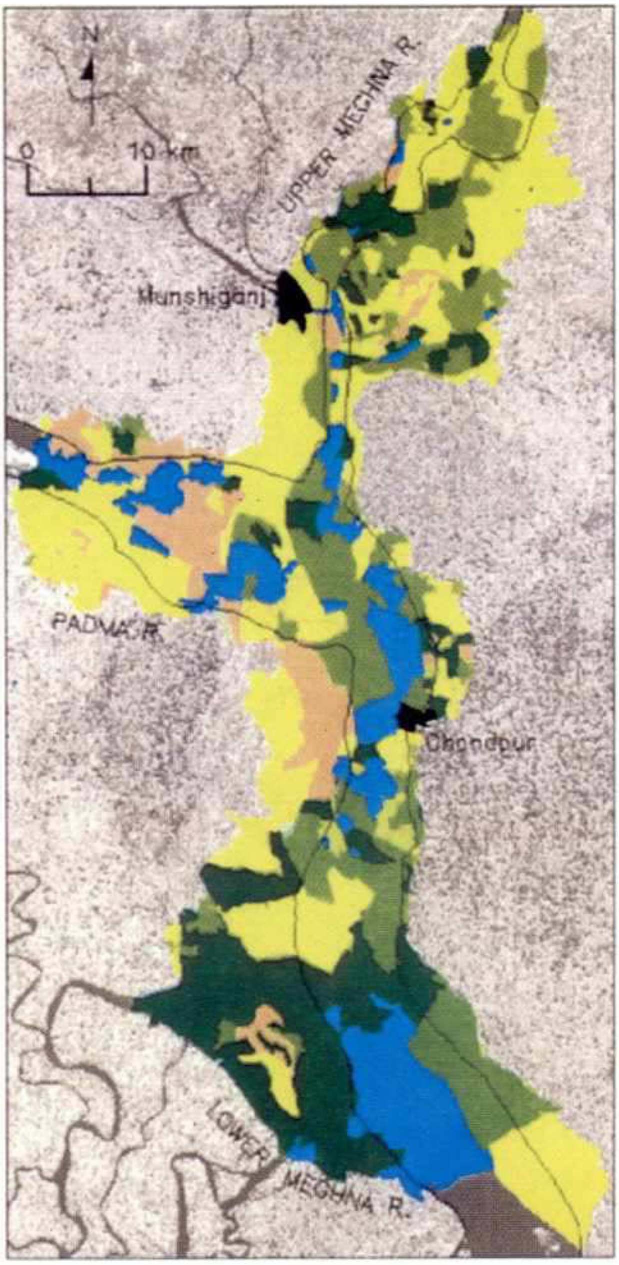
Broadcast aman (B aman) is the main monsoon crop in the area, and many varieties are tolerant of flooding and able to grow with rising water levels. Although B aman is often mixed with aus, the survey did not distinguish this crop mix, and Table 3.12 implies that it may only be commonly used in

Table 3.13 Mean Number of Years in Ten with Flood Damage to Selected Crops*

Crop	Upper Meghna	Confluence	Lower Meghna	Total
L Boro	1.6	2.6	1.2	1.8
HYV Boro	1.4	1.6	0.8	1.2
Aus	2.4	3.4	3.0	2.8
Jute	2.8	2.8	3.0	2.8
B Aman	3.2	3.2	2.4	3.0
TL Aman	2.0	2.4	0.6	1.4
HYV Aman	2.2	0.6	0.6	1.4

Source: FAP 16 Inventory Survey
*Based on incidence of damage from 1988 through 1992. Other crops had a damage incidence of less than 1 in 10 years.

BORO CROP COVER



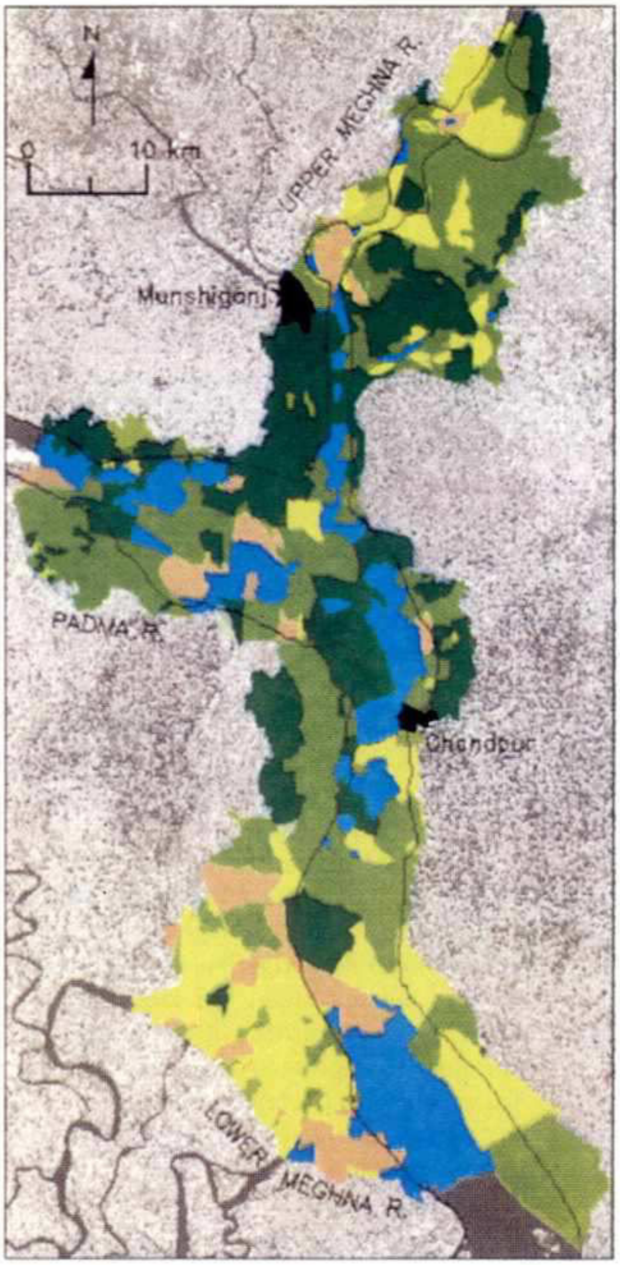
PROPORTION OF CULTIVABLE LAND UNDER BORO PADDY

- No Cult
- 0%
- 1-25%
- 26-50%
- 51-75%
- 75 + %
- No Data recorded
- Bankline, 1993

Source: ISPAN, 1993 Field data

Figure 3.19

RABI CROP COVER



PROPORTION OF CULTIVABLE LAND UNDER OTHER RABI SEASON CROPS

- No Cult
- 0%
- 1-25%
- 26-50%
- 51-75%
- 75 + %
- No Data recorded
- Bankline, 1993

Source: ISPAN, 1993 Field data

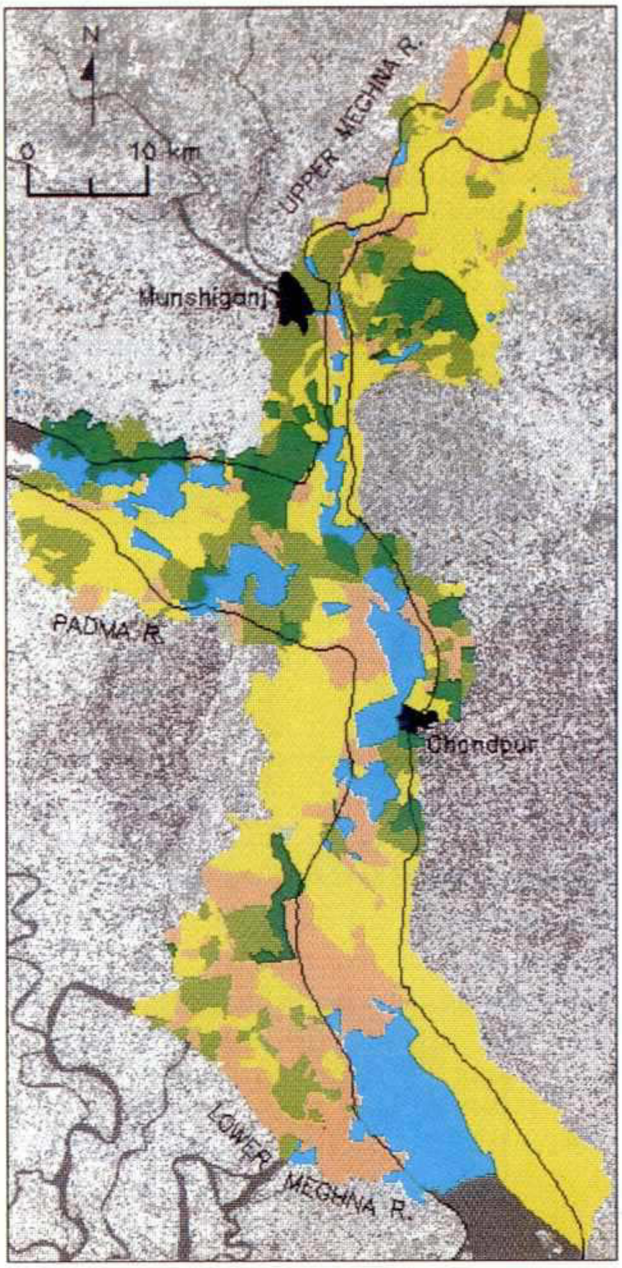
Figure 3.20

the confluence. Figure 3.21 shows that B aman is most extensively grown in the upper reach detached mainland and on the north bank of the Padma in the confluence. These areas are more deeply flooded than most (as shown in Section 3.6.2), but do not have the high risks of loss from river current and erosion found in the island chars. Even so, in both these reaches this crop was badly damaged by floods 1.6 times in five years (1988-92).

Transplanted aman is higher yielding than broadcast varieties (Table B.34) because it can be grown under more controlled conditions and with more inputs, but it is shorter stemmed and more vulnerable to flood damage. Local varieties (TL aman) tend to be taller than HYV aman, and little HYV aman is grown in the area. Both types of transplanted aman were damaged by floods less often than B aman in the past five years in the study area. This implies that these crops are grown on higher land and that farming systems in the Meghna charlands are well adjusted to flood risk. Figure 3.22 shows that most land in the island char of Hizla in the lower reach grows transplanted aman in the monsoon (TL and HYV aman are combined in the figure), higher yields were reported here and very little flood damage; this is consistent with the absence of flooding in this area shown in Section 3.6.2. The other concentration of T aman is on the north side of the confluence bordering the Meghna-Dhonagoda Irrigation Project. The reasons for this are not clear, the land may be higher, but there could also be a demonstration effect from the flood-protected interior of that project. In which case it might be possible to increase T. aman cultivation (using long-stem varieties) into other parts of this reach.

Agriculture is quite intensive in the Meghna chars, and it does not appear to be more hazardous or less productive than in neighboring mainland areas. There is a transition from more stable but deeply flooded areas in the upper reach, which produce mainly mixed rabi crops followed by B aman (a pattern that extends down the east side of the confluence), through sandier and more changeable chars, with somewhat more aus cultivation in the west side confluence, to the Lower Meghna. Farming conditions in the west bank island char complex of the Lower Meghna are very different; the lack of sandy soil and lower monsoon and flood water levels result in much of the area being double cropped with two transplanted paddy crops per year.

B. AMAN CROP COVER



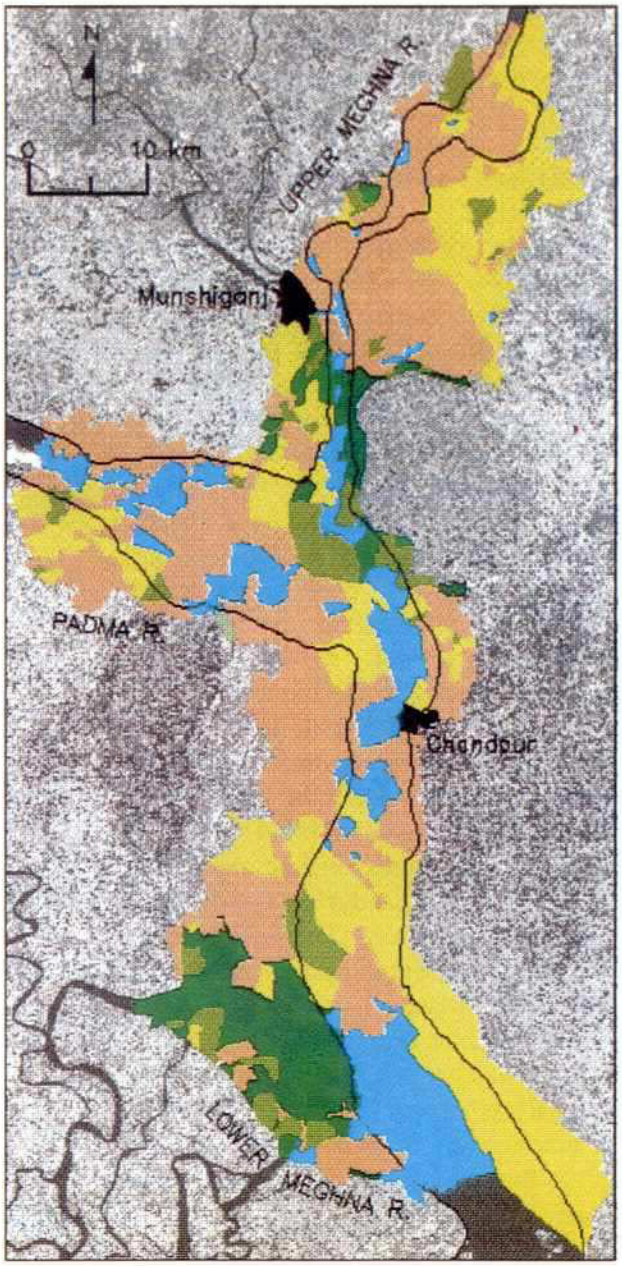
PROPORTION OF CULTIVABLE LAND UNDER BROADCAST AMAN PADDY

- No Cult
- 0%
- 1-25%
- 26-50%
- 51-75%
- 75 + %
- No Data recorded
- Bankline, 1993

Source: ISPAN, 1993 Field data

Figure 3.21

T. AMAN CROP COVER



PROPORTION OF CULTIVABLE LAND UNDER TRANSPLANTED AMAN PADDY

- No Cult
- 0%
- 1-25%
- 26-50%
- 51-75%
- 75 + %
- No Data recorded
- Bankline, 1993

Source: ISPAN, 1993 Field data

Figure 3.22

3.5.3 Livestock

Livestock was divided into three categories: large (cattle and buffaloes), small (sheep and goats), and poultry. Data were collected to determine the mean number of animals per household and the number of animals per km² of non-flooded land during the dry season. The latter is an indicator of grazing land and fodder availability.

The number of cattle (there are few buffaloes in most of the study area) in the charlands changes considerably between the dry and monsoon seasons (Tables B.36 and B.37). A total of just over 133,500 cattle and buffaloes were reported in the study area in the 1993 dry season, but there had been about 105,300 in the previous monsoon (79 percent of dry season number). This reflects practices found by the Upper Meghna and confluence RRAs. Grazing, crop residues, and bulk crops (sweet potatoes) are abundant during the dry and pre-monsoon seasons, but dry land and fodder are scarce in the monsoon. Some farmers, the RRAs found, buy cattle at the start of the dry season, use them to prepare the land for rabi crops, then fatten and sell them for higher prices at the start of the monsoon, thereby avoiding the risk of loss during floods. This practice is common in the Upper Meghna and confluence, but in the Lower Meghna there is less seasonal variation in large livestock numbers (Tables B.36 and B.37) and less monsoon inundation. Through the remainder of this section the analysis relates to dry season numbers since these are compared with dry season land area and reflect the importance of livestock rearing in the area.

There were 54 animals per km² of dry season land (Tables B.38 and B.39) in the study area. There are concentrations of large livestock in the unprotected mainland of the upper reach and confluence and in the detached mainland (about 200 animals per km²; red in Figure 3.23). There is a high density of large livestock in the island chars of the lower reach, but it is confined to the Hizla area where draft animals are needed for land preparation year-round (see Section 3.5.2). There does not appear to be much correlation between livestock and human population; some areas with high cattle densities do not have high population densities.

Data on the number of large livestock per 100 households reveal that there are generally fewer than one animal per household (Figure 3.24; Tables 3.14 and B.40). Livestock ownership is lowest in the confluence island chars and lower reach attached chars (yellow in the figure) where there is abundant seasonal grazing. The inventory figures, however, are much lower than those reported during RRAs in the confluence (2.5 cattle per household), implying that the inventory under-recorded cattle (at least in this area). There are concentrations of livestock ownership (red) in the detached mainland, some areas of unprotected mainland on the Padma side of the confluence, and in the Hizla island char, all of which are stable areas. Even so, availability of large livestock per household appears to be less than the national average, even in the dry season when there are favorable fodder resources.

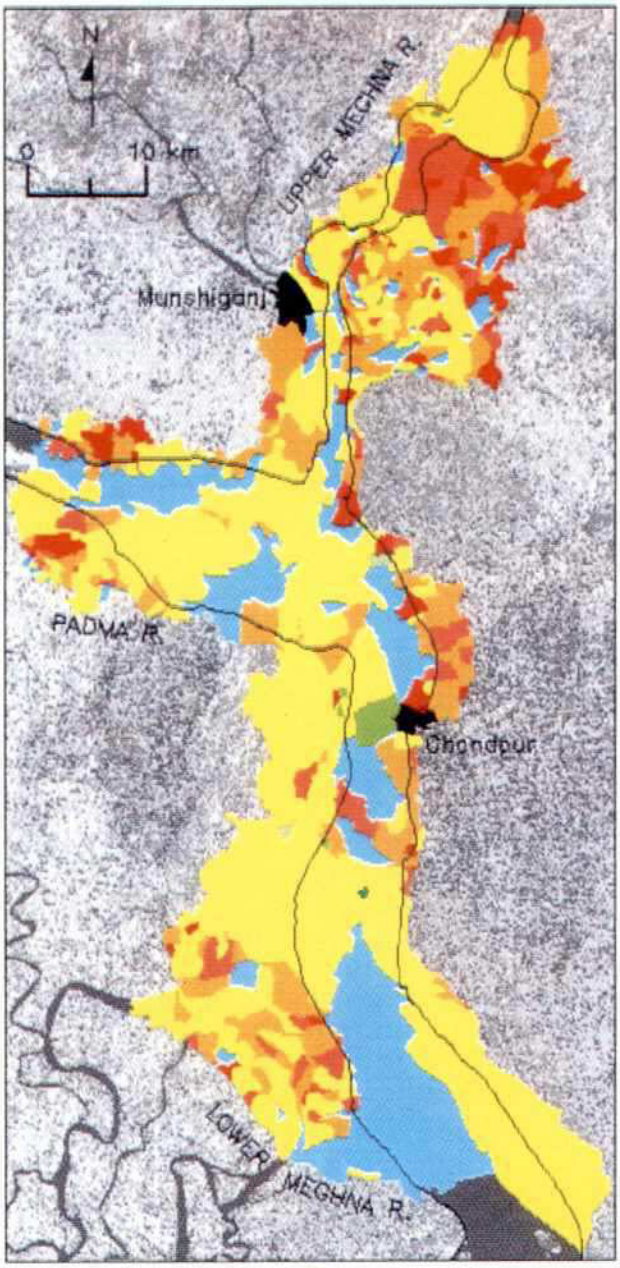
Table 3.14 Livestock Ownership Per Household

Land Category	Large Livestock	Small Livestock	Poultry
Island Chars	0.74	0.53	2.11
Attached Chars	0.56	0.63	1.87
Detached Mainland	1.09	1.52	3.12
Unprotected Mainland	0.70	0.70	1.93
Charland Average	0.73	0.76	2.13
Bangladesh Average†	1.33	0.96	4.99

†Based on 1983/4 Agriculture and Livestock Census and 1981 Population Census.

Although the least flood-prone area (Hizla) has the highest level of large livestock ownership, ownership in the more deeply flooded detached mainland is also high. This is likely due in the detached mainland to high population density, and in Hizla

DENSITY OF LARGE LIVESTOCK TO LAND AREA



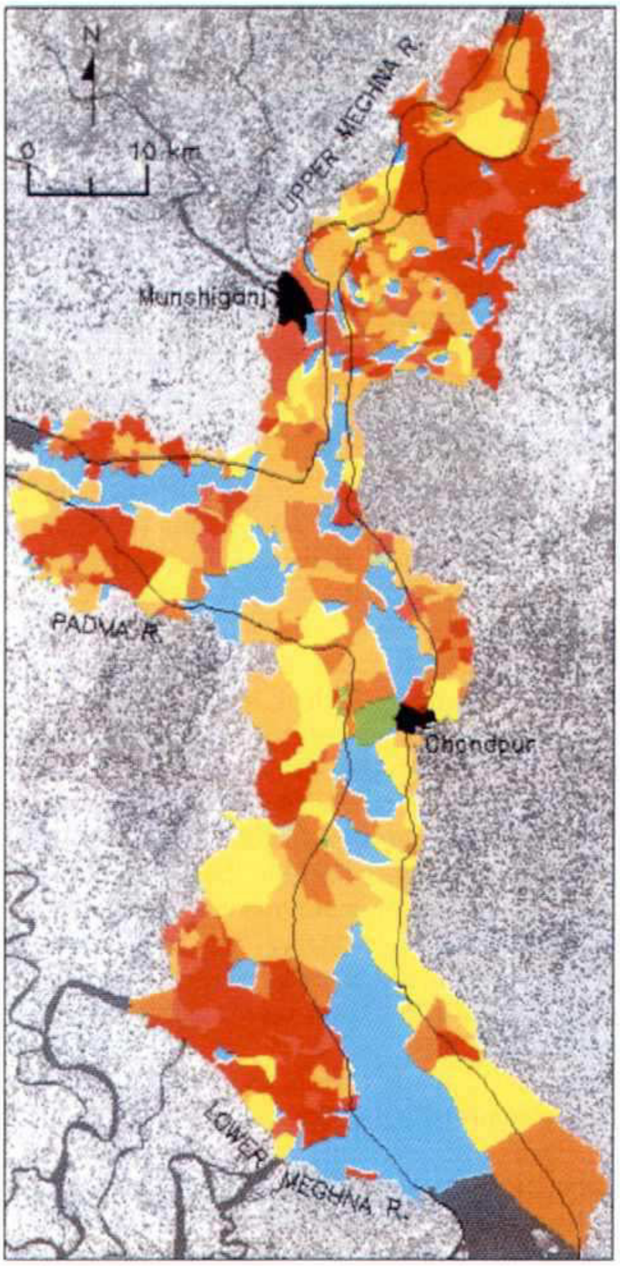
ANIMALS PER SQ. KM DRY SEASON LAND

- Uninhabited
- 0
- 1-100
- 101-200
- 201-350
- GT 350
- No Data recorded
- Bankline, 1993

Source: ISPAN, 1993 Field data and Satellite image data

Figure 3.23

LARGE LIVESTOCK PER 100 HOUSEHOLDS



ANIMALS PER 100 HOUSEHOLDS

- Uninhabited
- 0
- 1-25
- 26-50
- 51-75
- 76-100
- GT 100
- No Data recorded
- Bankline, 1993

Source: ISPAN, 1993 Field data

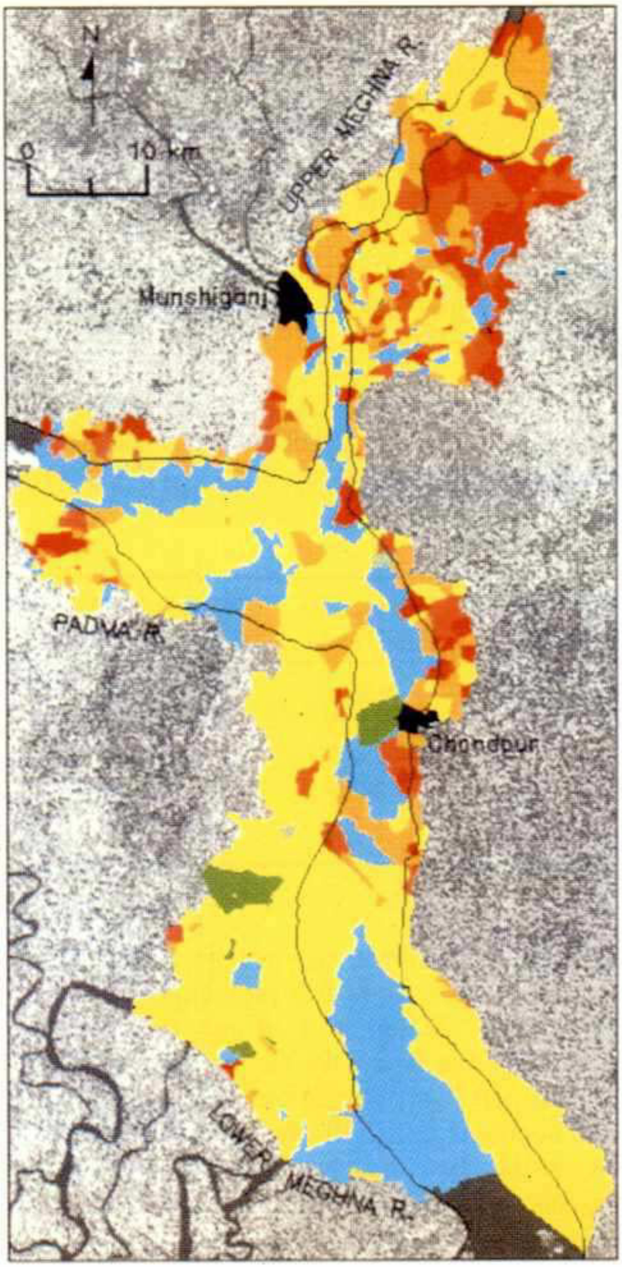
Figure 3.24

to plentiful grazing and more cultivable land per capita. In the large mauzas of the confluence and lower reach attached chars, where cattle ownership is low, either the inventory under-recorded livestock or the uncertainties of seasonal flooding constrain large livestock numbers. Local assessment of arrangements for safeguarding livestock in floods, of seasonal livestock numbers, and distributions is needed for planning cattle shelters in the Meghna charlands. Such measures might be beneficial in the upper reach, where there is a low risk of erosion and a lack of dry land to shelter cattle in floods was reported to be a problem (RRA surveys), but more detailed study is needed in the confluence, where other factors may constrain livestock enterprises.

The distribution of sheep, goats, and other small stock differs from that of large livestock. Tables B.41, B.42, and B.43 show a marked north-south trend: more than 2 animals per household in the upper reach, 0.8 per household in the confluence, and 0.3 in the lower reach. Figure 3.25 shows that concentrations of small stock (more than 200 per km^2, colored pink and red) are restricted to the detached mainland and east bank in the upper reach and to the east bank of the confluence. Although these areas also had the highest population densities in 1993. Only in the upper reach is there an average of more than one animal per household, which is higher than the national average. Grazing resources appear to be particularly under used in the lower reach, where there are few small stock.

Poultry numbers in the area are reported to be just over two birds per household, lower than the national average (Table 3.15). Poultry ownership per household is reported to be low throughout the area, but is somewhat higher in the upper reach, mainly in detached mainland (orange and pink in Figure 3.26). There appears to be very low ownership in the lower reach (Tables B.44 and B.45).

DENSITY OF SMALL LIVESTOCK TO LAND AREA



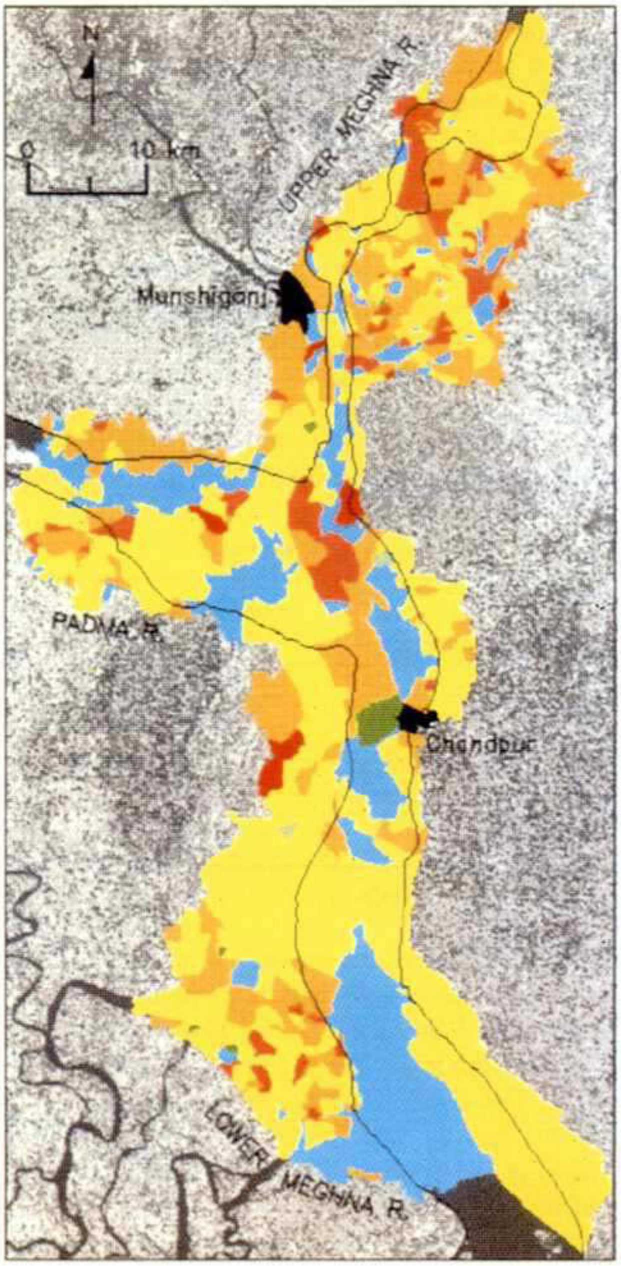
ANIMALS PER SQ. KM DRY SEASON LAND

- Uninhabited
- 0
- 1-100
- 101-200
- 201-350
- GT 350
- No Data recorded
- Bankline, 1993

Source: ISPAN, 1993 Field data and Satellite image data

Figure 3.25

NUMBERS OF POULTRY PER HOUSEHOLD



POULTRY PER HOUSEHOLD

- Uninhabited
- No Poultry
- ≤ 2
- 2.1-5
- 5.1-10
- GT 10
- No Data recorded
- Bankline, 1993

Source: ISPAN, 1993 Field data

Figure 3.26

3.5.4 Boat Availability

Small, non-mechanized boats are a vital household resource in the char areas, both as a means of transport in the monsoon and a means of saving life and property in severe floods. FAP 14 found that 26 percent of households in a sample of char villages took shelter on boats during a severe flood (FAP 14, 1992). Figure 3.21 shows that, although it is rare for every household in a mauza to own a boat, there is a high level of boat ownership in the Meghna study area. The highest ownership (dark red) is concentrated along the main channel in the upper reach. Non-mechanized boats include "country boats", which operate as commercial cargo carriers, but the majority in this category are small boats for household use. It is possible that the number of the smallest boats, dinghies, has been underestimated in this survey. The study survey found that there are eight households per non-mechanized boat (Table 3.15). Boat ownership is highest in the upper reach and lowest in the lower reach. The east bank unprotected mainland in all reaches has by far the lowest boat ownership, averaging 25 households per boat (Tables B.46 and B.47).

Table 3.15 Boat Availability

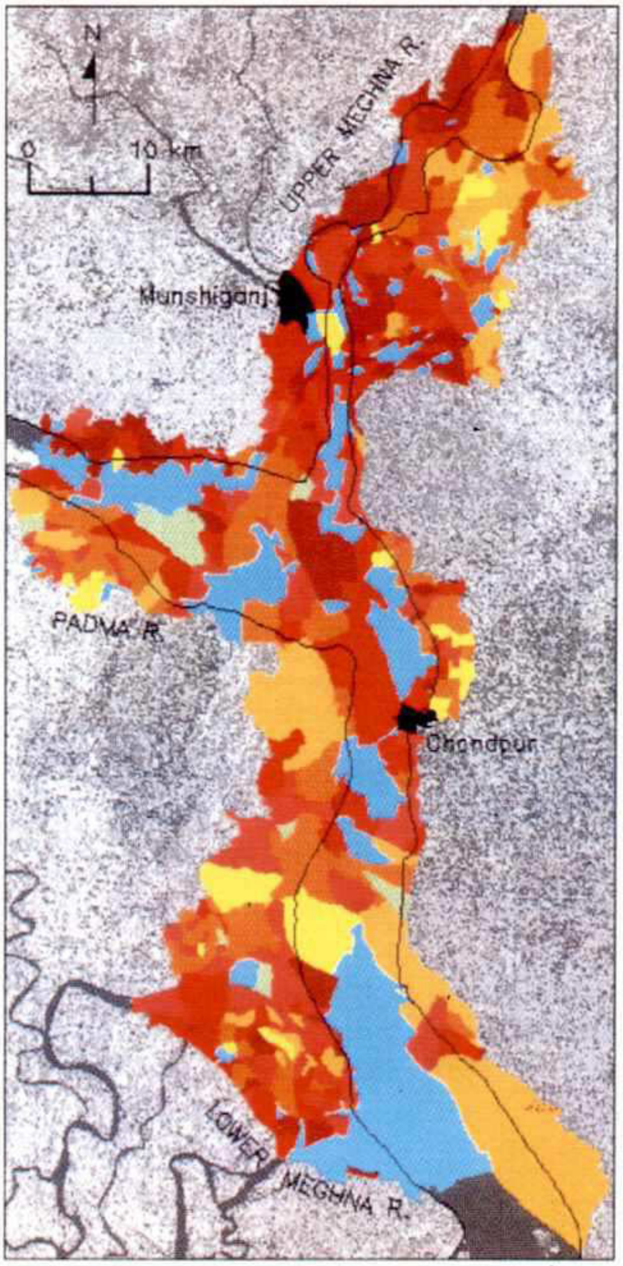
Land Category	Non-mechanized Boats (no.)	Households Per Non-mechanized Boat	Mechanized Boats (no.)	Households Per Mechanized Boat
Island Char	7,538	6	1,015	43
Attached Char	5,204	9	725	63
Detached Mainland	3,418	8	408	64
Unprotected Mainland	6,193	11	1,019	66
Total	22,353	8	3,167	58

Source: Tables B.46 to B.49

Although boats are a source of employment for very few of the study area households, since the late 1980s mechanized boats have become increasingly important as a means of transport in riverine areas, including the Meghna (Charland Study RRA surveys). These boats have helped improve the reliability of communications to marketplaces and the mainland, and they are the main means of speedy evacuation of people, livestock, and property when erosion or severe floods strike. Figure 3.28 shows that mechanized boats are widespread throughout the study area, but with more households per boat in the upper reach and fewer along the main Meghna channel (red). There are more mechanized boats on island chars than other areas (43 households per boat; Table 3.15), and more in the upper reach than in the confluence or lower reach (47 households per boat). The lowest ownership is in the east bank mainland at the confluence (Tables B.48 and B.49) where most boats may be based in Chandpur and Matlab, which were excluded from the survey.

Figure 3.28 highlights areas, such as the island chars in the lower reach, where there could be a shortage of boats in a severe flood. Although in normal monsoons there may not be a need for boats, in a severe flood this area might be less well adjusted. Along most of the river local mechanized boats now have the potential to provide transport and evacuation services during severe floods, especially if these privately owned boats can be contracted by local government to assist the poorest households, which may be unable to afford to evacuate, as well as to carry medical and relief services and supplies.

HOUSEHOLDS PER NON-MECHANIZED BOAT

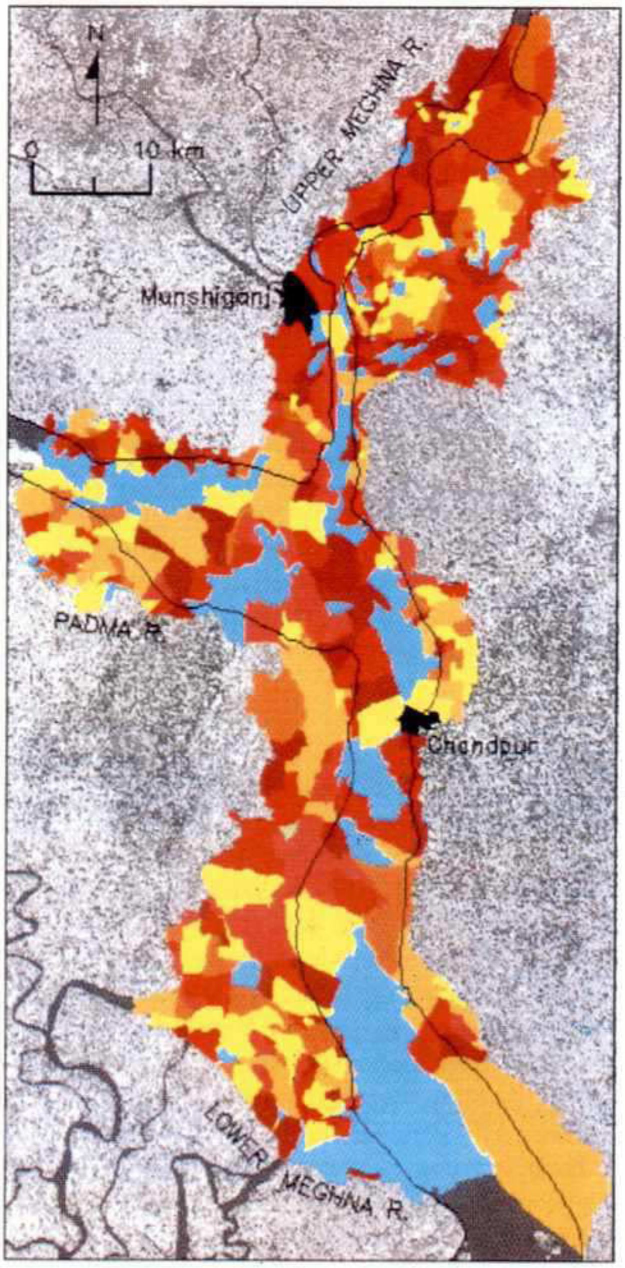


- Uninhabited
- 1-3
- 4-7
- 8-15
- 16-40
- GT 40
- No Boat
- No Data recorded
- Bankline, 1993

Source: ISPAN, 1993 Field data

Figure 3.27

HOUSEHOLDS PER MECHANIZED BOAT



- Uninhabited
- 1-20
- 21-50
- 51-100
- 101-200
- GT 200
- No Boat
- No Data recorded
- Bankline, 1993

Source: ISPAN, 1993 Field data

Figure 3.28

29

3.5.5 Social Conflict

The dynamism of charlands, where the chief economic resource—land—is constantly changing under the influence of erosion and accretion, brings with it the potential for considerable social friction. Past studies of the Jamuna and Lower Meghna char areas have found the combination of changes in land and movements of people to be a potent source of social conflict (Elahi *et al.*, 1991; Adnan, 1976; Zaman, 1989).

Although people may be unwilling to discuss land disputes, questions about disputes over allocation of newly accreted or re-emerged land were included in the inventory (for example, cases where a local informal court, called a *salish*, was involved). The inventory found that 58 percent of inhabited mauzas had experienced such land disputes, although in most cases (52 percent of mauzas with disputes) there have been fewer than one a year, and in only 11 percent of all mauzas were there reported to have been many disputes.

Disputes were concentrated in the Lower Meghna, where 84 percent of mauzas reported conflicts compared with only 36 percent in the Upper Meghna and 67 percent in the confluence (Table B.35). This is directly related to the extent of erosion and within-bankline changes in the confluence and lower reach and the lack of accretion in the upper reach (Chapter 2). It is not a consequence of population pressure; the highest population densities are in the upper reach. A high percentage of disputes involved violence (74 percent of mauzas with disputes).[5] Table 3.16 compares the severity of disputes in the whole study area and the Lower Meghna island chars, where 98 percent of mauzas experienced land disputes. In this area (mainly in Hizla) there reportedly has been considerable land-grabbing and disputes with outsiders. These problems may be continuing, since Section 3.3 showed that there was sizable in- and out-migration there in 1992.

These findings are consistent with past studies indicating that the estuarine chars have been the scene of violent land disputes. Land disputes are also not uncommon in the upper reach, where there has been little accretion. There, the disputes may arise when small areas accrete where there previously was no owned land, and hence no claim to it. Such may also be the case in some lower reach chars. Most of the confluence area, on the other hand, has been land at some time, so informal land allocation mechanisms might be expected to function there. The evidence is that disputes are still common. Further study would be needed to establish the present extent of these problems, but they imply that any development programs or flood proofing measures would need to be carefully planned to avoid being undermined by conflicts.

Land disputes often arise where mauza boundaries are unclear, and even where thana and district boundaries meet, so the extent to which char people have access to the local power structure and administration may be important (see Section 3.4.4).

Table 3.16 Land Dispute Incidence

	Percent of Inhabited Mauzas*	
Type of Dispute	Study Area	Lower Meghna Island Char
Any Dispute	58	98
Outsider Involvement	29	69
Violence	42	51
Deaths	10	14
Number of Mauzas	511	84

Source: FAP 16 inventory
*Information covers recent years.

HAZARDS

3.6 Hazards

3.6.1 Health Hazards and Loss of Life

Disease, in epidemic form, has been the main cause of human death among the hazards investigated. Averaged over five years the incidence of epidemic deaths every year is 38 per 100,000 people compared with 57 per 100,000 people in the 1988 flood. Informants were asked for the number of deaths from a variety of hazards in the past five years. The predominant hazards resulting in death are mapped in Figure 3.29. They include: the 1988 flood, epidemic disease since 1988, flooding after 1988, tornados/cyclones, and "famine." The causes of death shown in Figure 3.29 exclude deaths by natural causes and are based on the period 1988-92. The "other" category mainly includes the few deaths attributed to erosion, which may be difficult to separate from flood-related deaths. Cyclones and tornados appear to kill few people, and have been significant only in the lower reach island chars. There have been very few deaths due to flooding since 1988 (limited to the boundary with the Padma study area); while the few mauzas where famine was reported may have referred to food shortages in 1988.

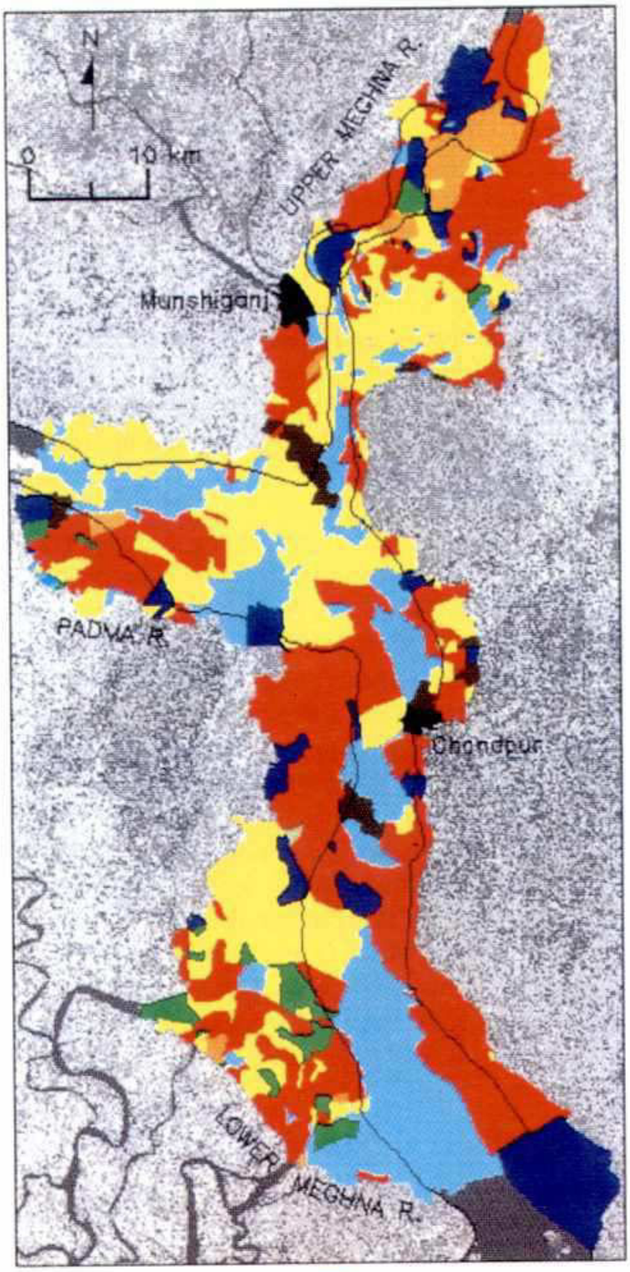
The number of deaths attributed to the 1988 flood are shown separately in Figure 3.30. Those 664 deaths were concentrated in the upper reach on island chars, but some were also on detached mainland and unprotected mainland (Figure 3.30; Table B.50). In addition, there is a band of mauzas with flood deaths stretching from the west bank attached chars of the confluence to the east bank attached chars of the lower reach, which is consistent with a trend toward more severe flooding in these mauzas (see Sections 3.6.2 and 3.6.3). Relative to the 1993 population (since the 1988 population is unknown), reported death rates were highest in the upper and lower reaches: 73 and 77 deaths per 100,000 people, respectively (Table B.51). By comparison 26 deaths per 100,000 were reported in the confluence. Figure 3.30 highlights (red) a small number of mauzas where improvements in flood warning and response, including flood shelters, might have saved lives. Detailed local study is needed to discover the reasons for these deaths and whether such measures are needed now.

Deaths reported from epidemic outbreaks of disease have been much more widespread, with more of them occurring in the unprotected mainland and in the upper reach (Figure 3.29; Tables B.52 and B.53). In mauzas where there were both disease deaths and 1988 flood deaths, particularly in the confluence and lower reach, disease deaths were higher. Despite the fact that many island char mauzas report deaths from epidemic disease, there are fewer such deaths per 100,000 people than in other land types.

These hazard-related deaths are only a fraction of the overall crude death rate (natural causes plus hazards), which was 11.5 deaths per 1,000 people in rural areas in 1991 (BBS, 1993). Therefore, the number of lives that can be saved by improving basic health care is likely to be greater than can be achieved by providing flood shelters. One component of flood-time health protection must be to prevent the widespread ill effects of drinking river water (see Section 3.4.3).

200

HUMAN DEATHS BY PRE-DOMINANT HAZARD TYPE

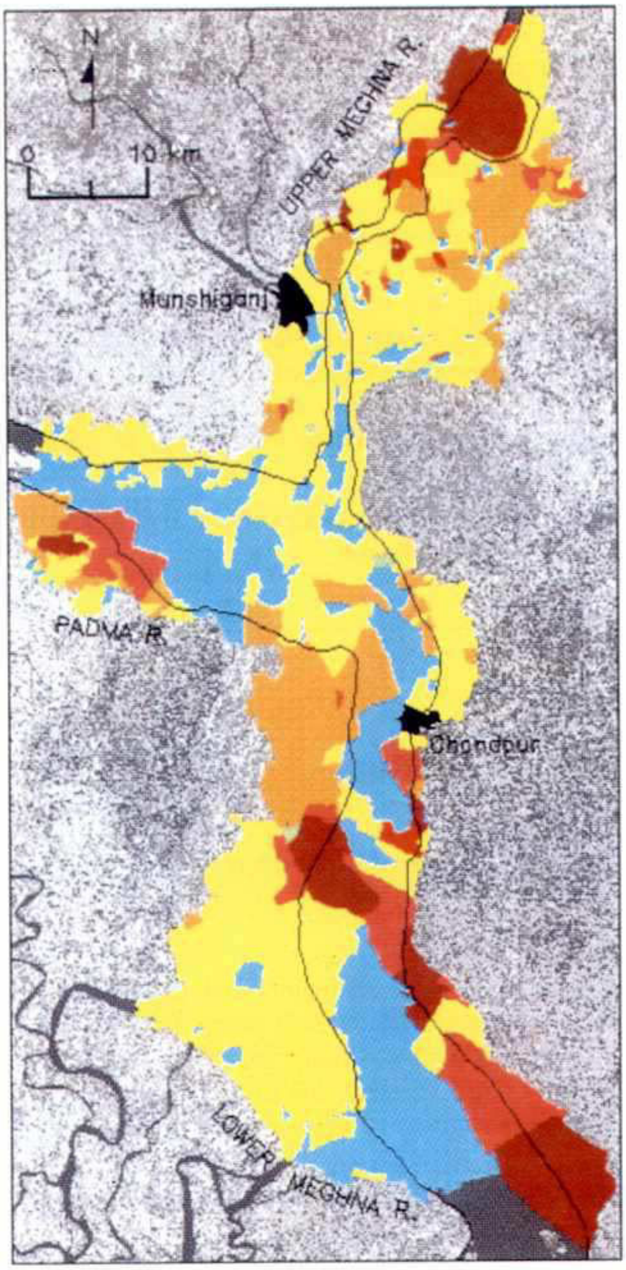


Source: ISPAN, 1993 Field data

- Uninhabited
- No Death
- 1988 Flood
- Flood after 1988
- Cyclone/Tornado
- Famine
- Disease
- Others
- No Data recorded
- Bankline, 1993

Figure 3.29

DEATHS DUE TO 1988 FLOODING



Source: ISPAN, 1993 Field data

- Uninhabited
- No Death
- 1-3
- 4-6
- 7-8
- ≥ 9
- No Data recorded
- Bankline, 1993

Figure 3.30

3.6.2 Recent Flood Experience

Estimates of flood extent and duration were collected in each mauza for each year from 1987 to 1992, a period that spans two high flood years (1987 and 1988), three more normal years (1989-91), and a low flow year (1992): Knowing the extent of flooding, it is possible to estimate the population that may have been affected by these floods. It also allows quantification of the normal extent of monsoon inundation and its influence on agriculture. Flooding duration is equally important in assessing the severity of the event, since it indicates the length of time that people may be marooned on, or evacuated to, embankments and higher land. In order to standardize the inventory estimates key informants were asked to estimate the percentage of cultivable land under water at the peak water level in each year, and the number of days that land was under water (these estimates may be more variable due to differences in interpretation). In some mauzas informants apparently could not estimate flooding duration, probably because variations in land level created an uneven flooding duration pattern. Separate estimates were made of the incidence of homestead flooding (Section 3.6.3).

Table 3.17 Percentage of Cultivable Land Flooded by Reach

Reach	1987	1988	1991	1989-92*
Upper	84	100	73	68
Confluence	81	99	66	61
Lower	52	61	47	41
Total	72	87	62	57

Source: Tables B.54, B.56, B.58, B.60
*Mean over four years.

The number of uninhabited mauzas (pale blue) changes from year to year. For example, more were uninhabited in 1987 and 1988 than in 1993. Since the absence of people generally correlates with submergence, these mauzas were already under water during the flood season in the relevant years and therefore do not figure in the flooding data.

Figure 3.31 shows that in 1987 the most extensively flooded areas were in the upper reach, particularly on the west bank and island chars (89 percent or more flooded on average, Table B.54), and on the east bank of the lower reach. Overall in that year, 66 percent of cultivable land was under water, but the few inhabited island char mauzas in the confluence were less affected (30 percent flooded on average), and the large island char in Hizla in the lower reach was not flooded at all. Table 3.17 shows that the mean percentage of flooded land declined gradually from the upper to the lower reach.

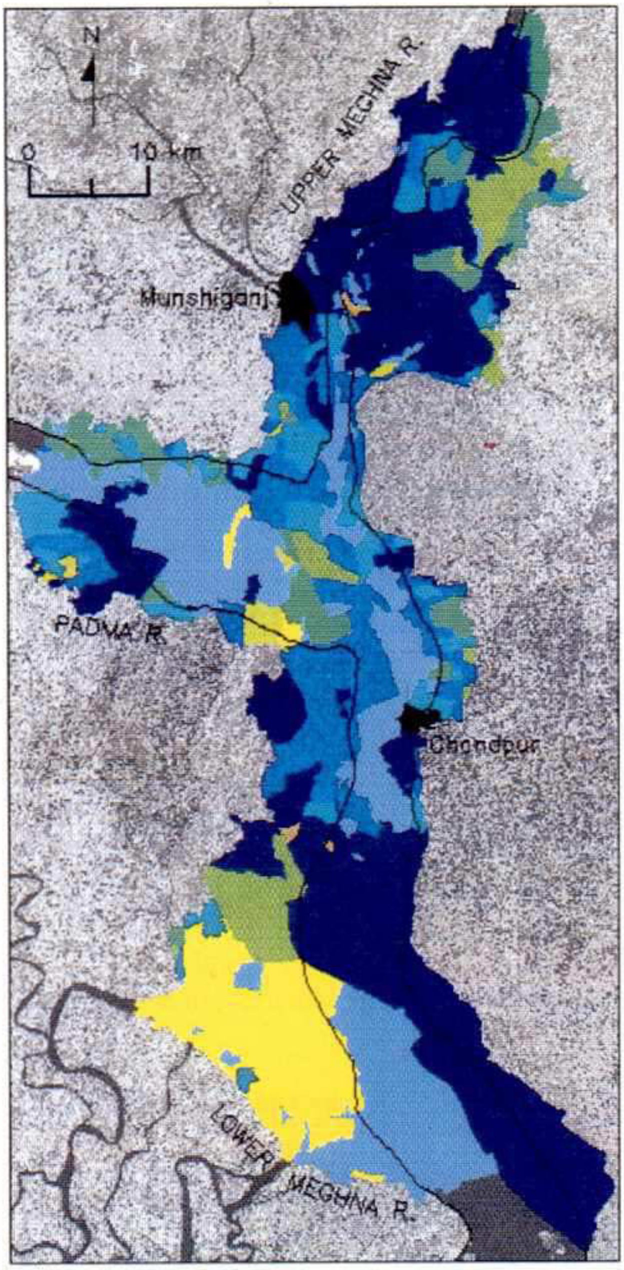
The north-south trend is even more apparent for duration of flooding in 1987. Figure 3.32 shows that mauzas where the flood lasted more than 40 days (dark blue) are concentrated within the banks and western mainland of the upper reach. The west bank unprotected mainland and the attached chars of the upper reach are the only areas that averaged more than 100 days flooding duration. Although east bank attached chars were extensively flooded in 1987 the duration was shorter, lasting just over a month (Table B.55). Average durations were very low in the lower reach because most island char mauzas were not flooded and this has been counted as zero days

Table 3.18 Duration of Flood by Reach (days)

Reach	1987	1988	1991	1989-92*
Upper	72	86	60	59
Confluence	40	40	29	32
Lower	13	16	11	10
Total	48	56	37	37

Source: Tables B.55, B.57, B.59, B.61
*Mean over four years.

PEAK FLOOD EXTENT 1987

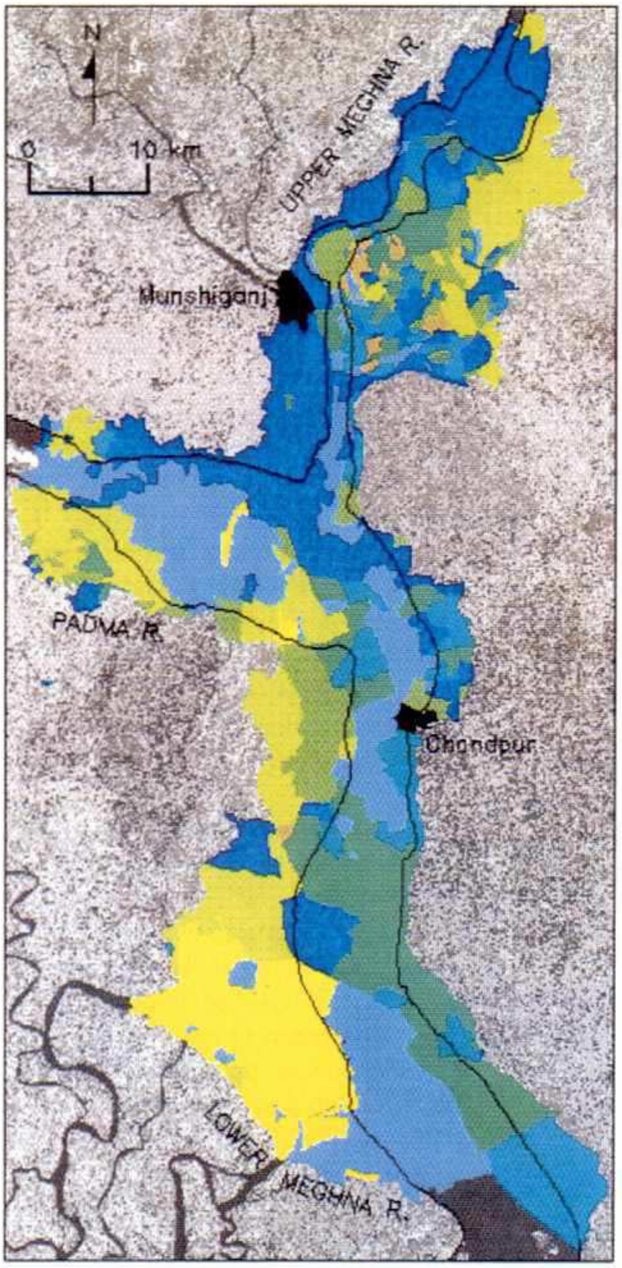


- Uninhabited
- No Flood
- 1-20%
- 21-40%
- 41-60%
- 61-80%
- 81-99%
- 100%
- No Data recorded
- Bankline, 1993

Source: ISPAN, 1993 Field data

Figure 3.31

PEAK FLOOD DURATION 1987



- Uninhabited
- No Flood
- 1-10 days
- 11-20 days
- 21-30 days
- 31-40 days
- GT 40 days
- No Data recorded
- Bankline, 1993

Source: ISPAN, 1993 Field data

Figure 3.32

Table 3.19 Percentage of Cultivable Land Flooded by Char Type

Char Type	1987	1988	1991	1989-92*
Island Char	44	57	39	39
Attached Char	85	99	74	68
Detached Mainland	78	100	67	57
Unprotected Mainland	84	99	73	64
Total	72	87	62	57

Source: Tables B.54, B.56, B.58, B.60
*Mean over four years.

duration. Despite differences in duration for areas reporting similar percentages of land flooded, overall flood duration in 1987, and in other years, correlates with the extent of flooding. Table 3.18 shows a stronger decline for duration than for extent between upper and lower reaches: average duration in the upper reach was about 2.5 months, in the lower reach it was only two weeks. Duration showed the greatest spread in the upper reach, although the detached mainland was extensively flooded; reported durations averaged only 27 days.

Figure 3.33 shows that virtually all cultivable land in the study area was flooded in 1988. The only exception was Hizla, where most mauzas reported no flooding (colored yellow). On average, then, only about 21 percent of island char land in the lower reach was reported flooded (Table B.56). This large difference in reported flood experience is presumably correct. Although the data reported in this section required that key informants recall flooding patterns over a period of six years, memories of the 1988 flood appear still to be clear. The island char of Hizla, therefore, can be termed flood-free (although Figure 3.29 showed that it had suffered a tornado or cyclone between 1988 and 1992), and flood proofing measures may be unnecessary for this area.

Figure 3.34 shows that flood durations were longer in the upper reach in 1988. The duration differences are larger than in 1987: the upper reach had a mean duration of 86 days, more than five times the average duration in the lower reach, where even in the badly flooded eastern bank flooding lasted just over 40 days (Table B.57). Durations appear to be slightly shorter to the south and west of the confluence.

The RRA found that key informants considered 1991 a normal to slightly above normal flood year. Flood extent for the whole study area that year averaged only slightly more than for 1989-92, while duration averaged the same as in 1989-92. Parts of the mainland in the upper reach and some island and attached chars in the confluence were not flooded in 1991. Although Table 3.19 shows flooding in island chars was much less extensive than in other land types, in 1991, as in other years, this is biased by the flood-free island in Hizla. In the upper reach, island chars were the most flooded land type in 1991 (94 percent of area flooded, Table B.58).

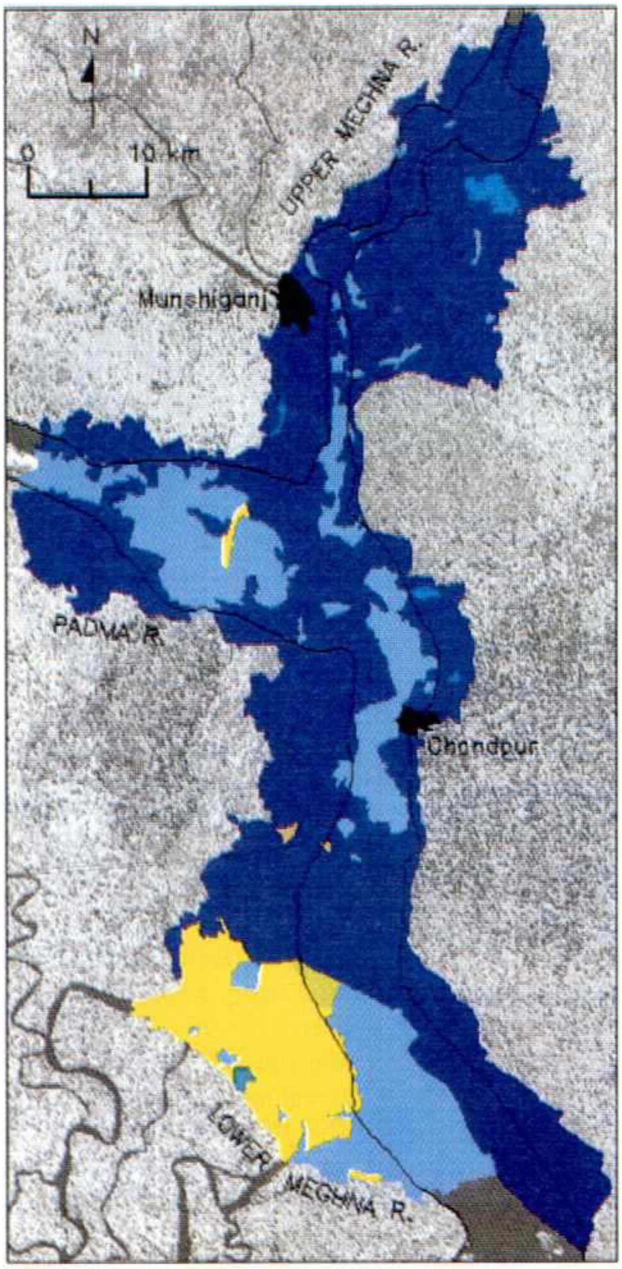
Flood duration in 1991 was about 25 percent shorter than reported in 1987 and 34 percent shorter than in 1988 (Tables 3.20 and B.59). There were longer durations of normal flooding in

Table 3.20 Duration of Flood by Char Type (days)

Char Type	1987	1988	1991	1989-92*
Island Char	37	42	26	28
Attached Char	50	60	41	40
Detached Mainland	27	41	16	14
Unprotected Mainland	66	74	50	51
Total	48	56	37	37

Source: Tables B.55, B.57, B.59, B.61
*Mean over four years.

PEAK FLOOD EXTENT 1988

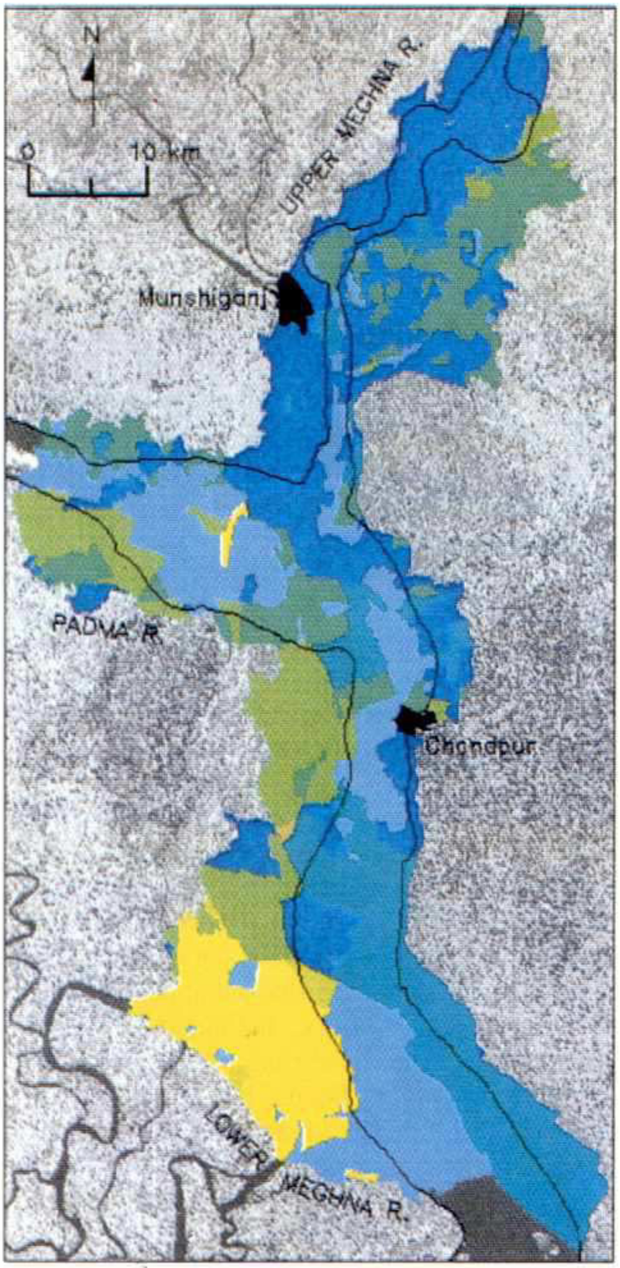


Uninhabited
No Flood
1-20%
21-40%
41-60%
61-80%
81-99%
100%
No Data recorded
Bankline, 1993

Source: ISPAN, 1993 Field data

Figure 3.33

PEAK FLOOD DURATION 1988



Uninhabited
No Flood
1-10 days
11-20 days
21-30 days
31-40 days
GT 40 days
No Data recorded
Bankline, 1993

Source: ISPAN, 1993 Field data

Figure 3.34

the channel and west bank in the upper reach, and on the west bank south of Munshiganj.

Average flood extent and duration for 1989 to 1992 should be a good indication of normal monsoon conditions, since these were not severe or unusual flood years for the Meghna. Extensive flooding of cultivable land is normal in the island chars, west bank mainland, and southern part of the detached mainland in the upper reach (dark blue in Figure 3.35). Flood durations in this reach are much lower in the detached mainland and east side of the channel than on the west side, implying that land levels are somewhat higher. Data are lacking for many of the detached mainland mauzas (colored sandy-fawn) where variation in land levels may make a mauza average difficult to estimate. Although mainland and attached chars in Munshiganj District are less extensively flooded, durations were more than 40 days (dark blue in Figure 3.36), again indicating deeply flooded areas. In the confluence and lower reach mauzas outside the bankline (mainly attached chars and unprotected mainland) flood duration, but not extent, appears to be shorter than in the adjacent island chars (Figure 3.36; Tables B.60 and B.61).

The 1989-92 flood averages are appropriate benchmarks against which to assess the severity of the 1987 and 1988 floods. Tables 3.17 and 3.19 show that in normal conditions 57 percent of study area cultivable land is under water in the monsoon, but the area of cultivable land flooded at peak level in 1987 was 26 percent higher, and in 1988 it was 53 percent higher. The island chars were least affected by the two severe floods, but this is because Hizla was not flooded in either 1987 or 1988. Detached mainland was most affected in 1988 (75 percent greater area flooded than normal), but in 1987 the increase in flood extent was about 31 percent in both detached and unprotected mainland. The confluence was hardest hit in 1987 and 1988. In 1987, 33 percent more land was inundated than in the 1989-92 average, and in 1988, 62 percent more was flooded. The upper reach, then, is normally extensively flooded, but in a severe flood the higher parts of the detached mainland and east bank are affected. Meanwhile, in the Padma-Meghna confluence, which received the peak flows from the Ganges and Brahmaputra, severe floods in 1987 and 1988 affected many areas that have not been inundated since. In the Lower Meghna the wide estuarine formation diminishes the extent of the same floods.

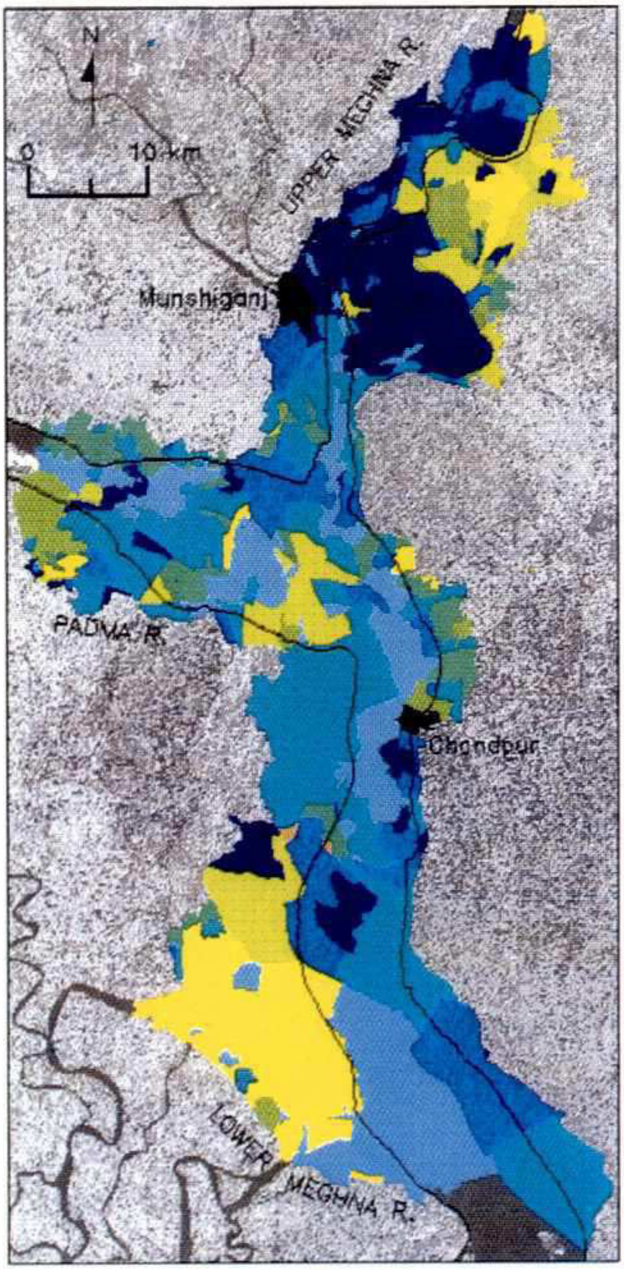
Flood duration during the 1987 and 1988 floods increased by percentages similar to those for extent in comparison with the 1989-92 averages. Tables 3.18 and 3.20 show that mean duration was 30 percent longer in 1987 and 51 percent longer in 1988. Average duration was longer (by about 20 percent) in 1988 than in 1987 in both the upper and lower reaches, but it remained about the same in the confluence in both years.

If it is assumed that agriculture and the charland economy are adjusted to normal monsoon conditions, and that the flooding averages for 1989-92 are that norm, then a comparison of Figures 3.31 through 3.34 with 3.35 and 3.36 shows the areas that are likely to have suffered the most crop damage. If the 1987 or 1988 maps show a darker/higher color in the scale of yellow through blue, then flood extent, flood duration, or both were greater than normal.

Homesteads in the Meghna area are typically raised above normal flood levels, and in the RRA surveys it appeared that 1991 was close to flooding homes, but at least in the Upper Meghna did not cause much damage or flood many houses. The increment in duration between 1989-92 conditions and 1987 and 1988 is an indication of the duration of homestead flooding (although not necessarily of within-house flooding). The maps in this case show that the duration of homestead flooding could have been less than two weeks in 1987 and almost three weeks in 1988.

FAP 25 flood frequency analysis is available for two gauging stations on the Meghna: the Meghna Ferry Ghat, which is in the upper reach adjacent to the southern end of the area of detached mainland, and Chandpur on the eastern boundary of the confluence and lower reaches (FAP 25, 1992). Unfortunately for this study, FAP 25 did not

AVERAGE PEAK FLOOD EXTENT 1989-92

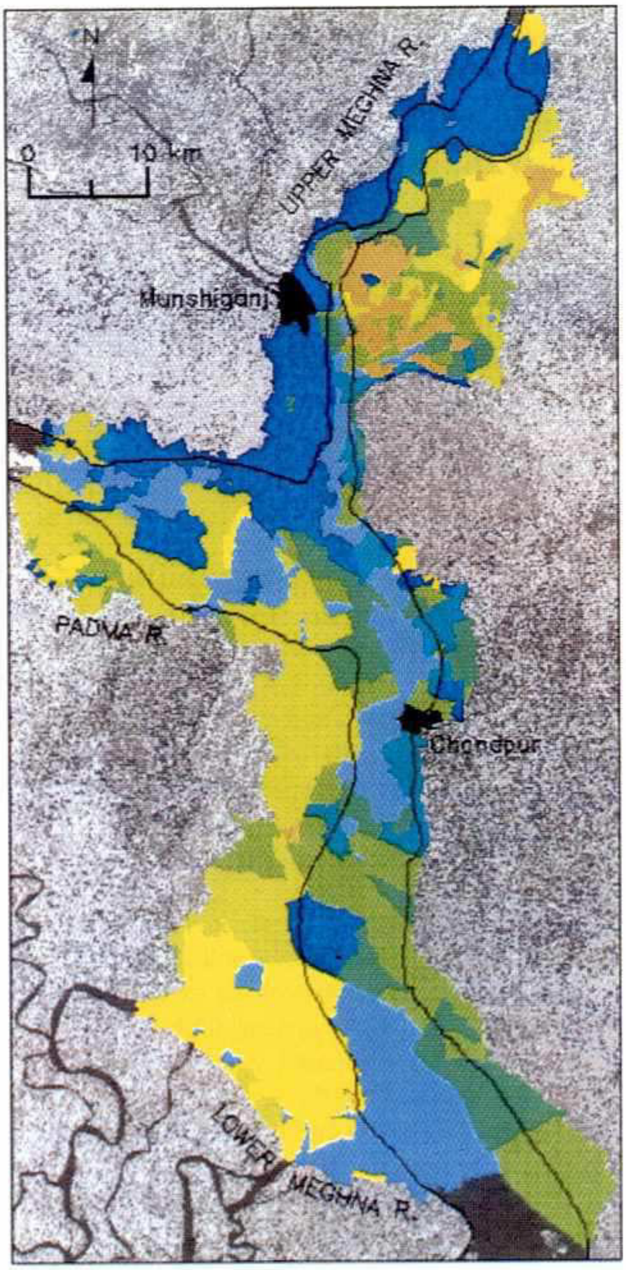


- Uninhabited
- No Flood
- 1-20%
- 21-40%
- 41-60%
- 61-80%
- 81-99%
- 100%
- No Data recorded
- Bankline, 1993

Source: ISPAN, 1993 Field data

Figure 3.35

AVERAGE PEAK FLOOD DURATION 1989-92



- Uninhabited
- No Flood
- 1-10 days
- 11-20 days
- 21-30 days
- 31-40 days
- GT 40 days
- No Data recorded
- Bankline, 1993

Source: ISPAN, 1993 Field data

Figure 3.36

Table 3.21 **Return Periods of Meghna Floods**

	Meghna Ferry Ghat		Chandpur	
Year	level (m)	RP* (years)	level (m)	RP (years)
1987	5.98	5.61	4.50	2.02
1988	6.53	32.97	4.99	31.48
1989	5.14	1.16	4.29	1.28
1990	5.12	1.1	4.32	1.3
1991	5.48	1.8	4.49	2.0

Source: 1987-89 FAP 25 (1992) Appendix 6; 1990 and 1991 FAP 25 unpublished data derived from BWDB gauging stations.
*Return Period; 5.61, for example, indicates a 1-in-5.61-year flood. Return periods for 1990 and 1991 are estimated from probability plots in FAP 25 (1992).

undertake flood frequency analysis any farther south in the Meghna. Table 3.21 lists the frequency of flood peaks estimated by FAP 25 and shows that the 1987 flood was moderate, having a return period of about 1-in-5 years in the upper reach but only 1-in-2 years in the confluence. The 1988 flood, on the other hand, was severe. Floods since 1988 have been more on the order of normal monsoon inundation.

The inventory reports from 1988 are consistent with the severity of the flood shown in Table 3.21, but inventory reports of the extent and duration of flooding in 1987 appear high for a 1-in-2-year event when compared with the 1989-92 average. This implies that there are only small differences in land elevation and that in the confluence a 1-in-2-year event is sufficient to result in the inundation of 15 percent more cultivable land than normal. Such an event also increases the average duration of inundation of all flooded land by about a week. Although the 1988 flood was extreme in terms of flood level, the high flood peak appeared to result in a relatively small increase in duration of inundation in the confluence compared with the upper reach (where the 1988 return period further upstream at Bhairab Bazaar was a 1-in-43-year event).

302

3.6.3 Flood Impacts on Housing

A homestead's vulnerability to flooding depends in part on its structure. Both the materials a house is made of and the level of its floor and plinth (foundation) in relation to flooding levels are important factors. For this study house construction was categorized as either *kutcha* (made of straw, jute sticks, grasses, and/or bamboo) or *pucca* (made of corrugated iron sheets, bricks, or concrete). In the Meghna study area very few *pucca* houses are constructed of brick or concrete, most were made either entirely of corrugated and galvanized iron (CI sheets) or had CI roofs and *kutcha* walls. Better construction generally implies more resources and indicates a household that may be able to support itself during a severe flood despite the lack of daily work and damage or destruction of crops. These households also may have spent more to raise their homes above flood levels, and their homes may be more strongly constructed and therefore less likely to collapse in a flood.

Thirty-seven percent of houses in the study area are reportedly all *kutcha* (Tables 3.22 and B.62). Many fewer houses have CI sheets in their construction in the confluence and lower reach island chars and west bank than in other areas. Figure 3.37 shows that mauzas having less than 50 percent of houses using some CI sheet construction (orange and pink) are concentrated in the more dynamic and recently settled confluence and lower reach mauzas. There are mostly CI or partly CI houses (red and dark red) in the stable areas of the upper reach and east bank mainland and attached chars, as well as on the mainland north of the confluence. Age of settlement may be as important as land productivity in affecting house construction since in Hizla, where in-migration is continuing, there are fewer CI sheet houses, yet Section 3.5.2 showed that the area has relatively intensive cultivation.

Table 3.22 Percentage of All-*Kutcha* Houses by Char Type

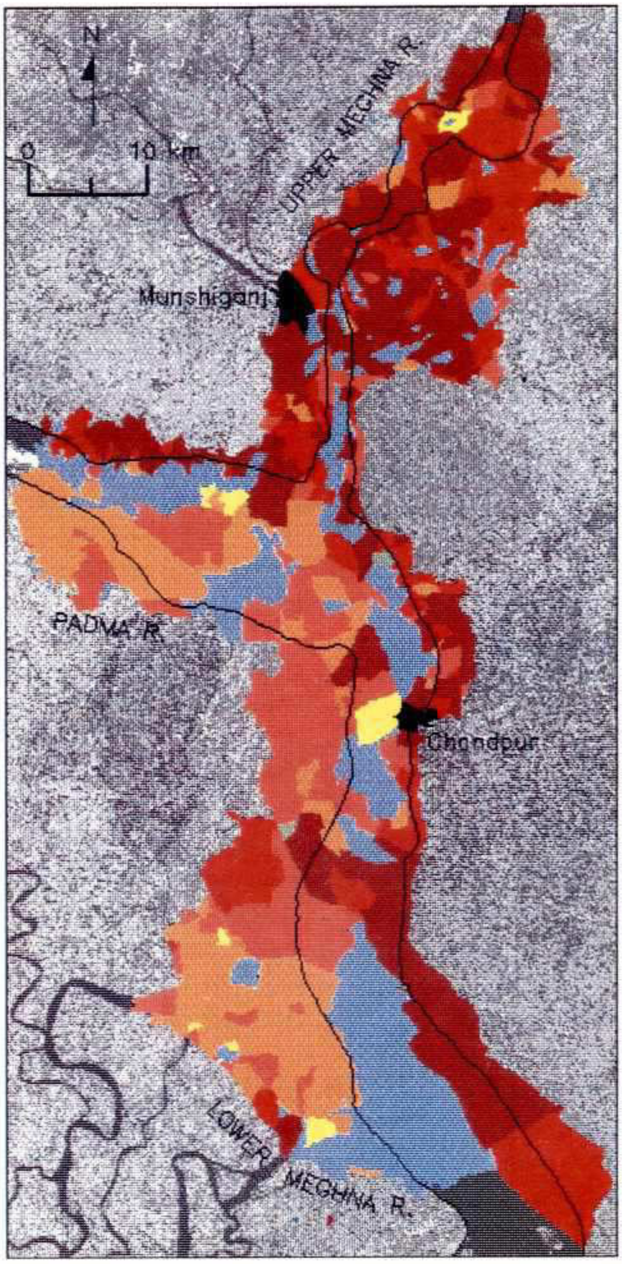
Char Type	Percentage *Kutcha*
Island Char	52
Attached Char	40
Detached Mainland	23
Unprotected Mainland	30
Total	37

Source: Table B.62

Another factor affecting homestead flood vulnerability is the security of its tenure. Temporary houses are likely to be less substantial, their residents to be poorer and economically and socially dependent on others. Such households will face greater hardships during times of stress (such as floods). Figure 3.38 shows that households taking shelter in 1993 either on other people's land or on public land were virtually absent from the Upper Meghna but were concentrated in the confluence and in Hizla. The island chars of the confluence are very dynamic and there has been considerable bank erosion since 1984, which explains the local concentrations of people sheltering without their own homestead land. The RRA of this area found that entire villages in this area may shift when their land is submerged, taking up residence nearby to wait until it reappears. Chapter 2 and Section 3.3 have previously shown that in Hizla there has been bank erosion and consolidation of the large island char, and that there was considerable in- and out-migration in 1992. Households sheltered there, then, may be doing so in response to past bank erosion and with the hope of acquiring access to land. An added attraction of this area is its apparent lack of flood risk (Section 3.6.2).

While houses are not usually moved in floods, people and possessions are often moved to higher places when flooding is severe. To do this effectively sufficient warning is needed. The RRAs found that in past floods people most often reacted according to observations of rising flood water. Informants said radio broadcast information, while it was the preferred means of obtaining official warning, was often not relevant because it was not

HOUSE CONSTRUCTION



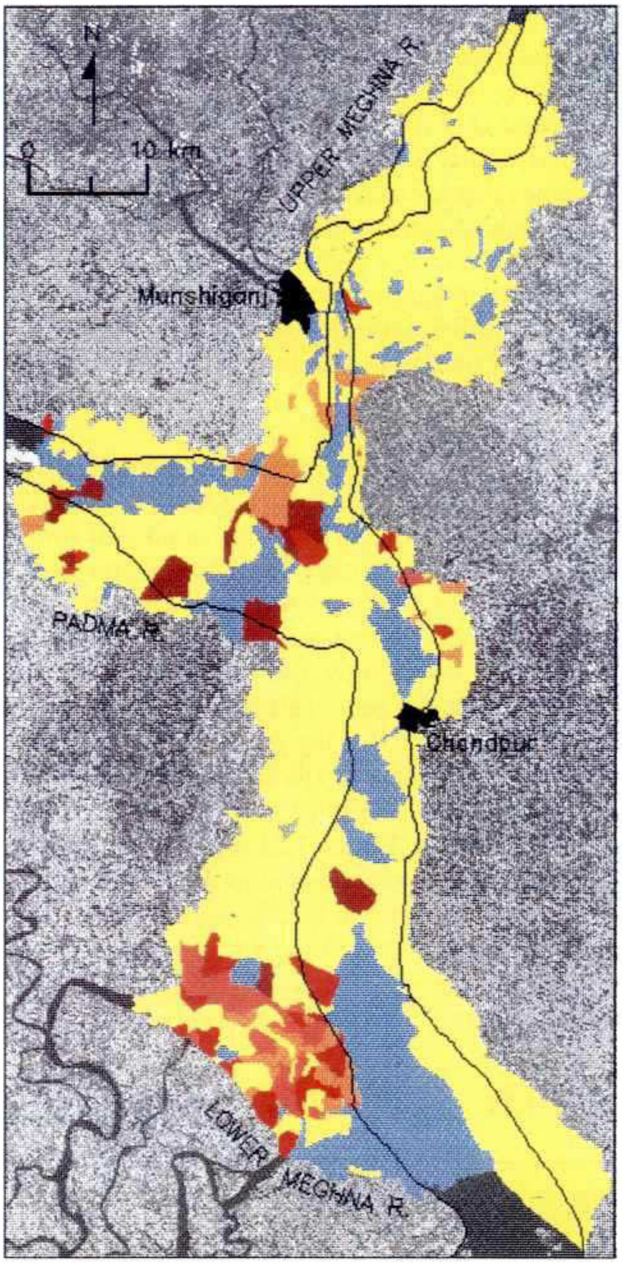
PROPORTION OF HOUSES WITH TIN OR BRICK IN CONSTRUCTION

- Uninhabited
- None
- 1-25%
- 26-50%
- 51-75%
- 76-100%
- No Data recorded
- Bankline, 1993

Source: ISPAN, 1993 Field data

Figure 3.37

HOUSEHOLDS SHELTERED IN MAUZA



PROPORTION OF HOUSEHOLDS SHELTERED ON PUBLIC OR OTHER PEOPLE'S LAND

- Uninhabited
- 0%
- 1-5%
- 6-10%
- 11-20%
- GT 20%
- No Data recorded
- Bankline, 1993

Source: ISPAN, 1993 Field data

Figure 3.38

specific to their location. Table B.63 shows that access to radios is reportedly good, an average of about one radio to eight households. More radios were reported in the Upper Meghna (six per household) than in the less severely flooded Lower Meghna (13 per household), but island char dwellers do not appear to be particularly disadvantaged. If timely warnings that are meaningful to people in the Meghna chars are broadcast by radio, therefore, there is a good chance that the messages will reach most people. Whether they can then save themselves and their property depends on the proximity of shelter and ease of access.

Table 3.23 Percentage of Houses Flooded by Year

Reach	1987	1988	1989-92*
Upper	70	97	7
Confluence	32	98	8
Lower	25	37	14
Total	48	82	9

Source: Tables B.64, B.66, B.68

*Mean percentage for four years, 1989-92.

The inventory obtained estimates of the percentage of houses flooded (above floor and above roof were collected separately but are combined in the maps) and the percentage of houses destroyed in each year from 1987 to 1992. In many cases part of a "destroyed" house may have been salvaged. In Tables B.64 to B.69 the reach and char type percentages have been calculated by weighting mauza percentages by the number of households present in the mauza in 1993. In 1987, 48 percent of all houses in the Meghna charlands were reportedly flooded, but Tables 3.21 and B.64 show that the situation was much worse in the Upper Meghna, where 70 percent of houses were flooded. The return period of the 1987 flood was probably more extreme in the upper reach compared with the lower. Figure 3.39 reveals a more complex pattern, which is consistent with the extent of flooding on agricultural land (Figure 3.31): high percentages of houses were flooded in 1987 in all char land types in the Upper Meghna, as well as in the east bank attached chars and unprotected mainland of the Lower Meghna. Fewer houses were flooded in the confluence, and none were flooded in the lower reach Hizla area (where even cultivable land was not flooded).

Table 3.24 Percentage of Houses Flooded to Roof

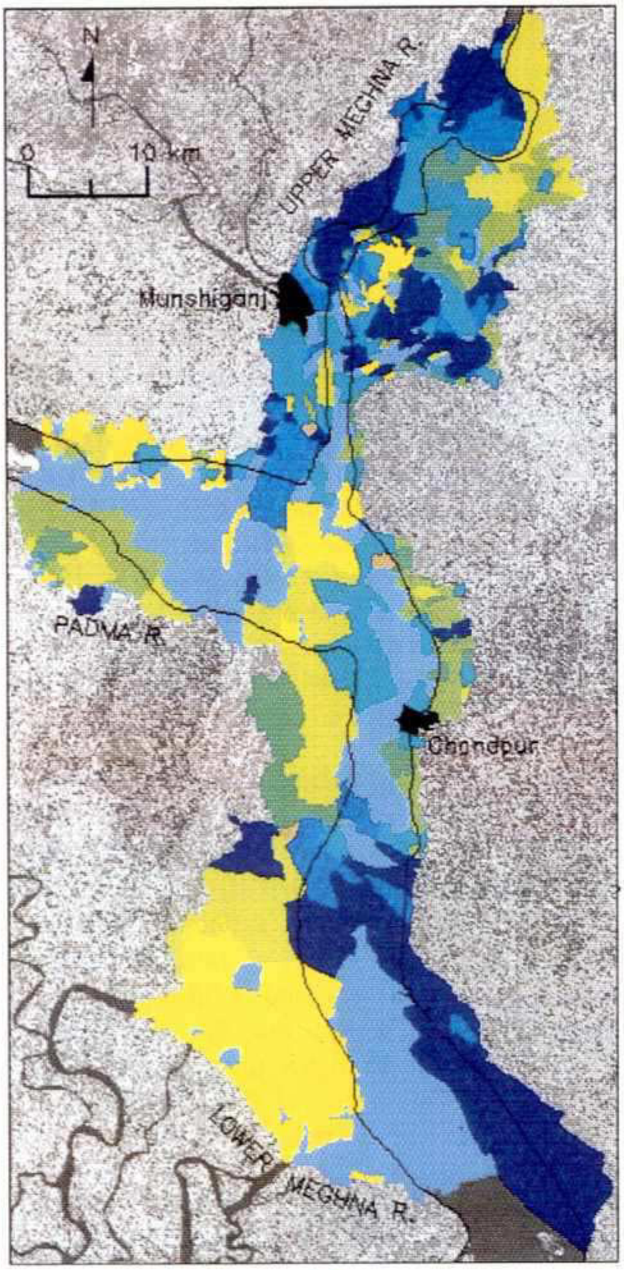
Reach	1987	1988	1989-92*
Upper	4	12	0
Confluence	2	8	0
Lower	4	6	2
Total	3	10	1

Source: FAP 16 Inventory

*Mean percentage for four years.

Although many houses were flooded in 1987, very few were flooded to the roof in any of the reaches (Table 3.24). Slightly more, 13 percent, were destroyed (Tables 3.25 and B.65), and Figure 3.40 shows that these were concentrated on the east bank of the lower reach and in the upper reach, particularly in the detached mainland. The reasons why homestead flooding and damage incidence was high in the lower reach east bank and low in the west bank and Hizla island char are unclear, but the difference may reflect the presence of large areas of low-lying island and attached chars in these mauzas. While local confinement of river flow by the Chandpur Irrigation Project embankment could contribute to the problem, flood modelling indicates that embankments would not raise water levels (FAP 25, 1993). Additionally, the large areas of high housing damage (blue) cover only a few large mauzas, it is therefore also possible that estimates from key informants are less reliable in large mauzas. While the extent of house damage reported is consistent with a moderate flood, it implies that in the upper reach many houses are not adjusted to a 1-in-5-year flood.

HOUSES FLOODED 1987



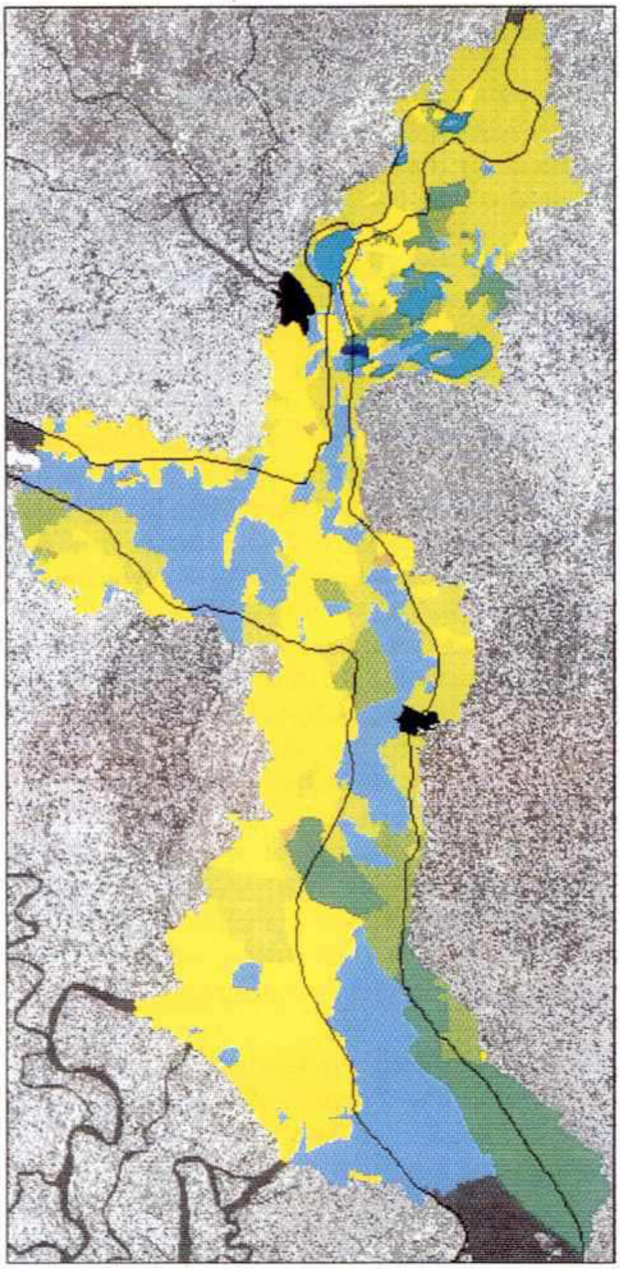
PROPORTION OF HOUSES WITH WATER ABOVE FLOOR LEVEL

- Uninhabited
- No Flood
- 1-20%
- 21-40%
- 41-60%
- 60-80%
- 80-99%
- 100%
- No Data recorded
- Bankline, 1993

Source: ISPAN, 1993 Field data

Figure 3.39

HOUSES DESTROYED BY FLOOD 1987



PROPORTION OF HOUSES DESTROYED

- Uninhabited
- No Flood
- 1-20%
- 21-40%
- 41-60%
- 61-80%
- 81-99%
- 100%
- No Data recorded
- Bankline, 1993

Source: ISPAN, 1993 Field data

Figure 3.40

In 1988 almost all study area houses were flooded (dark blue in Figure 3.41, averages of close to 100 percent in Table B.66). The striking exception was Hizla, where virtually none were flooded (yellow). Table B.67 and Figure 3.42 show high numbers of houses destroyed in the upper reach and confluence (Table 3.22), particularly on the south side of the Padma at the confluence, where many mauzas reported 60 percent or more houses destroyed in 1988 (blue shades). Yet an average of only 10 percent of houses were flooded above roof level. Flooding was somewhat deeper in the upper reach (Table 3.24), but many house were destroyed by water levels that were below roof level. Although the 1988 flood was more severe and caused more housing damage in the Upper Meghna than the one in 1987, the increase in damage in the confluence area was greater, which is consistent with the main flood peak coming from the Brahmaputra-Jamuna and with the difference between a 1-in-2-year and a 1-in-32-year flood. Land in the Upper Meghna is reasonably stable, although often flooded, and homesteads there are adjusted to the expected range of floods. In the confluence area, on the other hand, homesteads may be more vulnerable because the mauzas there were more recently settled. Since these settlers were previously displaced by erosion, and can expect erosion in the future, they may lack the incentive (and resources) to invest in raising their homesteads.

Table 3.25 Percentage of Houses Destroyed by Flood

Reach	1987	1988	1989-92*
Upper	20	41	1
Confluence	5	37	1
Lower	8	20	5
Total	13	34	2

Source: Tables B.65, B.67, B.69
*Mean percentage for four years, 1989-92.

On average during the four years 1989-92 there has been little flooding of homesteads in the Meghna charlands. The only exception is the lower reach east bank mauzas (Figures 3.43 and 3.44), where about 55 percent of houses have reportedly been flooded annually and 20 percent destroyed (Tables B.68 and B.69). These reports deserve follow-up study since average monsoon conditions prevailed in these years, and the possibility of exaggerated flood impacts should not be discounted. Elsewhere the pattern shown in the maps is plausible: higher percentages of houses flooded along the main river channel and very low percentages destroyed (about 1 percent).

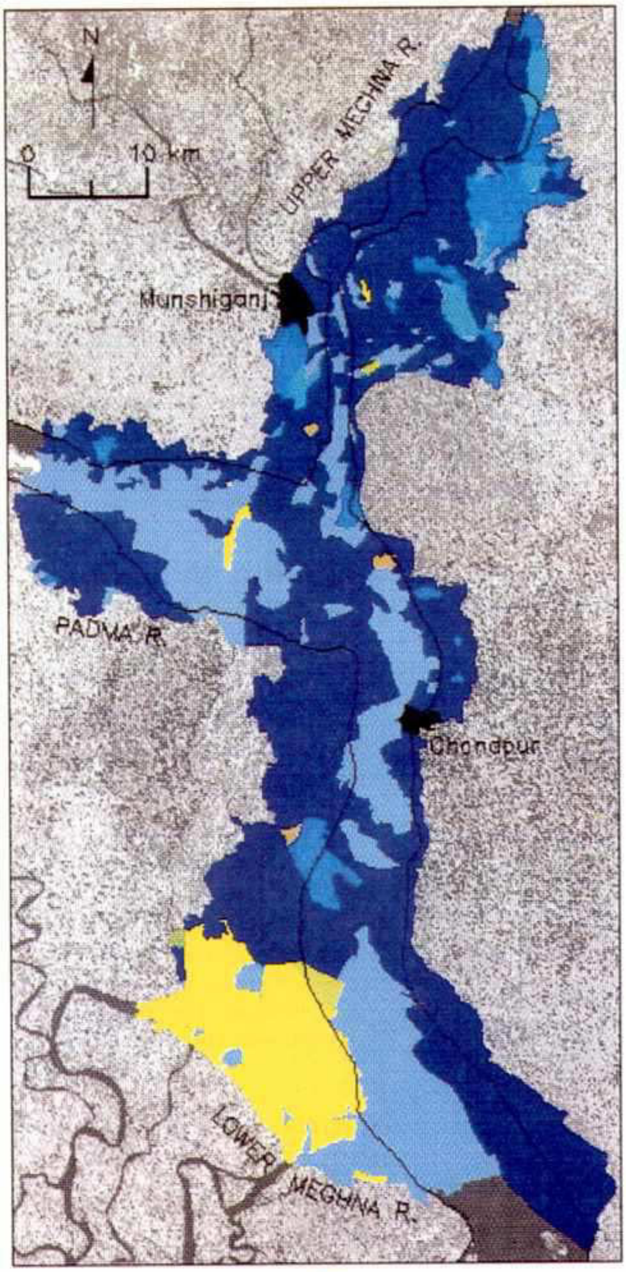
Compared with the 1989-92 average, in the 1987 flood about five times more charland houses were flooded than normal, and in 1988 about nine times more houses were flooded. It is very rare in normal monsoon conditions for houses to be destroyed by flooding, but the surveys revealed that in the Meghna charlands 2.6 times more houses were reportedly destroyed in 1988 than in 1987. The most affected areas were in the upper reach and confluence area. In 1988, one of every ten houses in the Meghna charlands was flooded to the roof.

With the exception of the upper reach in 1987, the percentage of houses destroyed shows a remarkable similarity with the flood return period estimates. While this might be used as a rule of thumb when responding to a flood emergency, more detailed investigation of housing damage relative to flood levels and return periods is needed. It would appear that the 1988 flood, which was 0.8-1.4 m higher than a normal peak annual water level, destroyed about 38-40 percent of houses in the upper reach and confluence.

3.6.4 Flood Risk

Flood severity and risk appear higher in the upper reach than in the lower reach. This indicates a priority need for flood proofing interventions in that reach under the present river regime. FAP 25 and FAP 5 flood modelling found that existing and proposed embankments are unlikely to result in any increase in flood levels of more than about 10 cm within the upper reach since local rainfall

HOUSES FLOODED 1988



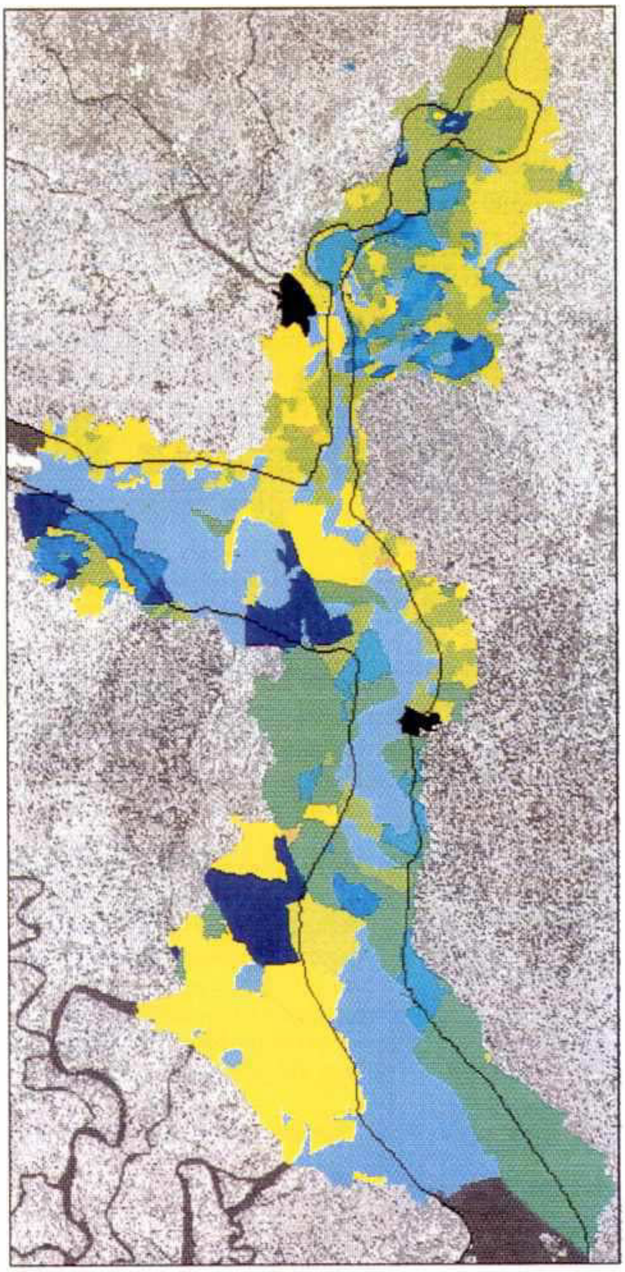
PROPORTION OF HOUSES WITH WATER ABOVE FLOOR LEVEL

- Uninhabited
- No Flood
- 1-20%
- 21-40%
- 41-60%
- 60-80%
- 80-99%
- 100%
- No Data recorded
- Bankline, 1993

Source: ISPAN, 1993 Field data

Figure 3.41

HOUSES DESTROYED BY FLOOD 1988



PROPORTION OF HOUSES DESTROYED

- Uninhabited
- No Flood
- 1-20%
- 21-40%
- 41-60%
- 61-80%
- 81-99%
- 100%
- No Data recorded
- Bankline, 1993

Source: ISPAN, 1993 Field data

Figure 3.42

keeps river levels in the Upper Meghna high during the monsoon season. In the Lower Meghna the channel is too wide for there to be a noticeable confinement effect when superimposed on the tidal range. However, FAP 5 has drawn attention to possible changes in the flood regime if there is an increase in the area protected by submersible embankments in the northeast region. It is thought that this could result in an earlier rise in water levels and longer inundation. This is unlikely to affect houses, but it could increase flood risks to boro and late rabi crops in the upper reach chars.

Further data, preferably mapped outputs from the hydraulic model linked to a digital elevation model (DEM), would be needed if current and accurate ground level data become available. These data could be used to more accurately model flood impacts, as well as the potential benefits of flood proofing measures. Failing this, a series of satellite images on a rising and falling flood would be useful, or images of flood peaks in successive years. Unfortunately, it is currently difficult to procure either the cloud-free data or radar imagery that would be required.

The inventory data and GIS should be seen as a way of prioritizing reaches of the river for different types of interventions, but more detailed study of flood impacts, local topography, and flood risks in particular reaches are needed before appropriate local flood proofing interventions can be designed.

NOTES

1. For one mauza, although informants reported that it was submerged, land could be seen in the mauza in the 1993 satellite image. This mauza was affected by an overlap between two thanas, so the GIS map may not accurately reflect the location of this mauza.

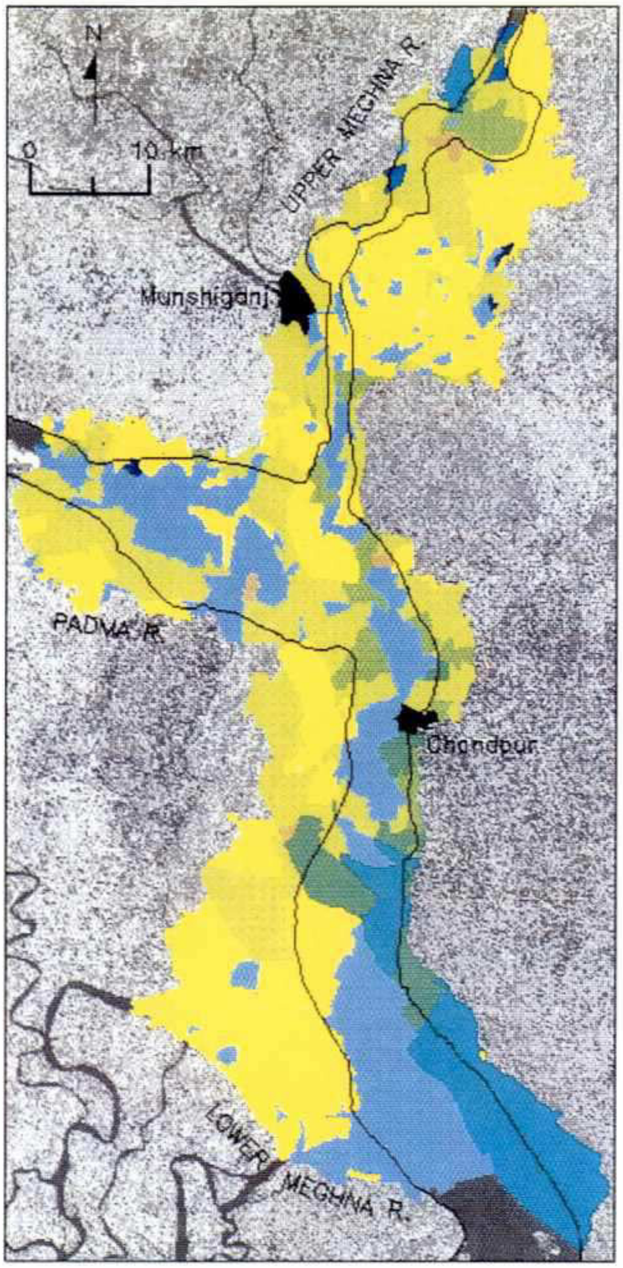
2. Population data from the 1991 census are not yet published for the Meghna area. The estimates reported here were based on information from Union Parishad Chairmen or Members wherever possible, and reflect the local "official" figures at the time of the survey, cross-checked with residents of the mauzas. The household numbers given in the inventory are believed to be generally reliable, and household sizes inferred in the inventory are consistent with Bangladesh averages. Comparison between the 1992 Brahmaputra-Jamuna inventory estimates and more detailed household listings for sample surveys, however, suggested that there is a risk that the numbers, but not the proportions, derived from the inventory may be too high on average.

3. The study area covered parts of many mauzas, so it was inappropriate to analyze chairmen's residence on a union basis.

4. BBS (1993) defines cropping intensity as total cropped area divided by net cropped area times 100. The inventory obtained estimates of the percentage of cultivable land cultivated under each crop type. These percentages have been summed to get mauza-level estimates of cropping intensity for Figure 3.16. In a small percentage of mauzas the percentages totalled less than 100 percent (but not less than 90 percent), indicating some current fallow in the past year and slightly reduced the estimated cropping intensity. For the tables, the percentage of land cultivated was weighted by the cultivated/vegetated area estimated from the 1993 satellite image in order to estimate the total areas under each crop and relate this to the total cultivated area.

5. The data summarize experience over an unspecified number of years so these events may have occurred during past land accretions.

HOUSES FLOODED 1989-92



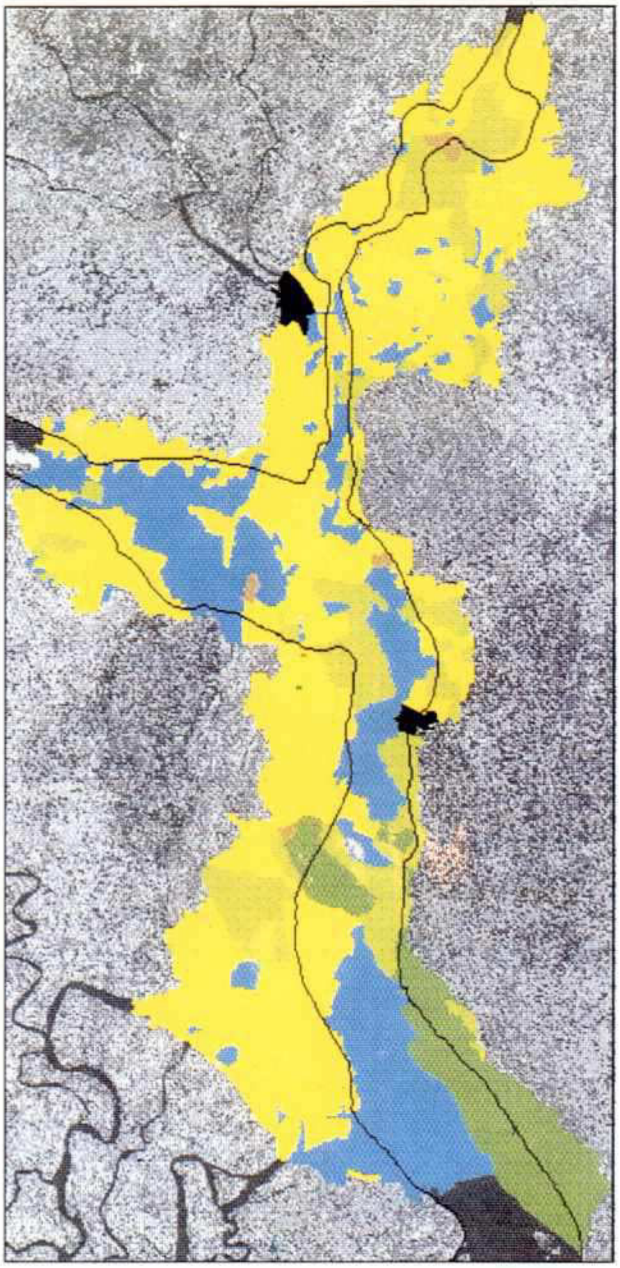
AVERAGE ANNUAL PROPORTION OF HOUSES WITH WATER ABOVE FLOOR LEVEL

- Uninhabited
- No Flood
- 1-20%
- 21-40%
- 41-60%
- 61-80%
- 81-99%
- 100%
- No Data recorded
- Bankline, 1993

Source: ISPAN, 1993 Field data

Figure 3.43

HOUSES DESTROYED BY FLOOD 1989-92



AVERAGE ANNUAL PROPORTION OF HOUSES DESTROYED

- Uninhabited
- No Flood
- 1-20%
- 21-40%
- 41-60%
- 61-80%
- 81-99%
- 100%
- No Data recorded
- Bankline, 1993

Source: ISPAN, 1993 Field data

Figure 3.44

Chapter 4

ANALYSIS OF POPULATION TRENDS WITH CHANNEL DYNAMICS

4.1 Data Sets

The Landsat satellite images and analysis of river morphology reported in Chapter 2 constitute a database for the Meghna that is independent of mauza boundaries. The inventory population and resources data is not easily divisible below the mauza level—the primary data collection unit. Despite this limitation on the integration of the two data sets, the alignment of mauza boundaries with the image data is reliable. At the mauza level, then, links between the data sets can be made.

The objective of the analysis in this chapter has been to estimate the potential aggregate impact of erosion and accretion on population and migration. This has been done for:

- population density relative to age of land (Section 4.2);
- reported areas and numbers of homesteads lost to erosion in each year from 1987 to 1992 (Section 4.3); and
- longer-term bank changes (erosion) between 1984 and 1993 relative to 1981 and 1992 populations (Section 4.4).

4.2 Population Density and Age of Land

The total 1993 population of the Meghna Charland Study area is estimated to have been about 1.16 million people (Section 3.2); compared with 0.97 million in 1981. This represents an increase of 20 percent. The 1993 population density of the area was 653 people per km^2 (total area, including water), and 933 people per km^2 of vegetated or cultivated land. By comparison, the national population density in the 1991 census was 763 people per km^2 (BBS, 1993).

Population density estimates from the 1993 inventory relative to vegetated/cultivated land are mapped in Figure 3.6. Age of land, which was mapped in Figure 2.9, and population density show a close association.[1] Table 4.1 shows that in aggregate mauzas where the land is reported to be 10 years old or less have only 216 people per km^2 of vegetated/cultivated land, compared with 1,268 people per km^2 in mauzas where the land is more than 70 years old. Only inhabited mauzas have been considered since uninhabited mauzas were either submerged or there was no one to estimate the age of any land present.

The fact that older land is more densely populated is probably related to the productivity of land on relatively stable chars. As the accreted land ma-

Table 4.1 Population Density in 1993 by Age of Land

Land Age (years)	Aggregate people per km^2	Mauza average people per km^2
1-10	216	696
11-20	529	743
21-30	830	1,048
31-70	843	1,375
71+	1,268	2,443
All land	975	1,875

Source: Inventory survey

tures, the organic material in its soil may increase, enhancing agricultural productivity. There also has been more time for people to move onto older chars. In the upper reach, mainland and detached mainland are old land with high population densities, but in the confluence and lower reach the east bank mainland areas had higher population densities and are the oldest land. These areas are now threatened by river erosion. Even if equivalent areas of charland are accreted to compensate for the eroding mainland, therefore, it seems that they would not be able to support the same number of people for many years.

4.3 Recent Erosion of Land and Homesteads

The inventory survey asked key informants to estimate the areas of land, number of homesteads, and number of lives lost to erosion in each year from 1987 to 1992. As Section 3.6.1 showed, very few lives were reported lost due to erosion.

The total study area is 195,660 ha, of which in March 1993 there were 119,537 ha of vegetated or cultivated land (Tables B.1 and B.4). While it is likely that informants' estimates of areas lost are subject to some error, the differences between years should indicate the relative severity of erosion in each year. Because the area of land actually present in the study area in each of the years from 1987 to 1992 could not be estimated independently, actual areas reported by informants rather than percentages were used in the analysis.

Figure 4.1 shows the distribution of mauzas reporting land erosion in the peak flood year of 1988, when a total of 3,082 ha were said to have eroded (Table B.71). There are visible concentrations of erosion in the lower reach island chars and east bank attached chars and unprotected mainland, but there are also small areas (orange) of eroded land in many mauzas along the main channel and secondary channels in the upper reach. The bankline changes discussed in Chapter 2 showed little erosion in the upper reach, but this did not cover secondary channels and also ignored within-channel changes. It is not clear why bank erosion in Hizla, on the west bank of the lower reach, was not reported in the inventory when it was the dominant erosion feature in the image analysis of Chapter 2. Since some of the adjacent mauzas lost all their land to erosion, respondents were not available to estimate the areas eroded.

Although erosion patterns in 1987 and 1988 (Figure 4.1) were similar, there was more than twice as much land reported lost to erosion in 1988, and the annual average area reported eroded between 1989 and 1992 was only 28 percent of the area reported eroded in 1988. This confirms the finding of the Jamuna inventory that there is more erosion in peak flood years.

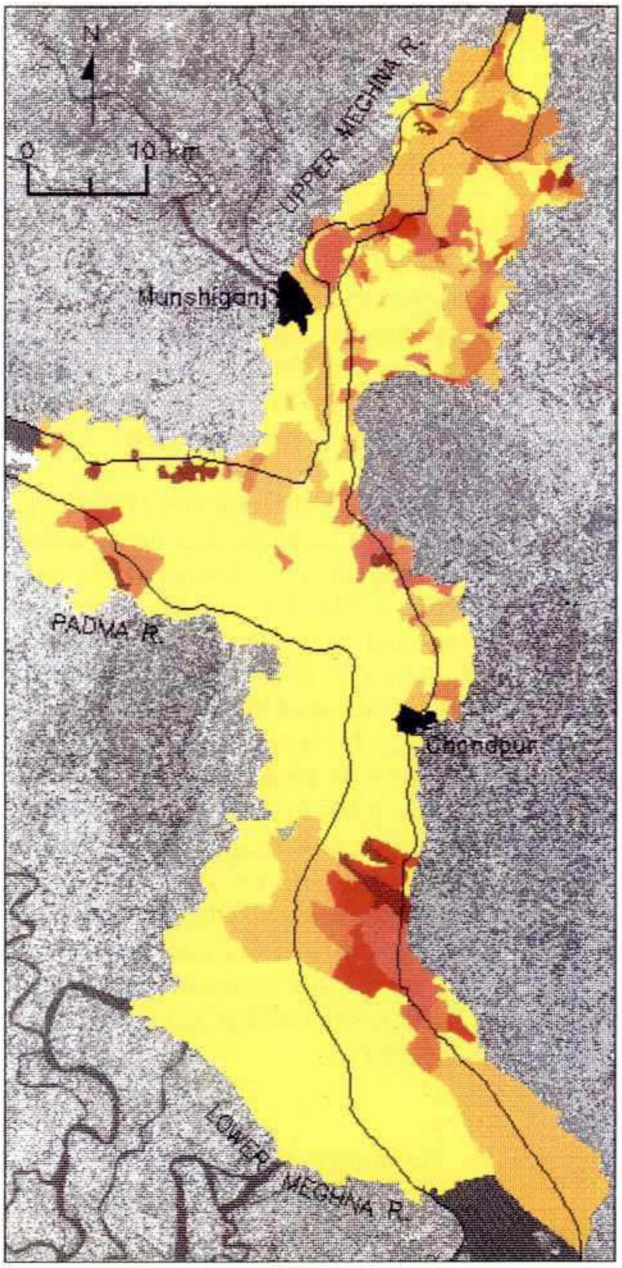
As expected, Figure 4.2 confirms that homestead erosion in 1988 was concentrated in the same mauzas that experienced land erosion. The figure also shows that the relatively small eroded areas of the upper reach resulted in a disproportionate number of eroded homesteads. In that reach the percentage of homesteads eroded (57 percent, Table 4.2) was particularly high in comparison with percentage of the land eroded that year (30 percent). This is a consequence of the area's high population density (Section 3.2.2). Although more than one household may live in a homestead, the only available data with which to show the relative severity of homestead erosion was the 1993 number of households (which underestimates the number of households affected). Locally, more than 15 percent of households were eroded in 1988 (dark red) along the upper and lower bank lines. In a few mauzas along the north bank of the

Table 4.2 Percentage of Eroded Homesteads in Each Reach

Reach	1987	1988	1989-92
Upper	55	57	50
Confluence	25	23	44
Lower	20	20	6
Total (no.)	953	2,407	2,362

Source: Tables B.73 to B.75

AREA ERODED 1988



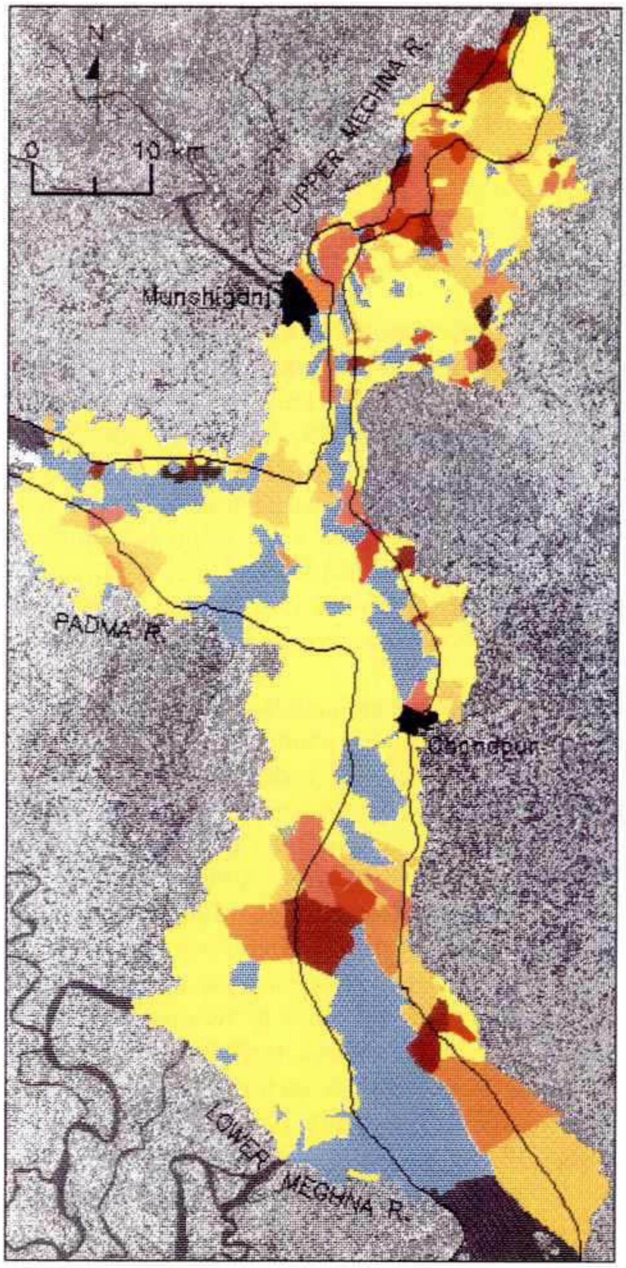
PROPORTION OF TOTAL MAUZA AREA ERODED

- No erosion
- .01- 2%
- 2-5%
- 5-10%
- 10-15%
- GT 15%
- No Data recorded
- Bankline, 1993

Source: ISPAN, 1993 Field data

Figure 4.1

HOMESTEADS ERODED 1988



PROPORTION OF 1993 HOUSEHOLDS ERODED

- Uninhabited
- No homesteads eroded
- .01-2%
- 2-5%
- 5-10%
- 10-15%
- GT 15%
- All homesteads eroded
- No Data recorded
- Bankline, 1993

Source: ISPAN, 1993 Field data

Figure 4.2

Padma at the confluence all households were eroded in 1988 (brown in the figure).

The distribution of erosion in the period 1989-92 was rather different (Figure 4.3). Small areas in many mauzas in the upper reach continued to be lost, but larger areas were reported eroded in the confluence, particularly along the north bank of the Padma (66 percent of the area reported eroded was in the confluence). This suggests that recent channel widening reported in Chapter 2 for the confluence area mainly occurred after 1988.

Although the number of homesteads reported eroded between 1989 and 1992 was almost the same as in 1988, implying an annual loss of 25 percent of that in 1988, homestead losses were very localized. The majority of those lost were in the island chars and west bank of the upper reach and confluence (Figure 4.4). Table 4.2 shows the relative increase in homestead loss to erosion in the confluence between 1987-88 and 1989-92 and decline in homestead losses in the lower reach.

Inventory reports indicate that 5,722 Meghna-area homesteads eroded (including both bank and char erosion) between 1987 and 1992 and their households had to move. Of these, 35 percent were in island char mauzas and may have been displaced by within-channel erosion. Although Figures 4.2 and 4.4 assumed one household per homestead in order to calculate the relative severity of erosion, in fact, that is probably an underestimate. Based on the RRA surveys, four to five households per homestead may be more typical, and six households per homestead is apparently common in the nearby ICDDR,B study area. This implies that about 15 percent of study area households were displaced by erosion during the 1987-92 period.

4.4 Changes in Population and Mainland 1980-92

4.4.1 Aggregate River Bank Changes

This section is based on calculation of areas lost to erosion or accreted along the west and east banks of the river between 1984 and 1993. The areas derived from the satellite image analysis have been summed on a mauza basis, then related with population data from the 1981 census and 1993 inventory.

Mauzas entirely within the channel in 1984 and 1993, and mauzas entirely on the mainland (not touching the bankline) in 1984 and 1993, were identified separately to check population trends in the two charland types that were unaffected by bank erosion. Mauzas within the channel still have experienced erosion and accretion, but this analysis concentrates only on bank erosion. The total areas are from the same image analysis as was used in Section 2.5, but here they have been summed for all mauzas in the study area.

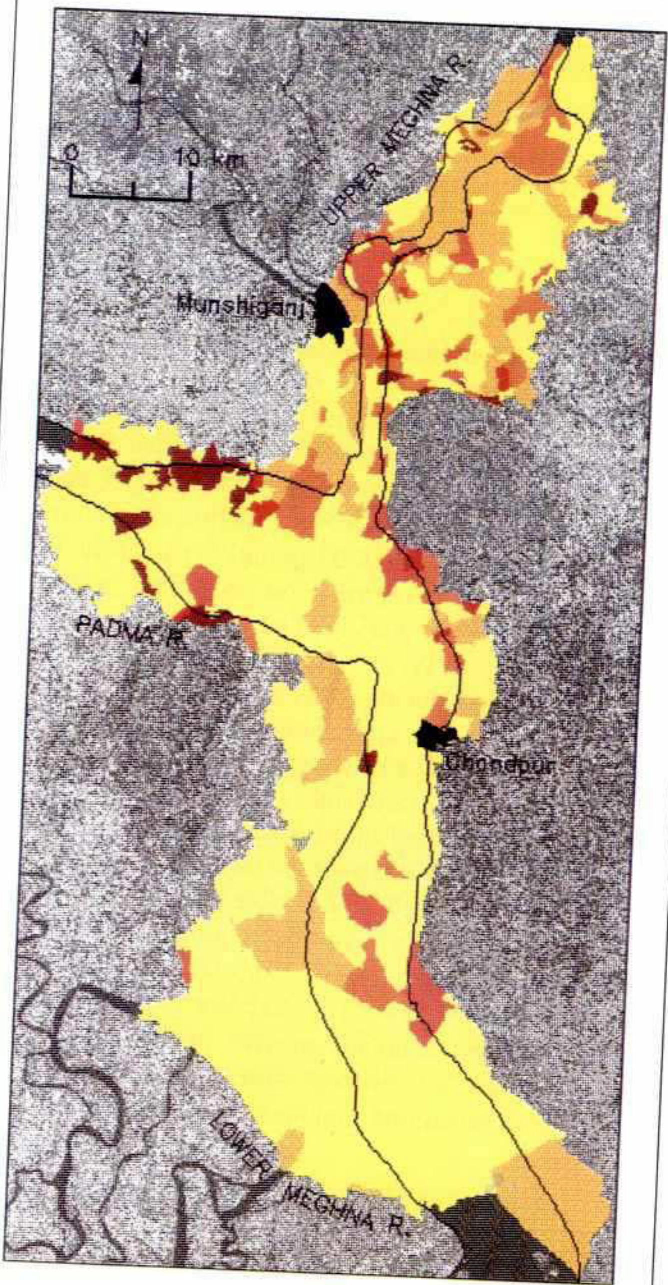
Table 4.3 shows that, in the Meghna study area, 15 percent of the 1984 mainland had been eroded by 1993 and converted into channel (river and chars combined). Table 4.4 breaks down this erosion by reach and bank, along with the small area of net accretion in the same period (which amounts to only 7 percent of the net eroded area). The net area lost was 18,543 ha. Bank erosion was concentrated in the west bank of the lower reach (60 percent of the total area lost). It should be remembered that this analysis ignores many morphological changes that occurred during the period. For example, some areas may have eroded and accreted within the period of analysis. Figure 4.5 shows the areas eroded and accreted between the 1984 and 1993 dry season satellite images overlaid on the mauza boundaries.

Table 4.3 Summary of Study Area

	Area (ha)
Mainland, 1984	136,692
Channel, 1984	68,556
Total, 1984	205,248
Mainland Eroded 1984-93	19,900
As Percentage of 1984 Mainland Area	14.6

Source: FAP 19 satellite image analysis

AREA ERODED
1989-92



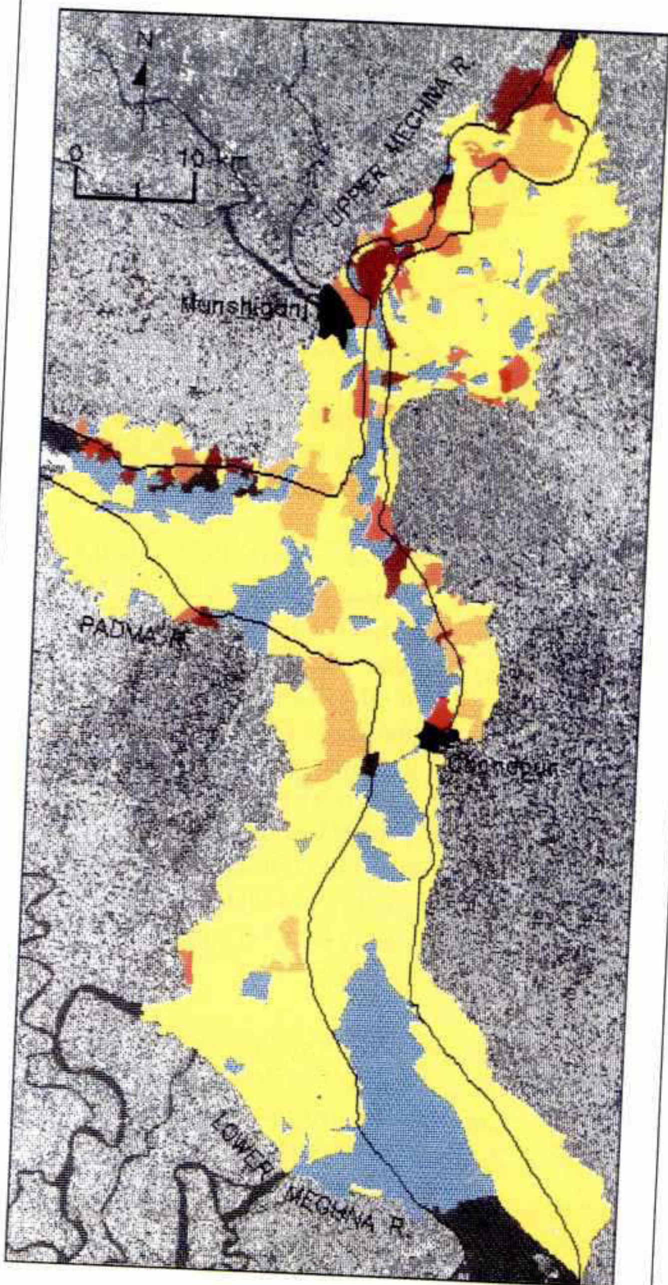
TOTAL AREA ERODED AS PROPORTION OF MAUZA AREA

- No erosion
- .01- 2%
- 2-5%
- 5-10%
- 10-15%
- GT 15%
- No Data recorded
- Bankline, 1993

Source: ISPAN, 1993 Field data

Figure 4.3

HOMESTEADS ERODED
1989-92



1989-92 TOTAL HOUSEHOLDS ERODED AS PROPORTION OF 1993 HOUSEHOLDS

- Uninhabited
- No homesteads eroded
- .01-2%
- 2-5%
- 5-10%
- 10-15%
- GT 15%
- All homesteads eroded
- No Data recorded
- Bankline, 1993

Source: ISPAN, 1993 Field data

Figure 4.4

Table 4.4 Net Area of Bank Erosion and Accretion, 1984-93

Reach	Eroded (ha)		Accreted (ha)	
	West	East	West	East
Upper	202	258	370	69
Confluence	3,993	1,024	786	3
Lower	11,949	2,476	0	131
Total	16,144	3,758	1,156	203

Source: FAP 19 satellite image analysis

4.4.2 Population Dynamics

Table 4.5 summarizes the 1981 and 1993 population in the study area. The population displaced by erosion can be estimated given three assumptions:

- that all of the 1981 population living in mauzas intersected by the bankline actually lived on the mainland (a few may have been on island chars, but there were few in the Lower Meghna and population density is low on island chars);
- that this population was evenly distributed over land whether it eroded in the period 1984-93 or was not lost; and
- that the population had not moved significantly, nor the bankline changed significantly between the 1981 census and 1984 image.[2]

The population changes that would have occurred after 1981 on that eroded land are unknown, as is the year of erosion for any particular location. Table 4.5 summarizes the 1981 population and the population estimated to have been displaced by bank erosion in this period, a total of 131,480 people—about 13 percent of the study area population in 1981, which is similar to the inventory-derived estimate in Section 4.3.

Normal population growth most likely would have resulted in somewhat more people being displaced as erosion progressed. Moreover, it is likely that households moved more than once during this period because of successive bank erosion events, but the history of population displacement cannot be gauged from the available data.

Assuming that population growth on eroded land occurred at the national average rate of 7.8 percent between 1981 and 1984 and that all erosion occurred in 1984 (conservative assumptions because of uncertainty about the sequence of erosion events and population shifts), then some 142,000 people were probably displaced by bank erosion. The estimated 1984 population affected by erosion during the 1984-93 period is shown in Table 4.6. Population density on this land averaged 660 people per km^2 of land, which is very similar to the density in 1981 for mainland unaffected by erosion during 1984-93 (639 people per km^2 of land). Although similar numbers of people were estimated to have been displaced by erosion of the west and east banks, on the east bank they were concentrated in the lower reach, while on the west bank they were spread between the confluence and lower reach. The table shows that population densities on the eroded mainland would have been very high in 1984, especially in the upper reach and east bank. The very low population density on eroded mainland mauzas in the west bank lower reach is consistent with low densities in this area on remaining mainland.

Table 4.5 Population by Land Status, 1981-93

Population in:	1981		1993	
	Number	%	Number	%
Unprotected Area	995,066	100	1,169,366	100
Within Banklines	198,144	20	227,282	19
Eroded Area 1984-93	131,480	13	0	0

Source: 1981 BBS census and 1993 FAP 16 inventory

Bankline Changes 1984–93 with Mauza Boundaries

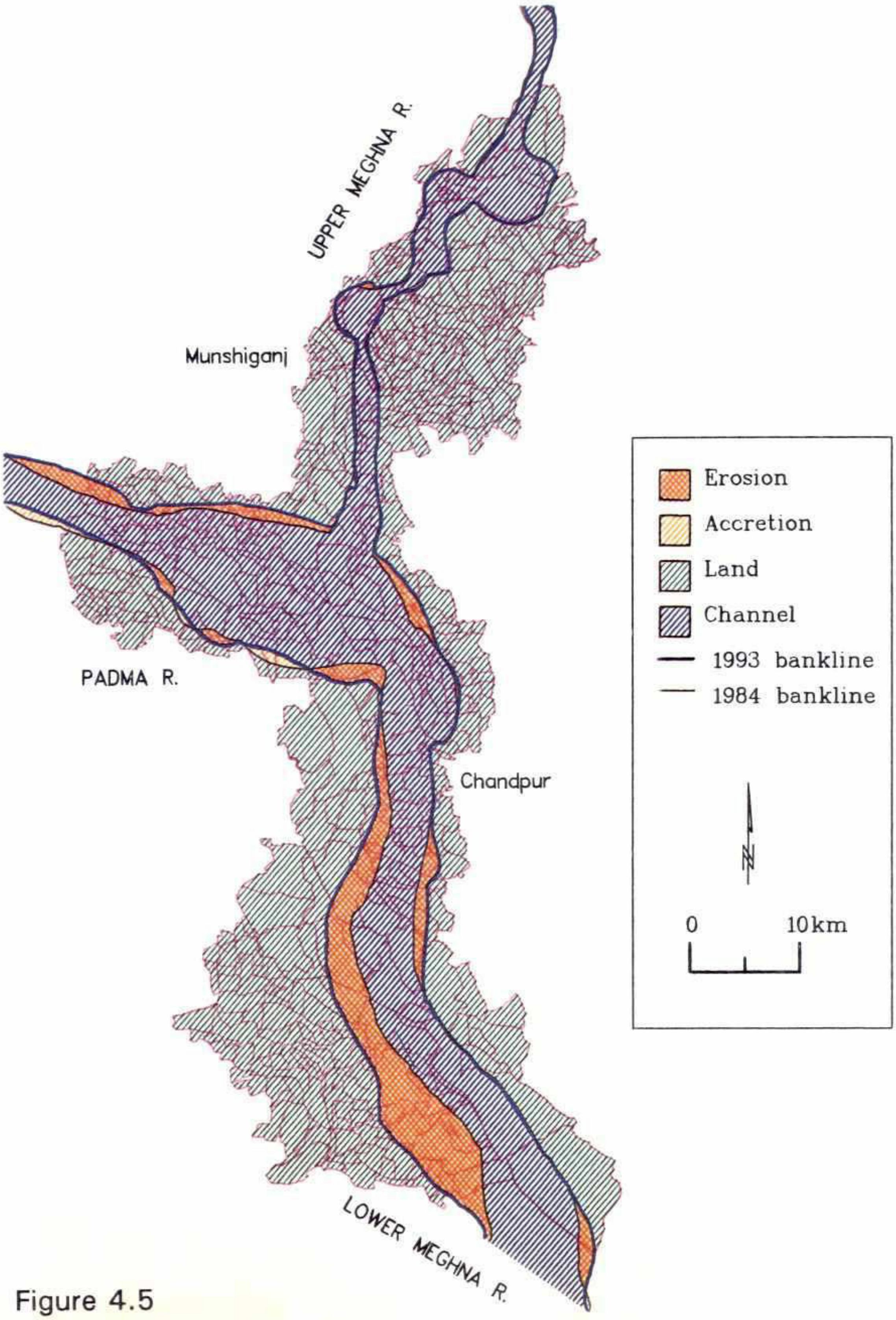


Figure 4.5

228

Table 4.6 **Estimated Population of Land Lost to Bank Erosion 1984-93**

Reach	Percent of 1984 Population		1984 Population Density (per km²)	
	West	East	West	East
Upper	5	15	1,668	4,064
Confluence	55	28	999	1,918
Lower	40	56	247	1,568
Total	72,789	68,947	450	1,835

Source: BBS 1981 Census data multiplied by 1.078 and apportioned according to area estimates from FAP 19 image analysis

The 1981 population of 45 people per km^2 is relatively high, but probably arises because some of these mauzas included land at the time of the 1981 census which had been eroded by the time of the 1984 satellite image. Consequently, there has been virtually no increase in population on the chars to compensate for displacement by bank erosion. There has been net accretion of just over 4,000 ha of vegetated char land within the main channel of the Lower Meghna between 1984 and 1993 (Table 2.6). This is much less than the 14,400 ha lost to bank erosion, and these chars are mostly very low-lying islands that can be cultivated in the dry season but are submerged in the monsoon. It remains to be seen whether they are a temporary phenomenon or will stabilize and build up into habitable islands.

Accretion resulted in a small compensating gain of 1,360 ha of land. Assuming the same population density as found in these mauzas as a whole this land was densely populated, having 1,500 people per km^2 in 1993, or a total of about 20,000 people (the majority of them in the west bank of the confluence and upper reach). The net impact was that mainland which had supported 122,000 people was lost to bank erosion, although the area of island chars increased in the same period.

As Chapter 2 explains, the river channel in the confluence and lower reach was widening during the period studied. While it has not been possible to relate population changes with in-channel morphology, the population trend in mauzas remaining completely in-channel over the period has been assessed. Table 4.7 shows a substantial increase in population in these mauzas in the upper reach where the chars are very stable, but a decline in population in the other reaches. In the confluence there has been a relatively small population decline, which is associated with changes in the configuration of the island char complex.

There are very few chars within the Lower Meghna banklines, and those present are mostly seasonally occupied (Section 3.3.2). The larger part of these mauzas is water, which explains the low population densities.

In the confluence and lower reach there is no evidence that the chars have absorbed people displaced by bank erosion, in fact char erosion has probably resulted in displacement of more people in the confluence. In the upper reach, char population growth has been relatively rapid, but no more than growth in adjacent mainland areas.

The equivalent figures for mainland mauzas not affected by erosion during the period show much higher population growth that is consistent with national averages, but it also indicates a decline in

Table 4.7 **Population Growth in Within-Bankline Mauzas (area = 25,984 ha)**

Reach	1981 Population per km²	1993 Population per km²	Percent Change
Upper	524	780	49
Confluence	177	149	-16
Lower	45	9	-80
Mean	223	242	8
Total	58,071	62,978	4,907

Source: BBS 1981 Census; inventory data; FAP 19 satellite image analysis population in the west bank lower reach and confluence (Table 4.8). The negative to low population growth in this area was already shown in Section 3.2.2. The deltaic sands (Geological Map of Bangladesh, 1990) of the island and attached char mauzas in this area appear to be relatively unproductive and have a low carrying capacity. Although there has been in-migration into the Hizla island char in recent years, it is not reflected in the population trend for the reach, and the inventory also noted substantial out-migration in 1992 from this area.

Table 4.8 Population Growth in Unaffected Mainland Mauzas (area = 71,614 ha)

	Percent Growth/Decline 1981-93	
Reach	West	East
Upper	77	35
Confluence	-26	63
Lower	-17	217
Average	2	51
Total Population 1981	243,130	214,486
Total Population 1993	248,105	323,965
People per km² 1981	542	803
People per km² 1993	553	1,212

Source: BBS Census 1981; inventory 1993

Table 4.8 shows that people have become more concentrated in east bank mauzas that have been unaffected by bank erosion between 1981 and 1993. Compared with an overall growth rate in the study area population of 20 percent, growth in east bank mauzas unaffected by erosion was 51 percent. While the population growth rate in these mauzas was little higher than the reach average in the upper reach, it was four times higher than the reach average in the confluence east bank mainland, and 36 times higher than the reach average in equivalent mauzas of the lower reach.

The exceptionally high population growth on the east bank of the lower reach presumably reflects a shift of people from lower reach eroded areas onto the remaining east bank mainland. In 1981, this area had a very low population density—only 351 people per km^2, but by 1993 it had increased to 1,111 people per km^2. This suggests that there are about 27,500 more people in these mauzas in 1993 than there would have been had the population growth during the 1984-93 period been the same as for the study area as a whole. An estimated 63,400 people were displaced by bank erosion in this reach, but there was no compensating increase in population in noneroded west bank mauzas, therefore about 57 percent of the displaced people from this reach are presumed to have moved out of the study area.

In 1993 fewer people are living in confluence mainland mauzas unaffected by erosion than in 1981. There was also a decline in population in within-bankline mauzas in this reach, therefore, more people are estimated to have left the study area than the 55,000 who were displaced by bank erosion. It would appear that the lack of braiding in the Meghna channel means that few erosion victims have stayed within the active floodplain. Some may have moved just out of the study area, onto the embankments that form its boundary, but there appear to be fewer people settled on Meghna embankments than on the Brahmaputra Right Embankment.

4.5 Implications of Analysis

The conclusion that many more people in the confluence and Lower Meghna have been affected by erosion than in the Upper Meghna, is not surprising. There is considerable anecdotal information on these losses, and the impacts of erosion in the estuarine Lower Meghna south of the area studied here have been investigated by Elahi, *et al.* (1991). Using the inventory together with satellite image analysis for two years, however, makes reliable aggregate estimates of erosion impacts possible for the first time.

Twenty-eight percent of the 1981 population of the lower reach and 15 percent of the 1981 population of the confluence are estimated to have been displaced by bank erosion between 1984 and 1993. In the Jamuna River, char-building processes during 1980-92 created land which could accommodate some of the erosion victims, but this has not been the case in the Meghna. New chars have emerged, particularly in the Lower Meghna, but as of 1993 they are mostly only used for dry season cultivation and are then submerged in the monsoon. If char building continues in the confluence and lower reach then more year-round habitable land may emerge, but at the cost of continued widening of the river and bank erosion of very densely populated mainland.

Even in the relatively stable Upper Meghna, the small areas eroded are densely populated. The total number of people affected is relatively low, but the remaining chars and mainland are already the most densely populated in the study area, so erosion is causing increasing pressure on these scarce resources.

A picture of historical erosion impacts could be developed by adding mauza-level population data from earlier censuses, comparative analysis of bankline changes from the 1973 and 1980 Landsat images, and historical maps. With the addition of data from more recent images and short field surveys, the databases could be used as a baseline to monitor continued channel changes and their impacts over time.

Erosion and accretion are not new phenomena along the Meghna, but this analysis draws attention to what may become an increasingly tragic human problem as ever more densely populated areas are eroded as the confluence and Lower Meghna continue to adjust to the range of flows from the Padma. The island chars formed within the migrating and widening channel are unable to take up this displaced population. Flood proofing may offer a partial solution for the residents of chars in the confluence and upper reach where flood risk does not preclude settlement. Yet the erosion threat, especially in the dynamic confluence area also limits the ability to build flood proof settlements, since the investment is likely to be washed away in a few years.

The future may lie in flood proof embankment settlements that are periodically retired or are protected from erosion and enable residents to commute seasonally to low-lying cultivable chars. Localized stabilization of island chars to increase their longevity, and assistance for communities to stay together and earn a livelihood in the face of flood and erosion risk, could also help. As part of the charland study more detailed case studies of flood and erosion impacts using RRA methods were undertaken in the Upper Meghna and confluence areas in 1993. The results of these studies are reported separately.

NOTES

1. Analysis of variance (ANOVA) indicated that population density was more strongly associated with age of land category than with land type, but even so, at the mauza level, it explained only a small part of the variations in population density. One reason is that large mauzas appear to have much lower population densities than small mauzas. Averages of mauza population densities are much higher than overall population densities (for example, the average of population densities in mauzas with land more than 70 years old is twice the overall population density for these mauzas if the total population is divided by the total area). This could reflect lower land productivity. Lower population may result in a lack of pressure to subdivide mauzas; but it could also reflect underestimation of population in large mauzas.

2. The 1984 image was selected for the analysis because an earlier image might have obscured erosion and accretion between the old image date and 1993 image.

329

Chapter 5

CONCLUSIONS AND FUTURE USE OF CHARLAND DATABASE

5.1 Objectives

The original aim of the inventory was to provide baseline data for development planning, and particularly, although not exclusively, for planning under the FAP. This report comprises analysis of population, resources, and morphology data of the charlands of the Meghna River. Section 5.2 briefly summarizes some of the findings from the inventory. Section 5.3 considers the future uses of the charland GIS and databases, with particular reference to development activities along the Meghna. The baseline data in the GIS is available for more localized analysis and planning than was possible for this report.

5.2 Summary of Findings

The study has demonstrated that data can be collected and mapped for the char areas despite the very dynamic nature of their land and population. Conducting a survey of the chars requires up-to-date maps, which are only obtainable by processing satellite images taken two to three months prior to the survey. Otherwise, conditions can change so much that the physical details shown in the maps will have altered (as shown for the confluence and Lower Meghna in the two images in Figures 2.1 and 2.2). Suitable maps normally are available for the annual dry season (December through March). The Charland Study has established a link between cadastral maps of mauza boundaries and digital, image-based maps of land use. These maps can be related to accurately show changes over time relative to mauza boundaries. They also enable mauza-level data, collected from key informants, to be related with maps of land use and channel changes derived from satellite image analysis.

The result is a powerful planning tool that could be refined and updated as the Meghna's morphology and population continue to change. Further satellite image analysis covering more than just two years, 1984 and 1993, would help in understanding these dynamics.

Tables 5.1, 5.2, and 5.3 summarize some of the most important inventory data by reach and by land type. As the data show, there are important variations in population and resource bases and in hazards between char types, between reaches, within reaches by char type, and even more localized differences that have been identified by mapping the data. In the Meghna charlands differences between reaches (Table 5.1) are often more marked than those between char land types (Table 5.2). While in part this reflects differences between reaches in the composition of land types (for example, all of the detached mainland is in the upper reach), the three reaches have clearly distinct environments:

- the upper reach with little bank erosion, deeply flooded stable land and sandy island chars;
- the confluence with dynamic (somewhat sandy) island chars and eroding mainland; and
- the lower reach with rapid bank erosion, large areas of accreted land, and the large silty island char in Hizla which appears to be flood-free and is attracting settlers.

128

Table 5.1 Qualitative Summary of Differences between Reaches

Characteristic	Upper Meghna	Confluence	Lower Meghna
Land	Sand in small area of chars, large area of detached mainland, 76% vegetated.	Most of sand in study area and water, 60% vegetated.	Little sand, 47% water, large island char on west side of main channel.
Population	Highest density, average 1,005 per km^2 in 1993 and growth greater than national average since 1981.	Moderate density (612 per km^2). Locally high population on east bank mainland, low on west bank south of Padma, but low growth overall.	Lowest density, 312 per km^2. Growth much lower than national average since 1981 on west bank and island chars (eroding). Higher on east bank.
Erosion Pattern	Small areas eroding slowly and steadily, but densely populated.	Widening results in erosion of densely populated mainland. Much erosion and accretion of island chars.	Rapid west bank erosion in past decade; few mid-channel chars to erode.
Migration in 1992	Very little migration of any type reported (under 1% households involved), consistent with stable environment.	High incidence permanent in-migration (9% of 1993 households came in 1992) due to rapid changes in island char complex where 26% are in-migrants.	High seasonal in- and out-migration in Hizla island char linked with seasonal demand for farm labor, and in new low-lying chars only cultivated in dry season.
Infrastructure	Good provision of primary and high school and health facilities. Access constrained by river channels.	Good primary and high school and health facility provision.	Poor provision of primary and high school and health facilities in all land types (inhabited mauzas only).
Occupations	54% households cultivate own land, 14% mainly fish.	High percentage fishing on island chars.	High percentage (34%) fishermen in all land types.
Agriculture	Diverse, HYV boro and B aman important.	B aus + aman and wide range of rabi crops.	L & HYV boro and T aman important in island char.
Livestock	High livestock numbers compared to land area and human population.	Moderate numbers.	Lowest numbers relative to land and human population, higher in island chars.
Boats	More mechanized boats relative to people.	Lowest numbers in Meghna, in attached chars.	About 68 households per mechanized boat.
Deaths	Concentrations of flood and disease deaths.	Lowest incidence of hazard-caused deaths.	Most flood deaths, particularly in attached chars.
Floods	Normal floods longer and more extensive than other reaches, high incidence of house damage in 1987 and 1988.	Extent as in upper reach but duration less in normal and peak floods, 98% houses flooded in 1988 but only 32% in 1987.	Normal floods much shorter duration, less impact in 1987 and 1988 floods when fewer houses flooded (37% in 1988), lowest damage.

Source: FAP 16 Charland Inventory

Table 5.2 Summary of Mauza Inventory Data by Char Land Type

Parameter	Island Char	Attached Char	Detached Mainland	Unprotected Mainland	Bangladesh*
Area (ha)	89,736	51,039	14,133	40,753	14.4 million
Percentage water	39	29	7	24	na
Percentage sand	5	2	1	1	na
Percentage vegetated	56	69	92	75	na
1993 population	325,485	260,635	169,248	410,419	109.9 million
Population per km^2 in 1993	363	511	1,198	1,007	763
Percentage increase, 1981-93	+33	-3	+31	+25	+26
Cultivable land per capita (ha) in 1993	0.12	0.13	0.08	0.07	0.09
% permanently out-migrating in 1992	2.0	2.0	0.2	1.7	na
% seasonally in-migrating in 1992	6.1	2.5	0.0	1.0	na
% mauzas with primary school	47	64	65	54	74
% mauzas with high school	6	19	14	16	13
% mauzas with health facility†	6	9	14	17	4
% households mainly farming	45	44	54	43	na
% households mainly fishing	22	21	11	19	na
Cropping Intensity	147	143	147	159	172
Cattle per household	0.74	0.56	1.09	0.70	1.33
Households per mechanized boat	43	63	64	66	na
1988 flood deaths per 100,000	50	64	59	57	1.4
1988 % area flooded	57	99	100	99	46
1989-92 % area flooded	39	68	57	64	na
1988 mean flood duration (days)	42	60	41	74	na
1989-92 mean flood duration (days)	28	40	14	51	na
% houses flooded in 1988	54	95	97	95	na
% houses flooded in 1989-92	6	11	2	14	na
% houses destroyed in 1988	26	38	50	33	na
% houses destroyed in 1989-92	1	2	1	3	na

Source: FAP 16/19 inventory and satellite image analysis

*BBS (1993), except flood data, which is from Rogers, *et al.* (1989). Population figures are for 1991. Comparisons are for rural Bangladesh.

†Facilities below the union health center level, such as private doctors, may have been included in the inventory.

Table 5.3 Summary of Mauza Inventory Data by Reach

Parameter	Upper Reach	Confluence	Lower Reach	Bangladesh*
Area (ha)	50,572	68,294	76,794	14.4 million
Percentage water	22	34	47	na
Percentage sand	2	6	1	na
Percentage vegetated	76	60	52	na
1993 population	508,031	418,055	239,701	109.9 million
Population per km^2 in 1993	1,027	665	363	763
Percentage increase, 1981-93	+34	+15	+6	+26
Cultivable land per capita (ha) in 1993	0.08	0.10	0.17	0.09
% permanently out-migrating in 1992	0.6	2.3	2.3	na
% seasonally in-migrating in 1992	0.5	3.2	4.5	na
% mauzas with primary school	58	61	46	74
% mauzas with high school	14	17	8	13
% mauzas with health facility†	13	12	7	4
% households mainly farming	52	42	40	na
% households mainly fishing	14	15	34	na
Cropping Intensity	155	145	150	172
Cattle per household	0.92	0.63	0.58	1.33
Households per mechanized boat	47	69	68	na
1988 flood deaths per 100,000	73	26	77	1.4
1988 % area flooded	100	99	61	46
1989-92 % area flooded	68	61	41	na
1988 mean flood duration (days)	86	40	16	na
1989-92 mean flood duration (days)	28	40	14	na
% houses flooded in 1988	97	98	37	na
% houses flooded in 1989-92	7	8	14	na
% houses destroyed in 1988	41	37	20	na
% houses destroyed in 1989-92	1	1	5	na

Source: FAP 16/19 inventory and satellite image analysis

*BBS (1993), except flood data, which is from Rogers, *et al.* (1989). Population figures are for 1991. Comparisons are for rural Bangladesh.

†Facilities below the union health center level, such as private doctors, may have been included in the inventory.

This report presents only aggregated maps, but more detailed maps, covering smaller reaches of the Meghna, can be produced for specialized uses.

Analysis of Landsat images from 1984 and 1993 revealed that the Upper Meghna river and charlands are very stable. However, the Padma-Meghna confluence and Lower Meghna charlands were very dynamic over that period, including channel migration, movement, and widening and complex patterns of submergence, erosion, and accretion of island chars (Chapter 2). Comparison of these images with historical maps might reveal longer term trends of channel movement, but the evidence is that the pattern of bank erosion has changed markedly over time, making prediction of erosion rates uncertain. The processes of bank erosion and channel changes have been studied through use of a GIS, which allows accurate measurement of changes between historical maps and satellite images. Between 1984 and 1993 there was an overall tendency for the Lower Meghna to move westward and widen, for the confluence to widen and mainland to be eroded, and for some island chars to be formed.

Chapters 3 and 4 reveal that the general result is that densely populated land is eroded and replaced to some extent with less densely populated and often more hazardous island chars. Over 130,000 people were probably displaced between 1984 and 1993 by aggregate changes in bankline alone; about 90 percent of them lived in the confluence and lower reach. Other things being equal, the trend is likely to continue in the foreseeable future. Slower erosion of more densely populated mainland in the upper reach and east bank in the other reaches may displace more people than faster erosion in the west bank of the lower reach.

5.3 Future Uses of Meghna Charland GIS

5.3.1 Overall Future

The charland GIS needs to have a continued and stable life if other institutions and projects are to make use of the wealth of detailed data it contains. This report presents details of the satellite image and inventory analyses for much of the riverine Meghna, but similar analysis would be possible for smaller planning areas within this study area. If the databases were expanded southward, similar analysis could be done for the cyclone-prone coastal belt. To achieve this the charland GIS will need to be operated, maintained, and updated by an organization that can work with studies inside and outside the FAP to identify the planning needs the GIS can meet. It must also be able to carry out detailed analysis and additional studies, and then produce tailored outputs for specific users. This need might be met by institutionalizing the capabilities of FAP 19 within an organization dedicated to planning and applied research on natural resource and hazard management.

Water resources development planning in the Meghna charlands falls between the boundaries of four FAP regional studies, but detailed feasibility studies are expected to address impacts in adjacent char areas. FAP 5's Gumti subregional feasibility study did not include detailed study of the nearby Upper Meghna charlands, but concluded from flood modelling that there would be little impact from their proposed interventions. More detailed mauza-level data would help to confirm this.

This is only one of many ongoing studies and planned or possible interventions that could be users of the Meghna charland GIS. Linkages between these interventions and the charland databases and GIS are discussed in the following sub-sections.

5.3.2 Southeast Regional Study (FAP 5)

FAP 5 covers the whole of the east bank of the Meghna study area. The proposals under the regional plan are likely to have a minimal impact on the Meghna charlands. There are no proposals to change the existing embankment projects that bound the charlands to the east (Chandpur Irrigation Project and the Meghna-Dhonagoda Irrigation Project), although there are possible bank protection works (see Section 5.3.3). Ultimately, the embankments will probably have to be retired, as they have been in the past, and this has implications for the charlands. People will be converted from mainlanders to char dwellers as a new embankment is built, the old one erodes leaving them open to flooding, and then their land erodes. In this sense more people are expected to be at risk from erosion and floods than are included in this inventory. Study of these areas is needed to estimate the potential benefits from engineering works to reduce erosion and protect these mainland areas.

5.3.3 Flood Modelling

The two feasibility studies undertaken under FAP 5 in this region appear to be benign in their potential impacts on the char areas. Proposals to improve drainage in Noakhali would neither affect Meghna flood peaks nor displace char people. Full flood protection of the Gumti area might have affected the upper reach charlands, but the present proposals are for a mixture of smaller interventions rather than major embankments. In any case flood modelling (FAP 25, 1993) indicated very little confinement effect on the Meghna. Even with full embankments along the Upper Meghna and along the Jamuna, Ganges, Padma, and Lower Meghna east bank (FAP 25 Scenario 5), it was estimated that water levels in the Upper Meghna would fall slightly in a flood of the magnitude of 1987's, and a 1988-magnitude flood would raise water levels in the Upper Meghna by only 2-3 cm and at Chandpur by 17 cm. The possible impacts of a 35 cm rise in sea level were also modelled by FAP 25, which found that the increase in peak flood level would be very small. Therefore, neither proposed engineering works nor sea level changes are likely to have much impact on flood risks in the Meghna chars. Housing is unlikely to be affected by higher flood levels, but the risks to agriculture in low-lying chars near Chandpur might be increased.

5.3.3 Bank Protection

The Meghna Left Bank Protection Project (FAP 9B) proposed protection works for a number of locations along the Meghna. Within the study area the key works would be at Chandpur. This town has been threatened by progressive erosion for a number of years, and proposals for bank protection works have been made since the early 1970s. Erosion rates in the recent past (1984 to 1993) have been relatively slow at this site compared with the west bank of the lower reach.

Bank protection works for the town of Chandpur have been proposed and to stabilize the bankline at this point. This "hard point" might divert the erosive forces of the Meghna elsewhere. FAP 4 (1993) expressed concern that if this were implemented and successful it might divert the flow of the Lower Meghna toward the west bank. The analysis of Chapter 2 has already shown that this area eroded severely during 1984-93. More charland might be lost if the flow is diverted, and channels into the south-central region might open up. The main charland impact might be increased west bank erosion.

Further detailed study of the potential impacts of any proposed works should make use of the inventory data. The satellite image and inventory analysis of FAP 16/19 should be integrated with any modelling of morphological changes. Understanding physical changes and the technical effectiveness of possible protection works are not sufficient to determine and design socially and economically viable interventions. The charland inventory and GIS are the basis for preliminary erosion impact assessment, as well as assessment of the potential social and settlement benefits of bank protection and char stabilization. They could be used as a starting point for more detailed feasibility study and implementation.

5.3.4 The Western Lower Reach

FAP 4 concluded that the Lower Meghna was too dynamic to be confined by embankments along its western banks. The complex pattern of lesser channels in the attached chars of this area, and the recent high erosion rates support this view. However, no proposals for reducing vulnerability to flood impacts or improving livelihoods of char or mainland people in this area were made. While there appears to be a very low flood risk in the southern part of this area (Hizla), the confluence area falls outside any flood loss mitigation strategy. The charland inventory could be used as a basis for designing flood-adjusted integrated rural development programs for this area. The reasons for apparent depopulation of part of this area, which is in marked contrast to trends in most of Bangladesh, deserve investigation.

5.3.5 West Bank Upper Meghna

The proposed Phase II of Narayanganj-Narsinghdi Irrigation Project would involve building an embankment along the west bank of the Upper Meghna from the northern limit of the study area to the Dhaleswari River. Work on this project was deferred (FAP 6, 1993) pending further information on the movements of the Meghna. It is not clear when this project might be implemented, but the evidence of Chapter 2 indicates very slow erosion along this bank. Construction might bring work to some of the char people in the short term.

5.3.6 Other Flood Proofing Programs

As a follow-up to FAP 23, a variety of pilot flood proofing interventions are being proposed for the Brahmaputra-Jamuna. Although flood risks are unlikely to worsen in the Meghna charlands, this does not mean that flood proofing should ignore these areas. The Upper Meghna is more suitable than many charland areas for small-scale flood proofing works because it is relatively stable and embankments are not practical for the islands.

It is hoped that this report can act as a catalyst to encourage flood proofing and char development programs in the Meghna, as FAP 3.1 has to integrated development in the middle Jamuna chars. FAP 3.1 has spurred the proposal of measures to enable char people to diversify and increase their incomes and so reduce vulnerability. Planning such interventions could use a combination of the GIS and inventory data to identify broad problems and program priorities. This would need to be followed up with more detailed local surveys and consultation to tailor implementation to local needs.

5.3.7 Local Government

Government services are limited in the char areas, although the inventory shows that some services are provided. The inventory can be used to identify areas reporting low service provision or no facilities relative to population, and to plan additional service. In addition, detailed information from this study on past and future erosion and accretion patterns will be important in ensuring that appropriate services are provided without a high risk of infrastructure loss. The Local Government Engineering Department (LGED) is currently preparing updated maps for all thanas, which will be incorporated in a GIS. The infrastructure data in the LGED maps could be combined with hazard and resource data in the charland inventory and the image analysis of morphological changes to form an integrated planning tool.

5.3.8 NGOs

The inventory found that relatively few mauzas in the Meghna charlands are within the programs of NGOs. The inventory demonstrates some of the needs of the Meghna charlands, and the types of problems found in these areas. NGOs active in the neighboring mainland areas may be interested in extending their operations into the chars to provide support through self-help programs. These NGOs could use the inventory data to identify priority issues and their locations and extent for planning their programs.

5.4 Longer-Term Institutional Approaches

The riverine charland areas appear to have been somewhat neglected, having rarely been the focus of government or NGO development programs. In part this reflects the highly mobile nature of charland resources and the population living on them. It is difficult for any administration with fixed boundaries to come to grips with something as temporary as charland. Under the FAP some

268

official attention, in the form of studies, has now been given to riverine chars (but not coastal chars), and a national database on these diverse and complex areas is being compiled. This information needs to be properly used and taken into account by the full range of ministries and departments that could and should be actively involved in improving the livelihoods of char people.

While the charlands are covered by normal development activities, to the extent that these activities are suited to the chars, government programs suited to the unique needs of char people have yet to be devised and implemented. This might be done by a specific program or development board involving relevant agencies, which would have the advantage of promoting the more integrated and interdisciplinary approach that seems to be needed in the chars. Alternatively, it might be accomplished by ensuring that each agency, in its own planning and service provision, take note of the problems and needs of the char areas. The government will, as a first step, need continued interactive access to the charland GIS and database.

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APPENDIX A

QUESTIONNAIRE FOR THE MEGHNA, PADMA, AND GANGES CHARLAND INVENTORIES

221

Checklist B (6.5.1993)
For primary level investigation

FCODE : |_|_|_|_|_|
Additional code |_|

BANGLADESH FLOOD ACTION PLAN
FAP- 16 ENVIRONMENTAL STUDY

POPULATION AND RESOURCE INVENTORY OF CHAR LANDS
IN THE GANGES, PADMA AND MEGHNA RIVER SYSTEMS

MAUZA/VILLAGE KEY INFORMANTS INVENTORY

Name and Identification of Participating Informants

Sl.	Name	Age	Id. code
1			
2			
3			
4			
5			
6			

[Id Codes: 1.Present/Past Chairman/Member 2.Teacher 3.Non-Govt. Officer/Worker 4.Traditional Doctor 5.Imam/Religious Leader 6.Govt Officer/Worker 7.Local Elite 8.Officer/Representative of local club/organisation 9.Other (specify)]

*NOTE: THE CODE -9 IS USED WHEN DATA IS **MISSING**, FOR EXAMPLE WHEN RESPONDENTS ARE UNABLE TO GIVE AN ANSWER OR WHERE A QUESTION WAS NOT ASKED. -8 MEANS **NOT APPLICABLE** - FOR EXAMPLE NO INHABITANTS SO OCCUPATIONS ARE NOT APPLICABLE. 0 MEANS NONE - FOR EXAMPLE JUTE IS NOT GROWN IN A MAUZA SO 0 AREA. IF A MAUZA IS NOT INHABITED AT THE TIME OF SURVEY THEN SECTIONS A, B, C, E.2, E.3, E.4, E.5 NEED TO BE COMPLETED, PLUS F IF OCCUPIED IN ANY YEAR AFTER 1986, THE OTHER SECTIONS WILL BE "NOT APPLCABLE". YES=1, NO=2.*

A. Mauza/Village Identification

CODE

A.1 Mauza Name: ____________ BBS no: |_|_|_|_|

River no: 1.Meghna 2.Padma 3.Ganges .... |_|_|_|_|

A.2 Name of main village this inventory refers to if mauza is split:

____

A.3 Char Name: ____________ |_|_|_|_|

A.4 District (Zila): ____________ |_|_|_|_|

A.5 Thana: ____________ |_|_|_|_|

A.6 Union: ____________ |_|_|_|_|

A.7 Distance of centre of mauza/village from nearest mainland: ....miles |_|_|

A.8 Nearest Bank to mauza/village (1.Left; 2.Right) ...... |_|

A.9 Dominant type of land in mauza/village: |_|

1.Island char 2.Attached char 3.Other unprotected land (set back)
4.Submerged (only if whole mauza submerged)

৮৩

B. Physiographic Background of the Land

B.1 1.Non-Cultivated 2.Cultivated.................... |_|

B.2 1. Inhabited 2. Non-Inhabited:.................... |_|

B.3 Year of last formation of char
[code 0 if mauza/village has 'always' been here]: Year |_|_|_|_|

B.4 Area accreted, if any, in 1991 .... Acres |_|_|_|_|

B.5 Area accreted, if any, in 1992 .... Acres |_|_|_|_|

Since char last formed:

B.6 Year natural vegetation growth started: ....Year |_|_|_|_|

B.7 Year first settled: .... Year |_|_|_|_|

B.8 Year cultivation started: .... Year |_|_|_|_|

Breakdown of total **mauza**:

B.9 What percentage of the **mauza** in the last dry season comprised the following categories? *[see instructions]*
In a normal monsoon at peak water level what percentage of land in each category is flooded/under water?

Char type	% **mauza** area in dry season	% of land flooded in normal monsoon
Island char		
Attached char		
Other unprotected land		
Submerged (under water in dry season)		NA
Total	100 %	NA

[For small areas it may be easier to obtain an estimate in acres, if this is done it must be clearly noted. First column adds to 100% - includes sand as well as vegetated/cultivated land. Second column gives % of land in first column under water in normal monsoon.]

B.10 What was the total area (acres) of land, including sand, in the last dry season in the mauza/village? ....Acres |_|_|_|_|

[rest of this question relates to this area of land]

a % this land under homesteads (including associated trees, ponds and vegetable plots)? ....% |_|_|_|

b % this land not cultivated during year (for example, sand or grazing; additional to homesteads) ....% |_|_|_|

c % this land under rabi/boro cultivation? ....% |_|_|_|

d % this land under kharif I/aus/jute cultivation? .....% |_|_|_|

e % this land under aman cultivation? ....% |_|_|_|

f % this land which is government owned khas land?......% |_|_|_|

g % this land not owned by anyone - common access? .....% |_|_|_|

h % this land owned by people not resident in this mauza/village? ....% |_|_|_|

B.11 Major type of topsoil (% of dry season land area):

1. Sandy (Bele):.....................................% |_|_|_|
2. Sandy-Loam/Silty-Loam (Doas):......................% |_|_|_|
3. Clay (Etel):......................................% |_|_|_|

B.12 What was the total area (acres) of land (above water) in the last monsoon season in the mauza/village? ....Acres |_|_|_|_|

What percentage was under cultivation? ....% |_|_|_|

B.13 First year erosion occurred :................Year |_|_|_|_|

What was the last year erosion occurred?...........Year |_|_|_|_|

[if never eroded code zero]

B.14 Has all the land in the mauza/village ever been totally submerged by the river for more than one full year?.YES/NO |_|_|

If yes, which year did it last disappear? Year |_|_|_|_|

which year did it last re-appear? Year |_|_|_|_|

B.15 When (if ever) was the land in this mauza/village legally recorded? ....Year |_|_|_|_|

C. <u>Migration, Population and Household Numbers in the Mauza/Village</u>

C.1 Population in the Mauza/Village

- Total number of households: ....nos. |_|_|_|_|_|
- Total population:...............................nos. |_|_|_|_|_|

C.2 Migration in last year:

Category	Nos	Area	Reason
Permanent in-migration (hh)			
Permanent out-migration (hh)			
Temprary in-migration (persons)			
Temporary out-migration (persons)			

[Area Code = Main origin (in-migration) or destination (out-migration): 1. Another Island Char 2. Attached Char or Setback Land Left bank 3. Attached Char or Setback Land Right bank 4. Nearby Mainland Left bank 5. Nearby Mainland Right bank 6. Distant Mainland Left bank 7. Distant Mainland Right bank 8. Other (Specify)................
Permanent means that people have no intention of returning
Main Reason Codes: 1.Bank Erosion 2.Char Erosion 3.Flood 4.Seeking Employment 5.Other (Specify)..........]

98

C.3 Settlement history of present inhabitants of mauza/village:

What percentage of households in this mauza/village best fit each of the following categories?

Type of Settlers	HH %
Original settler	
Permanent in-migrant	
Sheltered here during flood only (land not washed away and will return next dry season)	
Uthuli sheltered here waiting for land to re-emerge (submerged 1+ years)	
Sheltered here on own or public land waiting for land to re-emerge (submerged 1+ years)	
Uthuli sheltered here after erosion	
Sheltered here on own or public land after erosion	
Total	100 %

[If there are few households involved respondents may find it easier to give a number, calculate percentages of total in C.1 later, these must add to 100%]

C.4 Duration of Settlement
1.Seasonal 2.Temporary 3.Permanent: .... |_|_|

[seasonal=occupied for part of each year (eg. dry season); temporary=occupied for 1 year or more but expect to move; permanent=+1 year and do not expect to move]

Settlement Pattern
1.Nucleated 2.Scattered 3.Clustered 4.Linear 5.Mixed:...... |_|_|

C.5 Housing type in the Mauza/Village:

Main residential housing structures	%
All kutcha (straw, jute sticks, bamboo, grass, leaves etc.)	
Kutcha with tin roof	
All tin (walls and roof)	
Earth wall (kutcha, tile or tin roof)	
Pucca (brick/concrete wall)	
Total houses	100 %

[Where there are few houses of a type the number may be more accurate but then calculate %.]

D. Infrastructure and Services of the Mauza/Village

D.1 Sources used for drinking water in the mauza/village:

Source of water	No.	%hh in monsoon	%hh in peak flood 1988
Tubewell with handpump			
Hand-dug well			
Pond/beel/khal			
River	na		

D.2 How many pucca latrines are there in the mauza/village

..............nos |_|_|_|

D.3 Are any of the following health care facilities available within the mauza/village?
If no, how far to the one which most people use (in each category)? How accessible is it?

Health care facility	Yes/No	Distance	Access
Government Hospital			
Health care centre			
Family planning centre			
NGO health care facility			
Traditional doctor			
Pharmacy			

[Distance: in miles from centre of this mauza/village
Access: 1 land access throughout year, 2 boat journey needed throughout year, 3 boat journey in monsoon only]

D.4 Communications and Institutions in the Mauza/Village

1. Road length:
   - Brick/Paved: ....km |_|_|_|
   - Earthen:...km |_|_|_|
   - Cart track (Halot):..............................km |_|_|_|
2. Flood Embankments Length: ....km |_|_|_|
3. Launch Ghats:.......................................Nos |_|_|
4. Kheya Ghats:..Nos |_|_|
5. Number of motorised boats based here:...............Nos |_|_|
6. Number of non-motorised boats:......................Nos |_|_|_|
7. Electricity available...........................YES/NO |_|
7. Telephones:...Nos |_|_|
8. Radios:...Nos |_|_|_|
9. Televisions:..Nos |_|_|_|
10. Number of Banks:...................................Nos |_|_|
11. Number of NGOs working in Mauza/Village:...........Nos |_|_|
12. Names of NGO's ________________________________
    ____

28

D.5 Education Institutions
How many of the following are there in the mauza/village?
If none, how far to the one most used by children from the mauza/village?
How accessible is it?

Education facility	No.	Distance	Access
Primary School			
Junior High School (upto class VIII)			
High School			
Madrashas			
Colleges			

[Distance: in miles from centre of this mauza/village
Access: 1 land access throughout year, 2 boat journey needed throughout year, 3 boat journey in monsoon only]

D.6 How many markets of the following kinds are there in the mauza/village?
If none, how far to the one most used by people of this mauza/village?
How accessible is it?

Market type	No.	Distance	Access
Hat			
Bazar			
Major bazar			
Independent shops			
Ferrywallas		NA	NA

[Distance: in miles from centre of this mauza/village
Access: 1 land access throughout year, 2 boat journey needed throughout year, 3 boat journey in monsoon only]

D.7 Date the Mauza/Village was last visited by Government Institutional personnel:

Institutions	Year	Month
Agricultural Extension Officer		
Police Officer		
Health Worker		
Social Welfare Officer		
Veterinary Officer		
Family Welfare Visitor		
NGO Representative		
Others ____________________		

[Code 0 if never visited by that official]

D.8 Does your UP Chairman live in this mauza? ....YES/NO |_|_|
If no, does he live in this Union? ....YES/NO |_|_|

E Socio-Economic and Agricultural Conditions

E.1 What are the main sources of household livelihood in the Mauza/Village?

Main Occupation	% of HHs with Primary source	% of HHs with Secondary source
Cultivating (own or sharecrop land)		
Fishing		
Agricultural labouring		
Non-agricultural labouring		
Transport		
Petty business (daily basis)		
Larger business		
Service		
Paid household work		
Remittances from outside		
Others (specify)		
No livelihood generating activity		
Total	100 %	NA

[Note: main occupation percentages should sum to 100%]

E.2 Cropping Intensity: what percentage of last year's cultivated area of the mauza/village is...
[Actual area may be noted if very small, but calculate % later]

Cropping Intensity	% cultivated area
Single cropped	
Double cropped	
Triple cropped	

E.3 Agricultural Production

What percentage of the cultivated area last year was under each crop? Typically in a normal year what is the average yield? How many times (if any) has this crop been damaged by flood in the last five years (1988-1992)?

Crop	% of cultivated area	average yield (md/acre)	no years in last 5 damaged by flood
Kaun/china			
Ground nut			
Pulses			
Onion			
Til			
Chilies			
Wheat			
Potatoes			
Sweet Potatoes			
Mustard			
Local Boro			
HYV Boro			
Aus paddy			
Jute			
B. Aman			
T. L. Aman			
HYV Aman			
Sugarcane			
Dhaincha			
Catkin grass			
Others (Specify)			

[For crops covering small areas actual acreages may be easier for respondents to estimate in which case the % of cultivated area should be calculated based on the area given in B.10]

E.4 Livestock and Poultry - Estimated Numbers in Mauza/Village

Type	No. in dry season	No. in monsoon
Cattle		
Buffalo		
Goat/sheep		
Chickens/ducks		
Others (specify)		

E.5 Are any of the following tree types present in the mauza/village?

Banana ....YES/NO |_|_|
Babla ....YES/NO |_|_|
Bamboo ....YES/NO |_|_|
Boroi ....YES/NO |_|_|
Mango ....YES/NO |_|_|
Jackfruit ....YES/NO |_|_|

F **Hazard Occurrence and Losses**

F.1 How was the mauza/village affected by floods in the last six years?

Year	% cultivable land flooded	duration (days)	% houses not flooded	% houses flooded > floor and < roof	% houses flooded above roof	% houses destroyed	No human lives lost
1992							
1991							
1990							
1989							
1988							
1987							

[% of land is of land which was or could have been cultivated in the preceding year (dry season or monsoon), but was under water at peak flood time in that year. Duration also applies to peak flood time.]

F.2 How was the mauza/village affected by erosion in the last six years?

Year	Area lost to erosion (acres)	No. homestead plots lost	No. human lives lost
1992			
1991			
1990			
1989			
1988			
1987			

F.3 How many times (if any) have the following occurred in the mauza/village in the last **5 years**? What has been the most important loss? Were there any human deaths? (how many?)

Hazard	No. of occasions	Main loss	Total No. human deaths
Severe storm (with high wind eg tornado)			
Hailstorm			
Drought			
Sand carpeting			
Famine			
Epidemic			
Other (specify)			

[Loss/damage codes: 1.Crop 2.Housing 3.Large/small Livestock 4.Infrastructure (Roads/Buildings) 5.Poultry 6.Human Death 7.Other (Specify)]

G Land settlement and rights

G.1 When land has emerged in this mauza/village (if applicable) have there been problems or disputes over its allocation? (for example cases where the salish is involved, or where cases are registered)
1.Never 2.Up to one a year on average 3.A few in a year
4.Many |_|_|

If yes, were any of the parties involved resident outside the mauza? ....YES/NO |_|_|

Has violence ever been used in land disputes?........YES/NO |_|_|

If yes, were there any deaths?.......................YES/NO |_|_|

ADDITIONAL COMMENTS BY ENUMERATOR ON ANY SPECIAL ISSUES IN THE MAUZA/VILLAGE WHICH ARE NOT COVERED IN THE QUESTIONNAIRE:

Signature of Supervisor
Date: ....

Signature of Enumerator
Date:..................

CODING AND INTERVIEW INSTRUCTIONS:

MAUZA OR VILLAGE?

IF THE MAUZA IS SPLIT WITH ONE OR MORE VILLAGES IN EACH OF TWO PHYSICALLY SEPARATED CHARLAND TYPES YOU MUST FILL OUT A QUESTIONNAIRE FOR EACH PART OF THE MAUZA. FOR EXAMPLE, MAUZA CONTAINS PART OF AN ISLAND CHAR WITH VILLAGE AND AN ATTACHED CHAR WITH TWO VILLAGES, THEN COMPLETE AN INVENTORY FOR THE ISLAND CHAR VILLAGE AND ANOTHER FOR THE ATTACHED CHAR. ALSO SPLIT A MAUZA IF YOU CANNOT FIND RESPONDENTS WHO ARE ABLE TO GIVE A CONSENSUS OF DATA REPRESENTING THE WHOLE MAUZA - FOR EXAMPLE A VERY LARGE MAUZA WITH MANY VILLAGES. IN SUCH CASES YOU SHOULD REFER TO THE VILLAGE(S) WHEREVER THE QUESTIONNAIRE REFERS TO MAUZA, AND MARK ITS BOUNDARY ON THE MAP.

LOCATE MAUZA/VILLAGE ON THE BASE IMAGE, IF THE MAUZA IS SPLIT MARK THE APPROXIMATE ACTUAL BOUNDARIES OF EACH PART OF THE MAUZA WITH A SEPARATE INVENTORY. LIKEWISE IF YOU FIND THE MAUZA ACCORDING TO RESPONDENTS IS IN A DIFFERENT LOCATION OR HAS CLEARLY DIFFERENT BOUNDARIES FROM THOSE ON THE IMAGE PROVIDED, THEN MARK THE BOUNDARIES FOUND IN THE FIELD WHERE THESE DIFFER FROM THOSE ON THE BASE IMAGE, WRITE IN THE NAME OF THE VILLAGE IF A SPLIT MAUZA.

CODES

THE CODE -9 (MINUS NINE) IS USED WHEN DATA IS ***MISSING,*** *FOR EXAMPLE WHEN RESPONDENTS ARE UNABLE TO GIVE AN ANSWER OR WHERE A QUESTION WAS NOT ASKED. THE CODE -8 MEANS (MINUS EIGHT)* ***NOT APPLICABLE*** *- FOR EXAMPLE NO INHABITANTS SO OCCUPATIONS ARE NOT APPLICABLE. 0 MEANS NONE - FOR EXAMPLE JUTE IS NOT GROWN IN A MAUZA SO 0 AREA. IF A MAUZA IS NOT INHABITED AT THE TIME OF SURVEY SECTIONS A, B, C, E.2, E.3, E.4, E.5 NEED TO BE COMPLETED, PLUS F IF OCCUPIED IN ANY YEAR AFTER 1986, THE OTHER SECTIONS ARE "NOT APPLICABLE".*

IN YES/NO QUESTIONS CODES AREA: YES=1, NO=2.

DASHES "-" ARE NOT ACCEPTABLE, USE 0 FOR A NUMBER ZERO (ZERO ACRES, ZERO PERCENT ETC), OR -8 IF NOT APPLICABLE ETC.

যাচাইপত্র--'খ'　　৮ মে, ১৯৯৩ ইং
প্রাথমিক স্তরের জরীপের জন্য

এফ কোড ঃ |　|　|　|　|　|　|　|　|　|　|
সংযুক্ত ক্রম ঃ [　]

১৪৭

বাংলাদেশ ফ্লাড এ্যাকশন প্লান

(বাংলাদেশ বন্যা নিয়ন্ত্রণে কার্যকর পরিকল্পনা)

ফ্যাপ--১৬ পরিবেশ স্টাডি

পপুলেশন এ্যান্ড রিসোর্স ইনভেন্টরী অব চরল্যান্ডস্ ইন দ্য গঙ্গা/পদ্মা/মেঘনা রিভার সিস্টেমস্

(গঙ্গা/পদ্মা/মেঘনা নদীর অন্তর্ভুক্ত চরসমূহের জনসংখ্যা ও সম্পদসমূহের জরীপ)

অংশগ্রহণকারী তথ্যদাতাদের নাম ও পরিচয়

ক্রমিক নং	নাম	বয়স	পরিচয় কোড
১.			
২.			
৩.			
৪.			
৫.			
৬.			

পরিচয় কোড ঃ ১. ইউনিয়ন পরিষদের বর্তমান/সাবেক চেয়ারম্যান, সদস্য/সদস্যা, ২. শিক্ষক, ৩. বেসরকারী প্রতিষ্ঠানের কর্মকর্তা/কর্মী, ৪. স্থানীয় সনাতনী চিকিৎসক, ৫. মসজিদের ইমাম/ধর্মীয় নেতা, ৬. সরকারী কর্মকর্তা/কর্মচারী, ৭. এলাকার প্রবীন ব্যক্তিবৃ, ৮. স্থানীয় ক্লাব/সংস্থার কর্মকর্তা/প্রতিনিধি, ৯. অন্যান্য (উল্লেখ করুন)।

নোট ঃ যেসব ক্ষেত্রে তথ্য "পাওয়া যাবে না" সেসব ক্ষেত্রে কোড নং '-৯' ব্যবহার করুন। উদাহরণঃ যদি উত্তরদাতারা কোন প্রশ্নের উত্তরদানে অক্ষম হন অথবা কোন প্রশ্ন জিজ্ঞাসা করা না হয়। প্রযোজ্য নয়। এসব ক্ষেত্রে কোড নং '-৮' ব্যবহার করুন। উদাহরণঃ যে চরে বসতি নেই সে চরে পেশা সংক্রান্ত প্রশ্ন প্রযোজ্য নয়। যে প্রশ্নের উত্তরে "নাই" হবে সে ক্ষেত্রে কোড "০" হবে। উদাহরণঃ কোন মৌজায় যদি পাট না হয় তবে পাটচাষের জমির পরিমাণ "০" হবে। জরীপ কার্য চলার সময় যদি কোন মৌজা জনবসতিপূর্ণ না হয় সে ক্ষেত্রে শুধুমাত্র সেকশন ক, খ, গ, ঙ২, ঙ৩, ঙ৪, ঙ৫ সমূহ পূরণ করতে হবে। সেই সাথে যদি ১৯৮৬ সালের পর যে কোন বৎসর বসতি থেকে থাকে তবে সেকশন 'চ' অতিরিক্ত পূরণ করতে হবে। বাকী প্রশ্নগুলো প্রযোজ্য নয় '-৮' হবে। উত্তর হ্যাঁ বা না হলে ঃ হ্যাঁ = ১ ও না = ২

কোড

ক. মৌজা/গ্রাম পরিচিতি ঃ

ক.১ মৌজার নাম ঃ ______________________　নদী নং
নদী কোড নং ঃ ১. মেঘনা, ২. পদ্মা, ৩. গঙ্গা　বি, বি, এস নং

ক.২ গ্রামের নাম ঃ ______________________
যদি মৌজাটিতে একাধিক গ্রাম থাকে

ক.৩ চরের নাম ঃ ______________________

ক.৪ জিলা ঃ ______________________

ক.৫ থানা ঃ ______________________

ক.৬ ইউনিয়ন ঃ ______________________

ক.৭ মৌজা বা গ্রামের কেন্দ্র থেকে নিকটতম মূলভূমির দূরত্ব ঃ __________ মাইল

ক.৮ মৌজা/গ্রামের নিকটতম নদী তীর কোন দিকে (১ বাম/২ ডান) __________

ক.৯ মৌজা বা গ্রামটি প্রধানতঃ কোন ধরনের ঃ __________

মৌজা ধরণ ঃ ১. দ্বীপ চর, ২. সংলগ্ন চর, ৩. অন্যান্য অরক্ষিত ভূমি (সেটব্যাক), ৪. ডুবন্ত মৌজা (যদি সম্পূর্ণ মৌজা ডুবন্ত থাকে)

কোড

চর ভূমির গঠন ও প্রকৃতিগত প্রেক্ষাপট

খ.১ ১. অনাবাদী, ২. আবাদী

খ.২ ১. জনবসতীপূর্ণ, ২. জনবসতিহীন

খ.৩ এই চর কোন্ সালে সর্বশেষ জেগে ওঠে ______________________ বৎসর
(মৌজা/গ্রামটির অবস্থান যদি সবসময় থেকে থাকে তবে কোড্ '০' দিন)

খ.৪ যদি ভূমি জেগে থাকে, ১৯৯১ ইংরেজী বছরে জেগে ওঠা এলাকার পরিমাণ________ একর

খ.৫ যদি ভূমি জেগে থাকে, ১৯৯২ ইংরেজী বছরে জেগে ওঠা এলাকার পরিমাণ________ একর

শেষবার চর জেগে ওঠার পর :

খ.৬ কোন সালে প্রথম প্রকৃতিগতভাবে ঘাস-পালা জন্মায়? ______________________ সাল

খ.৭ বসতি স্থাপন কোন্ সালে শুরু হয়? ______________________ সাল

খ.৮ প্রথম চাষাবাদ কোন্ সালে শুরু হয়? ______________________ সাল

সম্পূর্ণ মৌজা (পরিসংখ্যানগত বিশ্লেষণ)

খ.৯ গত শুষ্ক মৌসুমে মৌজার কত অংশ কোন ধরনের চরের অন্তর্ভূক্ত হয়। *(নির্দেশ দেখুন)*

সাধারণ বর্ষায় নিম্নবর্ণিত জমির কত অংশ পানিতে নিমজ্জিত থাকে?

চরের ধরণ	শুষ্ক সময়ে মৌজা এলাকার অংশ (%)	সাধারণ বন্যার সর্বোচ্চ পানির সময় ঐ স্থির শতকরা কতভাগ জলমগ্ন থাকে (%)
দ্বীপ চর		
নদী তীর সংলগ্ন চর		
অন্যান্য অরক্ষিত ভূমি (সেটব্যাক)		
নদীতে নিমজ্জিত (শুষ্ক মৌসুমে জলমগ্ন)		প্রযোজ্য নয়
সর্বমোট	১০০%	প্রযোজ্য নয়

(ছোট জায়গায় বেলায় একরে পরিমাণ নির্ণয় সহজ হইবে, যদি তাই করা হয় তবে তা পরিষ্কারভাবে লিখতে হবে)। প্রথম কলামের যোগ ১০০% হবে। এখানে বালুময়, ঘাসাচ্ছাদিত, চাষকৃত ভূমি অন্তর্ভূক্ত হবে। দ্বিতীয় কলামের প্রতিটি সারি প্রথম কলামের সারির শতকরা কত অংশ স্বাভাবিক বর্ষায় পানিতে নিমজ্জিত থাকে।

খ.১০ গত শুষ্ক মৌসুমে বালুময় এলাকাসহ মৌজা/গ্রামের মোট জমির পরিমাণ কত একর ছিল ?
(পরবর্তী প্রশ্নসমূহ উপরোল্লিখিত ভূমি সংক্রান্ত)

অ- খ.১০ এর শতকরা কত অংশ বসতবাড়ী (গাছপালা, পুকুর সব্জীবাগানসহ) ? %

আ- খ.১০ এর শতকরা কতঅংশ জমিতে গত বৎসর কোন চাষাবাদ হয়নি। (উদাহরণস্বরূপ বসতবাটিসহ বালু বা গোচারণ ভূমি) %

ই- খ.১০ এর শতকরা কত অংশে রবিশস্য/বোরো চাষ করা হয়েছে ? %

ঈ- খ.১০ এর শতকরা কত অংশে খরিফ-১ আউশ/পাট চাষ করা হয়েছে ? %

উ- খ.১০ এর শতকরা কত অংশে আমন চাষ করা হয়েছে ? %

ঊ- খ.১০ এর শতকরা কত অংশে সরকারের খাস জমি ? %

ঋ- খ.১০ এর শতকরা কত অংশ (জনগণের সাধারণ ব্যবহার্য) ব্যক্তিমালিকানাধীন নয় ? %

এ- খ.১০ এর শতকরা কত অংশ এই মৌজা/গ্রামের বাসিন্দার মালিকানাধীন নয় ? %

খ.১১ উপরিভাগের মৃত্তিকার ধরন (শুষ্ক মৌসুমের শতকরা কতভাগ জমি) ?

১. বেলে %

২. বেলে-দোআঁশ/দোআঁশ %

৩. এঁটেল %

খ.১২ গত বর্ষায় মৌজা/গ্রামের মোট কত একর জমি প্লাবনযুক্ত ছিল? একর

ঐ জমির কত অংশে চাষাবাদ হয়েছে? %

১৫৪

১৩ প্রথম কোন বৎসর মৌজায় নদী ভাঙ্গন ঘটেছে — সাল

সর্বশেষ কোন্ সালে নদীভাঙ্গন ঘটেছে — সাল

(যদি কখনোই ভাঙ্গন না ঘটে থাকে তবে কোড় ৪ দিন)

খ.১৪ কখনও কি একটা পুরো বছরের চেয়েও বেশী সময় ধরে মৌজা/গ্রামের সমস্ত জমি নদীতে তলিয়ে ছিলো? — হ্যাঁ / না

১৪.১ যদি 'হ্যাঁ' হয়, তবে সর্বশেষ কোন্ সালে তা পুরোপুরি তলিয়েছিল? — সাল

১৪.২ সর্বশেষ কোন্ সালে ঐ জমি পুনরায় জেগে ওঠে? — সাল

খ.১৫ কোন সালে মৌজা/গ্রামটি সরকারের নথিভূক্ত/রেকর্ড হয় (যদি হয়ে থাকে) — সাল

গ. মৌজা/গ্রাম এর জনস্থানান্তর, জনসংখ্যা ও খানার সংখ্যা

গ.১ মৌজা/গ্রামের জনসংখ্যা

– মোট খানার সংখ্যা — টা

– মোট জনসংখ্যা — জন

গ.২ গত এক বৎসরে জনস্থানান্তর ঃ

ধরণ	সংখ্যা	এলাকা	কারণ
স্থায়ীভাবে আগমন (খানা)			
স্থায়ীভাবে নির্গমন (খানা)			
সাময়িকভাবে আগমন (ব্যক্তি)			
সাময়িকভাবে নির্গমন (ব্যক্তি)			

এলাকা কোড ঃ *প্রধান এলাকা (আগমন) বা গন্তব্যস্থল (নির্গমনের জন্য)*

১. অন্য বালচর; ২. বা তীর সংলগ্ন চর বা 'সেটব্যাক' ভূমি; ৩. ডান তীর সংলগ্ন চর বা 'সেটব্যাক' ভূমি; ৪. বা তীর নিকটবর্তী মূলভূমি; ৫. ডান তীর নিকটবর্তী মূলভূমি; ৬. বা তীর দূরবর্তী মূলভূমি; ৭. ডান তীর দূরবর্তী মূলভূমি; ৮. অন্যান্য (নির্দিষ্ট করে লিখুন)

(উপরে স্থায়ী বলতে আর কখনও ফেরার ইচ্ছে নেই বোঝানো হচ্ছে)

প্রধান কারণ ঃ ১. নদীতীর ভাঙ্গন; ২. চর ভাঙ্গন; ৩. বন্যা; ৪. কর্মসংস্থানের খোঁজে; ৫. অন্যান্য (নির্দিষ্ট করে লিখুন)

গ.৩ মৌজা/গ্রামের বর্তমান বাসিন্দাদের বসতি স্থাপনের ইতিবৃত্ত ঃ

(নিচে বর্ণিত বসতির ধরণ অনুযায়ী প্রযোজ্য খানাসমূহ শতকরা হারে লিখুন)

বসতির ধরণ	খানার %
আদি বসতি	
স্থায়ীভাবে আগত	
শুধুমাত্র বন্যার সময় আশ্রয়গ্রহণকারী (জমি ভেঙ্গে যায়নি পরবর্তী শুষ্ক মৌসুমে ফিরে যাবে)	
উঠুলি, জমি পুনঃজেগে উঠার অপেক্ষায় এখানে আশ্রয় নিয়েছে (ভূমি বৎসরাধিককাল যাবত ডুবে আছে)	
জমি পুনঃজেগে উঠার অপেক্ষায় এখানে নিজ অথবা খাস জমিতে আশ্রয় নিয়েছে (ভূমি বৎসরাধিককাল যাবত ডুবে আছে)	
উঠুলি, নদী ভাঙ্গনের পর এখানে আশ্রয় নিয়েছে	
নদী ভাঙ্গনের পর এখানে নিজ অথবা খাস জমিতে আশ্রয় নিয়েছে	
মোট	১০০ %

খানার সংখ্যা অল্প হলে উত্তরদাতার পক্ষে সংখ্যা বলা সহজ হবে। গ.১ কে মোট ধরে এইসব সংখ্যার শতকরা হার বের করে লিখুন। এই শতকরা হারের যোগফল অবশ্যই ১০০% হবে।

কোড

গ.৪ বসতি স্থাপনের কাল :

১. সাময়িক	২. অস্থায়ী	৩. স্থায়ী

সংজ্ঞা : সাময়িক– প্রতি বৎসরের কিছু সময়কাল/নির্দিষ্ট সময়কাল অবস্থান করেন (শুষ্ক সময়ে)
অস্থায়ী– এক বৎসর বা ততোধিককাল আছেন কিন্তু চলে যাবার আশা করেন
স্থায়ী– এক বৎসর বা তার অধিককাল ধরে আছেন এবং চিরস্থায়ীভাবে বসবাসের আশা করেন

বসতি বিন্যাসের ধরন :

১. কেন্দ্রিক	২. ছড়ানো–ছিটানো	৩. গুচ্ছধরনের	৪. সরলরৈখিক	৫. মিশ্র

গ.৫ মৌজা/গ্রামের ঘরবাড়ির ধরন :

প্রধান আবাসিক ঘর–বাড়ির কাঠামো	%
কাঁচা ঘর (খড়, পাটখড়ি, বাঁশ, ছনপাতা ইত্যাদি)	
কাঁচা ঘর (টিনের চাল)	
সম্পূর্ণ টিনের ঘর (বেড়া ও চালসহ)	
মাটির দেয়াল ঘর (কাঁচা অথবা টিনের চাল/টাইল)	
পাকা (ইট/কংক্রিট দেয়াল)	
মোট ঘর	১০০%

(যেখানে ঘরের সংখ্যা কম সেখানে সরাসরি সংখ্যা থেকে হিসেব করে শতকরা হারে লিখুন।)

ঘ. অবকাঠামো এবং সুযোগসুবিধা (মৌজা/গ্রামে) :

ঘ.১ খাবার পানির উৎস

পানির উৎস	সংখ্যা	% খানা বর্ষাকালে	% খানা ১৯৮৮'র সর্বোচ্চ বন্যায়
১. হাতলযুক্ত নলকূপ			
২. খননকৃত কূয়া			
৩. ডোবা/বিল/পুকুর			
৪. নদী	প্রযোজ্য নয়		

ঘ.২ মৌজায়/গ্রামে কতগুলি পাকা পায়খানা আছে? সংখ্যা __________ টা

ঘ.৩ নিম্নবর্ণিত স্বাস্থ্য সুবিধাদি এই মৌজা/গ্রামে আছে কিনা? যদি না থাকে অধিকাংশ মৌজা/গ্রামবাসীগণ স্বাস্থ্যসুবিধা যেখান থেকে পান সেটা কতদূর? কিভাবে সেখানে যাতায়াত করেন, প্রত্যেক প্রকারের দূরত্ব ও যাতায়াতের ধরন লিখুন :

স্বাস্থ্য সুবিধা	হ্যাঁ/না	দূরত্ব	যাতায়াতের ব্যবস্থা
১. সরকারী হাসপাতাল			
২. স্বাস্থ্য কেন্দ্র			
৩. পরিবার পরিকল্পনা কেন্দ্র			
৪. এনজিও স্বাস্থ্য রক্ষা সুবিধা			
৫. সনাতন চিকিৎসক			
৬. ঔষধের দোকান			

নির্দেশিকা : দূরত্ব – মৌজার কেন্দ্র থেকে দূরত্ব মাইলে লিখুন, ভগ্নাংশের ক্ষেত্রে দশমিক ব্যবহার করুন (যেমন: আধামাইল = .৫০ বা সিকিমাইল = .২৫)
যাতায়াত– ১. সারা বৎসর স্থলপথ, ২. সারা বৎসর নৌকায়, ৩. শুধুমাত্র বর্ষাকালে নৌকায়

কোড

ঘ.৪ মৌজা/গ্রামে যোগাযোগ ও প্রতিষ্ঠান ঃ

১. মৌজা/গ্রামে রাস্তার দৈর্ঘ

ইট বিছানো রাস্তা/পাকা রাস্তা ______________________ মাইল

মাটির রাস্তা ______________________ মাইল

হালট/গরু/মহিষের গাড়ী যাতায়াত রাস্তা ______________________ মাইল

২. বন্যা নিয়ন্ত্রণ বাঁধ ______________________ মাইল

৩. লঞ্চঘাট (সংখ্যা) ______________________ টি

৪. খেয়া ঘাট (সংখ্যা) ______________________ টি

৫. মৌজায়/গ্রামে যন্ত্রচালিত নৌকার সংখ্যা ______________________ টি

৬. মৌজায়/গ্রামে নৌকার সংখ্যা (যন্ত্রচালিত নয়) ______________________ টি

৭. বিদ্যুৎ ব্যবস্থা আছে কিনা ______________________ হ্যাঁ / না

৮. টেলিফোন (সংখ্যা) ______________________ টি

৯. রেডিও (সংখ্যা) ______________________ টি

১০. টেলিভিশন (সংখ্যা) ______________________ টি

১১. ব্যাংক (সংখ্যা) ______________________ টি

১২. মৌজা/গ্রামে কর্মরত এনজিও (সংখ্যা) ______________________ টি

১৩. এনজিও'দের নাম ______________________

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ঘ.৫ শিক্ষা প্রতিষ্ঠানসমূহ

(নিম্নবর্ণিত প্রতিষ্ঠানসমূহের কয়টি মৌজা/গ্রামে/চরে বিদ্যমান। যদি এগুলির একটিও মৌজা/গ্রামে/চরে না থাকে তবে মৌজা/গ্রামের/চরের বেশীরভাগ ছেলেমেয়েরা যে প্রতিষ্ঠান ব্যবহার করে সেই প্রতিষ্ঠান/প্রতিষ্ঠানসমূহ কতদূরে এবং যাতায়াতের ব্যবস্থা লিখুন।)

শিক্ষা ব্যবস্থা সুবিধা	সংখ্যা	দূরত্ব	যাতায়াত ব্যবস্থা
১. প্রাথমিক বিদ্যালয় (সংখ্যা)			
২. জুনিয়র বিদ্যালয় (৮ম শ্রেণী পর্যন্ত)			
৩. উচ্চ বিদ্যালয়			
৪. মাদ্রাসা			
৫. কলেজ			

নির্দেশিকা ঃ দূরত্ব – মৌজার কেন্দ্র থেকে দূরত্ব মাইলে লিখুন, ভগ্নাংশের ক্ষেত্রে দশমিক ব্যবহার করুন (যেমনঃ আধামাইল = .৫০ বা সিকিমাইল = .২৫)

যাতায়াত– ১. সারা বৎসর স্থলপথ; ২. সারা বৎসর নৌকায়; ৩. শুধুমাত্র বর্ষাকালে নৌকায়

৪৮

কোড

৬ মৌজা/গ্রামে হাট–বাজার

(নিম্নবর্ণিত হাটবাজারগুলির মধ্যে কয়টি মৌজা/গ্রামে আছে? যদি এগুলির একটিও মৌজা/গ্রামে না থাকে তবে মৌজা/গ্রামের বেশীরভাগ লোকজন যে হাটবাজারে যায় সেই সমস্ত হাটবাজার কতদূরে এবং যাতায়াতের ব্যবস্থা লিখুন।)

হাটবাজারের প্রকার	সংখ্যা	দূরত্ব	যাতায়াত ব্যবস্থা
১. হাট			
২. বাজার			
৩. বড় বাজার			
৪. দোকান (ব্যক্তি মালিকানাধীন)			
৫. ফেরীওয়ালা		প্রযোজ্য নয়	প্রযোজ্য নয়

নির্দেশিকা : দূরত্ব – মৌজার কেন্দ্র থেকে দূরত্ব মাইলে লিখুন, ভগ্নাংশের ক্ষেত্রে দশমিক ব্যবহার করুন (যেমন: আধামাইল = .৫০ বা সিকিমাইল = .২৫)

যাতায়াত– ১: সারা বৎসর স্থলপথ; ২: সারা বৎসর নৌকায়; ৩: শুধুমাত্র বর্ষাকালে নৌকায়

ঘ.৭ সরকারী প্রাতিষ্ঠানিক দায়িত্ববান ব্যক্তি সর্বশেষ কবে গ্রাম/মৌজায় এসেছেন

প্রতিষ্ঠান	সাল	মাস
কৃষি সম্প্রসারণ কর্মকর্তা/কর্মী		
পুলিশ কর্মকর্তা		
স্বাস্থ্য কর্মী		
সমাজসেবা কর্মকর্তা		
পশুপালন কর্মকর্তা		
পরিবার কল্যাণ পরিদর্শক		
এনজিও প্রতিনিধি		
অন্যান্য ১. ______		

নির্দেশিকা : যদি কখনও পরিদর্শনে কোন কর্মকর্তা/কর্মী না এসে থাকে '০' কোড দিন।

ঘ.৮ ইউনিয়ন পরিষদের চেয়ারম্যান এই মৌজাতে বসবাস করেন কি? হ্যাঁ / না

যদি 'না' হয়, তবে তিনি কি এই ইউনিয়নে বাস করেন? হ্যাঁ / না

কোড

৬. আর্থ–সামাজিক এবং কৃষি বিষয়ক অবস্থা

৬.১ মৌজা/গ্রামের খানাসমূহের জীবনধারনের প্রধান অবলম্বন/উপায়সমূহ কি?

মুখ্য পেশা		শতকরা কতভাগ খানার আয়ের প্রধান উৎস	শতকরা কতভাগ খানার আয়ের গৌণ উৎস
১.	কৃষি (নিজস্ব অথবা বর্গা জমি)		
২.	মৎস্য		
৩.	দিন মজুর (কৃষি)		
৪.	দিন মজুর (অকৃষি)		
৫.	পরিবহণ		
৬.	ক্ষুদ্র ব্যবসায় (দৈনিক ভিত্তিক)		
৭.	বড় ব্যবসায়		
৮.	চাকুরী		
৯.	গৃহস্থালী কাজ (অর্থের বিনিময়ে)		
১০.	বাহির থেকে প্রেরিত অর্থ		
১১.	অন্যান্য (উল্লেখ করুন)		
১২.	জীবিকা নির্বাহের উপযোগী কোন আয় নাই		
	মোট	১০০ %	প্রযোজ্য নয়

(বিঃদ্রঃ প্রধান পেশার যোগফল ১০০% হইবে)

৬.২ ফসলের নিবিড়তা : মৌজা/গ্রামে গত বৎসরের চাষকৃত জমির শতকরা কত অংশ নিম্নোল্লেখিত ধরনের অন্তর্ভূক্ত ছিল।

নির্দেশিকা– *(জমির পরিমাণ কম হলে যথার্থ সংখ্যা একরে নোট করে তারপর শতকরা হারে হিসাব করে লিখুন)*

ফসলের নিবিড়তা	চাষকৃত জমির %
১. এক–ফসলী	
২. দো–ফসলী	
৩. তিন–ফসলী	

৬.৩ কৃষি উৎপাদন

গত বৎসর প্রতি ফসলের জন্য ব্যবহৃত জমির শতকরা পরিমাণ কত? সধারণতঃ প্রাকৃতিক দুর্যোগমুক্ত বৎসরের গড় ফলন কত? গত ৫ (পাঁচ) বৎসরে (১৯৮৮–৯২) যদি ফসলের ক্ষতি হয়ে থাকে তবে কতবার?

ফসল		গত বছর চাষকৃত জমির শতকরা হার (%)	গড় ফলন (মণ/একর)	গত ৫ বৎসরে (১৯৮৮ – ৯২) বন্যায় কত বছর ফসল ক্ষতিগ্রস্ত হয়েছে
১.	কাউন/চিনা			
২.	চীনাবাদাম			
৩.	ডাল			
৪.	পেঁয়াজ			
৫.	তিল			
৬.	মরিচ			
৭.	গম			
৮.	গোল আলু			
৯.	মিষ্টি আলু			
১০.	সরিষা			

১১ দেশী জাতের বোরো			
১২. উফশী বোরো			
১৩. আউশ			
১৪. পাট			
১৫. বোনা আমন			
১৬. রোপা আমন			
১৭. উফশী আমন			
১৮. ইক্ষু			
১৯. ধনচে			
২০. কাশ বন			
২১. অন্যান্য (উল্লেখ করুন)			

(যে সব ফসল অল্প জমিতে চাষ করা হয় সেসব ক্ষেত্রে জমির পরিমাণ একত্রে নোট করে তা ঘ.১০ এর শতকরা কত ভাগ তা হিসেব করে লিখুন)।

ঙ.৪ মৌজা/গ্রামে গৃহপালিত পশু এবং হাঁস-মুরগীর – আনুমানিক সংখ্যা

প্রকরণ	শুষ্ক মওসুমে সংখ্যা	বর্ষাকালে সংখ্যা
১. গরু		
২. মহিষ		
৩. ছাগল/ভেড়া		
৪. হাঁস/মুরগী		
৫. অন্যান্য (উল্লেখ করুন)		

ঙ.৫ নিম্নলিখিত প্রকৃতির কোন গাছ কি এই মৌজা/গ্রামে আছে?

কলা	হ্যাঁ / না
বাবলা	হ্যাঁ / না
বাঁশ	হ্যাঁ / না
বড়ই	হ্যাঁ / না
আম	হ্যাঁ / না
কাঁঠাল	হ্যাঁ / না

চ. দুর্যোগ ও তার ক্ষতির পরিমাণ

চ.১ গত ৬ (ছয়) বৎসরে মৌজা/গ্রামে বন্যায় কিরূপ ক্ষতি হয়েছে?

বৎসর	শতকরা কত ভাগ চাষ যোগ্য জমি প্লাবিত হয়েছে (*) *	কতদিন বন্যা ছিল	শতকরা কতভাগ বাড়ী প্লাবিত হয়নি	মেঝের উপরে এবং ছাদের নীচে পানি ছিল শতকরা কত ভাগ ঘরে	চালের উপরে পানি উঠে- ছিল শতকরা কত ভাগ ঘরে	বিনষ্ট হয়েছে শতকরা কতভাগ ঘর	জীবনহানির সংখ্যা
১৯৯২							
১৯৯১							
১৯৯০							
১৯৮৯							
১৯৮৮							
১৯৮৭							

* [বিগত বছরে (শুষ্ক বা বর্ষায়) শতকরা যে পরিমাণ আবাদযোগ্য জমি চাষ করা যেতো; কিন্তু সর্বোচ্চ বন্যায় ডুবিয়ে ছিলো। কতদিন ডুবিয়ে ছিলো তা সর্বোচ্চ বন্যার সময় থেকে বিবেচনা করবেন।]

চ.২ গত ছয় বৎসরে ভাঙ্গনের ফলে মৌজা/গ্রামের কিরূপ ক্ষতি হয়েছে?

বৎসর	কত একর জমি ভেঙ্গেছে (একর)	কয়টি বাড়ীর ভিটা ভেঙ্গেছে	কতগুলি জীবনহানি হয়েছে
১৯৯২			
১৯৯১			
১৯৯০			
১৯৮৯			
১৯৮৮			
১৯৮৭			

চ.৩ গত পাঁচ বৎসরে নিম্নলিখিত দুর্যোগসমূহ কতবার (যদি হয়ে থাকে) হয়েছে? তন্মধ্যে সবচাইতে গুরুত্বপূর্ণ ক্ষয়ক্ষতি কি? ঐ দুর্যোগে কোন জীবনহানি হয়েছে কি? (কত?)

দুর্যোগ	কতবার ঘটেছে সংখ্যা	প্রধান ক্ষতি (কোড)	জীবনহানির সংখ্যা (জীবনহানি হয়ে থাকলে)
১. বড় রকমের ঝড় (ঘূর্ণিঝড়, যেমনঃ টর্নেডো)			
২. শিলাবৃষ্টি			
৩. খরা			
৪. ভূমিতে বালির স্তর পড়া			
৫. দুর্ভিক্ষ			
৬. রোগ/মহামারী			
৭. অন্যান্য (উল্লেখ করুন)			

ক্ষতি : ১. ফসল; ২. ঘরবাড়ি; ৩. গরু–ছাগল; ৪. অবকাঠামো (রাস্তা/দালানকোঠা);
৫. হাঁস–মুরগী; ৬. মানুষের জীবনহানি/মৃত্যু; ৭. অন্যান্য (নির্দিষ্ট করে লিখুন)

ছ. ভূমি ব্যবস্থা ও স্বত্ব

ছ.১ চর জাগার পর এই মৌজায় ভূমি বন্টন নিয়ে কোন গোলমাল হয়েছিলো কি? (যেমন গ্রাম্য সালিশীর প্রয়োজন পড়েছে অথবা থানায়/কোর্টে মামলা দায়ের করতে হয়েছে।)

নিম্নলিখিত কোডসমূহের মধ্যে যেটি সঠিক সেটি কোড ধরে লিখুন :

কোড : ১. কখনও না; ২. এক বৎসরের মধ্যে গড়ে একটি/একটি বা কম;
৩. এক বৎসরে কয়েকটি; ৪. অনেক

১. যদি সংঘাত হয়ে থাকে তবে এই মৌজার বাহিরে থাকে এমন কোন দল/লোক কি এই সংঘাতে জড়িত ছিল? হ্যাঁ / না

২. জমি সংক্রান্ত সমস্যা নিয়ে কোন সংঘাত হয়েছিলো কি? হ্যাঁ / না

৩. যদি 'হ্যাঁ' হয়, তবে সংঘাতে কি কোন মৃত্যু ঘটেছিল? হ্যাঁ / না

এ প্রশ্নপত্রে উল্লেখ নেই এমন বিশেষ কোন পর্যবেক্ষণ সহ প্রশ্নমালাভুক্ত এলাকার প্রাসঙ্গিক মন্তব্য (প্রয়োজনে অতিরিক্ত সিট ব্যবহার করুন)।

তত্ত্বাবধায়কের স্বাক্ষর ও তারিখ

তথ্যসংগ্রহকারীর পূর্ণনাম স্বাক্ষর ও তারিখ

কোড এবং সাক্ষাৎকার নির্দেশনা ঃ

মৌজা বা গ্রাম ঃ

মৌজাটি যদি চরজাতীয় ভূমি হয় এবং বাস্তবিকই দুই অংশে বিভক্ত থাকে যার প্রতি অংশে এক বা একাধিক গ্রাম রয়েছে সেক্ষেত্রে অবশ্যই মৌজাটির প্রতি অংশের জন্যে একটি করে প্রশ্নপত্র পূরণ করতে হবে। উদাহরণস্বরূপ মৌজাতে একটি গ্রামবিশিষ্ট দ্বীপচর এবং দুইটি গ্রাম বিশিষ্ট নদী তীর সংলগ্ন চর থাকলে সেক্ষেত্রে দ্বীপচরের জন্য একটি এবং নদী তীর সংলগ্ন চরের জন্যে একটি প্রশ্নপত্র (তালিকা প্রণয়ন) পূরণ করতে হবে। এছাড়াও একটি সমগ্র মৌজার প্রতিনিধিত্ব মূলক তথ্য যদি উত্তরদাতা প্রদান করতে অক্ষম হন সে ক্ষেত্রেও একটি মৌজার জন্যে একাধিক প্রশ্নপত্র পূরণ করা যাবে, উদাহরণস্বরূপ অনেক গ্রামসম্বলিত একটি বড় মৌজা। এরূপ ক্ষেত্রে প্রশ্নপত্রের মৌজার জায়গায় গ্রাম বা গ্রামসমূহের নাম লিখতে হবে এবং মানচিত্রে এর সীমানা নির্দেশ করতে হবে।

মূল ইমেজে মৌজা/গ্রাম সনাক্ত করুন, মৌজাটি যদি একাধিক অংশবিশিষ্ট হয় সেক্ষেত্রে প্রতিটি অংশের সীমানা চিহ্নিত করুন এবং প্রতিটির জন্যে আলাদা আলাদা প্রশ্নপত্র ((তালিকা পূরণ করুন। ইমেজে মৌজার অবস্থান যেভাবে দেয়া আছে উত্তরদাতাদের মতে যদি তার অবস্থান ভিন্ন হয় এবং সীমানা সম্পূর্ণ ভিন্ন হয় তবে কার্যক্ষেত্রে প্রাপ্ত সীমানা এবং ইমেজের বিচ্যুতি স্থলগুলো চিহ্নিত করুন এবং মৌজাটি যদি কয়েক অংশে বিভক্ত হয় তবে গ্রামসমূহের নাম লিখুন।

কোডসমূহ ঃ

যেসব ক্ষেত্রে তথ্য পাওয়া যাবে না সেসব ক্ষেত্রে কোড '–৯' লিখুন। উদাহরণস্বরূপ যেসব ক্ষেত্রে কোন উত্তরদাতা কোন প্রশ্নের উত্তর দিতে অক্ষম হবেন বা যেসব ক্ষেত্রে কোন প্রশ্ন জিজ্ঞেস করা হয়নি।

প্রযোজ্য নয় এরূপ ক্ষেত্রে কোড '–৮' লিখুন। উদাহরণস্বরূপ যেখানে জনবসতি নেই সেখানে পেশা প্রশ্ন প্রযোজ্য নয়।

নাই এর ক্ষেত্রে কোড '০' লিখুন। উদাহরণস্বরূপ এলাকায় যদি পাট না জন্মে তবে এক্ষেত্রে '০' লিখুন।

জরীপ চলাকালীন সময়ে যদি মৌজাটি জনবসতিপূর্ণ না হয় সেক্ষেত্রে শুধুমাত্র সেকশন ক, খ, গ, ঙ.২, ঙ.৩, ঙ.৪ এবং ঙ.৫ পূরণ করতে হবে। ১৯৮৬ সাল হতে জরীপ চলাকালীন সময়ের মধ্যবর্তী কোন সময়ে যদি জনবসতি থেকে থাকে তবে সেকশন 'চ'ও পূরণ করতে হবে।

হ্যাঁ/না প্রশ্নসমূহের ক্ষেত্রে কোড হ্যাঁ = ১, না = ২ হবে।

* ড্যাস '–' চিহ্ন গ্রহণযোগ্য নয়।

* শূন্য সংখ্যার জন্য '০' ব্যবহার করুন (উদাহরণস্বরূপ ০ একর, ০% ইত্যাদি। অথবা –৮ প্রযোজ্য নয় এমন ক্ষেত্রে ব্যবহার করুন।

250

APPENDIX B

SUMMARY DATA TABLES BY RIVER REACH AND CHAR TYPE

Note: The areas covered by each river reach and char type are shown in Figure 3.1.

Table B.1 **Gross Study Area by Reach and Char Land Type (Hectares)**

River Reach	Unprotd Mainland West	Attached West	Island Char	Submerged	Attached East	Detached Mainland	Unprotd Mainland	Sub Total Attached	Sub Total Unprotd Mainland	Total
Upper Meghna	7795	5130	11450	1089	6482	14133	4536	11611	12331	50614
Confluence	7350	21515	25616	5407	2589	-	5816	24105	13166	68294
Lower Meghna	1000	10162	35525	10690	5161	-	14256	15323	15256	76794
Total	16144	36807	72591	17186	14232	14133	24608	51039	40753	195702

Source: FAP 19 Satellite Image Estimates Apportioned by Predominant Charland Type

Table B.2 **Water Area By Reach and Char Type From 1993 Imagery (Hectares)**

River Reach	Unprotd Mainland West	Attached West	Island Char	Attached East	Detached Mainland	Unprotd Mainland East	Sub Total Attached	Sub Total Unprotd Mainland	Total
Upper Meghna	1491	1295	4485	2005	1043	813	3300	2304	11133
Confluence	179	4804	15537	1408	-	1407	6212	1585	23335
Lower Meghna	399	3158	25215	2119	-	5345	5277	5744	36237
Total	2069	9258	45238	5533	1043	7565	14790	9634	70705

Source: FAP 19 Satellite Image Estimates Apportioned by Predominant Charland Type

Table B.3 **Sand Area By Reach and Char Type From 1993 Imagery (Hectares)**

River Reach	Unprotd Mainland West	Attached West	Island Char	Attached East	Detached Mainland	Unprotd Mainland East	Sub Total Attached	Sub Total Unprotd Mainland	Total
Upper Meghna	125	139	366	138	101	47	277	172	916
Confluence	73	755	2908	5	-	43	760	115	3783
Lower Meghna	6	54	612	26	-	63	80	69	761
Total	204	948	3886	168	101	153	1116	357	5460

Source: FAP 19 Satellite Image Estimates Apportioned by Predominant Charland Type

Table B.4 **Total Cultivated/Vegetated Area By Reach and Char Type From 1993 Imagery (Hectares)**

River Reach	Unprotd Mainland West	Attached West	Island Char	Attached East	Detached Mainland	Unprotd Mainland East	Sub Total Attached	Sub Total Unprotd Mainland	Total
Upper Meghna	6178	3695	7688	4339	12988	3676	8034	9855	38565
Confluence	7098	15957	12578	1177	-	4367	17133	11465	41177
Lower Meghna	594	6950	20387	3015	-	8849	9966	9443	39796
Total	13871	26602	40653	8531	12988	16892	35133	30762	119537

Source: FAP 19 Satellite Image Estimates Apportioned by Predominant Charland Type

Table B.5 1993 Cultivated Land Areas Calculated from Questionaire Returns and Digitized Mauza Areas (Hectares)

River Reach	Unprotd Mainland West	Attached West	Island Char	Attached East	Detached Mainland	Unprotd Mainland East	Sub Total Attached	Sub Total Unprotd Mainland	Total
Upper Meghna	4980	2966	5988	3683	10817	3028	6649	8008	31462
Confluence	5544	13045	11049	1015	-	3451	14060	8996	34105
Lower Meghna	435	5826	16185	2632	-	7487	8458	7921	32564
Total	10959	21837	33221	7330	10817	13966	29167	24925	98130

Source: FAP 16 Field Survey Mauza Estimates Apportioned by Predominant Charland Type

Table B.6 Population Numbers 1981

River Reach	Unprotd Mainland West	Attached West	Island Char	Submerged	Attached East	Detached Char	Unprotd Mainland East	Sub Total Attached	Sub Total Unprotd Mainland	Total
Upper Meghna	58249	31078	69076	1080	48520	129169	42976	79598	101225	380148
Confluence	73510	113692	61307	11525	20356	-	83979	134048	157489	364369
Lower Meghna	8864	29827	89806	10840	25972	-	61499	55799	70363	226808
Total	140623	174597	220189	23445	94848	129169	188454	269445	329077	971325

Source: BBS Small Area Atlases Apportioned by Predominant Charland Type

Table B.7 Population Numbers 1993

River Reach	Unprotd Mainland West	Attached West	Island Char	Attached East	Detached Mainland	Unprotd Mainland East	Sub Total Attached	Sub Total Unprotd Mainland	Total
Upper Meghna	85711	43692	106532	55129	169248	47719	98821	133430	508031
Confluence	63988	90295	132081	23072	-	108619	113367	172607	418055
Lower Meghna	5039	23450	86872	24997	-	99343	48447	104382	239701
Total	154738	157437	325485	103198	169248	255681	260635	410419	1165787

Source: FAP 16 Field Survey Mauza Estimates Apportioned by Predominant Charland Type

Table B.8 Aggregate Population Densities 1993 per Km Square of Total Area

River Reach	Unprotd Mainland West	Attached West	Island Char	Attached East	Detached Mainland	Unprotd Mainland East	Sub Total Attached	Sub Total Unprotd Mainland	Total
Upper Meghna	1100	852	934	850	1198	1052	851	1082	1027
Confluence	871	420	516	891	-	1868	470	1311	665
Lower Meghna	504	231	245	484	-	697	316	684	363
Total	958	428	449	725	1198	1039	511	1007	653

Source: FAP 16 Field Survey and Landsat Imagery.

Table B.9 **Change in Population Density 1981 to 1993 per Km Square of Total Area**

River Reach	Unprotd Mainland West	Attached West	Island Char	Submerged	Attached East	Detached Mainland	Unprotd Mainland East	Sub Total Attached	Sub Total Unprotd Mainland	Total
Upper Meghna	352	246	328	-99	102	284	105	166	261	253
Confluence	-130	-109	276	-213	105	-	424	-86	115	79
Lower Meghna	-383	-63	-8	-101	-19	-	265	-48	223	17
Total	87	-47	145	-136	59	284	273	-17	200	99

Source: FAP 16 Field Survey and BBS Small Area Atlases Apportioned by Predominant Char Type

Table B.10 **Population Densities 1993 per Km Square of Cultivated/Vegetated Land Area**

River Reach	Unprotd Mainland West	Attachd West	Island Char	Attached East	Detached Mainland	Unprotd Mainland East	Sub Total Attachd	Sub Total Unprotd Mainland	Total
Upper Meghna	1387	1182	1386	1271	1303	1298	1230	1354	1317
Confluence	901	566	1050	1960	-	2487	662	1506	1015
Lower Meghna	848	337	426	829	-	1123	486	1105	602
Total	1116	592	801	1210	1303	1514	742	1334	975

Source: FAP 16 Field Survey Mauza Estimates Apportioned by Predominant Charland Type

Table B.11 **Population Densities 1993 per Km Square of Dry Season Unflooded Land Area**

River Reach	Unprotd Mainland West	Attached West	Island Char	Attached East	Detache Mainland	Unprotd Mainlan East	Sub Tota Attached	Sub Tota Unprotd Mainland	Total
Upper Meghna	1360	1140	1323	1231	1293	1282	1189	1331	1287
Confluence	892	540	853	1952	-	2463	634	1491	930
Lower Meghna	840	335	414	822	-	1115	482	1097	591
Total	1099	571	731	1186	1293	1500	719	1319	933

Source: FAP 16 Field Survey Mauza Estimates Apportioned by Predominant Charland Type

Table B.12 **Household Numbers 1993**

River Reach	Unprotd Mainland West	Attached West	Island Char	Attached East	Detached Mainland	Unprotd Mainland East	Sub Total Attached	Sub Total Unprotd Mainland	Total
Upper Meghna	8891	6254	14525	8772	26038	8242	15026	17133	72722
Confluence	11551	18195	11172	3841	-	18435	22036	29986	63194
Lower Meghna	1043	4174	17589	4338	-	19434	8512	20477	46578
Total	21485	28623	43286	16951	26038	46111	45574	67596	182494

Source: FAP 16 Field Survey Mauza Estimates Apportioned by Predominant Charland Type

Table B.13 **Mean Household Sizes 1993**

River Reach	Unprotd Mainland West	Attached West	Island Char	Attached East	Detached Mainland	Unprotd Mainland East	Sub Total Attached	Sub Total Unprotd Mainland	Total
Upper Meghna	9.6	7.0	6.8	6.3	6.5	5.8	6.6	7.9	7.0
Confluence	5.5	5.0	11.8	6.0	-	5.9	5.1	5.8	6.6
Lower Meghn	4.8	5.6	4.8	5.8	-	5.1	5.7	5.1	5.2
Total	7.2	5.5	7.3	6.1	6.5	5.5	5.7	6.1	6.4

Source: FAP 16 Field Survey Mauza Estimates Apportioned by Predominant Charland Type 1993

Table B.14 **Number of Permanent Out-Migrant Households 1992**

River Reach	Unprotd Mainland West	Attached West	Island Char	Attached East	Detached Mainland	Unprotd Mainland East	Sub Total Attached	Sub Total Unprotd Mainland	Total
Upper Meghna	59	46	101	75	45	71	121	130	397
Confluence	489	510	16	89	-	405	599	894	1509
Lower Meghna	2	116	792	70	-	137	186	139	1117
Total	550	672	904	234	45	613	906	1163	3023

Source: FAP 16 Field Survey Mauza Estimates Apportioned by Predominant Charland Type 1993
Note: 6 Mauzas Have Missing Data.

Table B.15 **Permanent Out-Migrant Household 1992 as Percentage of Char/Reach Type 1993 Households**

River Reach	Unprotd Mainland West	Attached West	Island Char	Attached East	Detached Mainland	Unprotd Mainland East	Sub Total Attached	Sub Total Unprotd Mainland	Total
Upper Meghna	0.66	0.73	0.69	0.85	0.17	1.00	0.80	0.82	0.57
Confluence	4.06	2.73	0.14	2.26	-	2.15	2.65	2.90	2.33
Lower Meghna	0.19	2.70	4.19	1.59	-	0.70	2.14	0.67	2.34
Total	2.50	2.29	2.02	1.36	0.17	1.34	1.95	1.72	1.65

Source: Field Survey Mauza Estimates Apportioned by Predominant Charland Type

Table B.16 **Number of Permanent In-Migrant Households in 1992**

River Reach	Unprotd Mainland West	Attached West	Island Char	Attached East	Detached Mainland	Unprotd Mainland East	Sub Total Attached	Sub Total Unprotd Mainland	Total
Upper Meghna	33	122	186	145	129	5	267	38	620
Confluence	1091	1090	2936	70	-	706	1160	1797	5893
Lower Meghna	7	252	321	0	-	128	252	135	708
Total	1131	1464	3443	215	129	839	1679	1970	7221

Source: FAP 16 Field Survey Mauza Estimates Apportioned by Predominant Charland Type
Note: 19 Mauzas Have Missing Data.

Table B.17 **Permanent In-Migrant Households in 1992 as Percentage of Char/Reach Type 1993 Households**

River Reach	Unprotd Mainland West	Attached West	Island Char	Attached East	Detached Mainland	Unprotd Mainland East	Sub Total Attached	Sub Total Unprotd Mainland	Total
Upper Meghna	0.37	1.95	1.28	1.65	0.50	0.10	1.78	0.24	0.88
Confluence	9.45	5.99	26.28	1.82	-	3.83	5.26	5.99	9.33
Lower Meghna	0.67	6.04	1.77	0.00	-	0.66	2.96	0.66	1.52
Total	5.26	5.11	7.86	1.27	0.50	1.86	3.68	2.96	3.98

Source: FAP 16 Field Survey Mauza Estimates Apportioned by Predominant Charland Type 1993

Table B.18 **Number of Seasonal Out-Migrant in 1992**

River Reach	Unprotd Mainland West	Attached West	Island Char	Attached East	Detached Mainland	Unprotd Mainland East	Sub Total Attached East	Sub Total Unprotd Mainland	Total
Upper Meghna	0	0	186	12	96	144	12	144	438
Confluence	153	20	250	100	-	74	120	227	597
Lower Meghna	218	320	1836	100	-	447	420	665	2921
Total	371	340	2272	212	96	665	552	1036	3956

Source: FAP 16 Field Survey Mauza Estimates Apportioned by Predominant Charland Type 1993
Note: 5 Mauzas Have Missing Data.

Table B.19 **Seasonal Out-Migrants in 1992 as Percentage of Char/Reach Type 1993 Households.**

River Reach	Unprotd Mainland West	Attached West	Island Char	Attached East	Detached Mainland	Unprotd Mainland East	Sub Total Attached	Sub Total Unprotd Mainland	Total
Upper Meghna	0.00	0.00	1.28	0.14	0.37	2.10	0.08	0.90	0.62
Confluence	1.32	0.11	2.24	2.60	-	0.40	0.54	0.76	0.94
Lower Meghna	20.90	7.67	10.13	2.31	-	2.30	4.93	3.25	6.22
Total	1.73	1.19	5.18	1.25	0.37	1.48	1.21	1.56	2.19

Source: FAP 16 Field Survey Mauza Estimates Apportioned by Predominant Charland Type 1993

Table B.20 **Number of Seasonal In-Migrants in 1992**

River Reach	Unprotd Mainland West	Attached West	Island Char	Attached East	Detached Mainland	Unprotd Mainland	Sub Total Attached East	Sub Total Unprotd Mainland	Total
Upper Meghna	30	305	0	9	0	2	314	32	346
Confluence	215	387	1298	7	-	112	394	327	2019
Lower Meghna	83	425	1378	0	-	229	425	312	2115
Total	328	1117	2676	16	0	343	1133	671	4480

Source: FAP 16 Field Survey Mauza Estimates Apportioned by Predominant Charland Type 1993
Note: 6 Mauzas Have Missing Data.

Table B.21 Seasonal In-Migrants in 1992 as Percentage of Char/Reach Type 1993 Households

River Reach	Unprotd Mainland West	Attached West	Island Char	Attached East	Detached Mainland	Unprotd Mainland East	Sub Total Attached	Sub Total Unprotd Mainland	Total
Upper Meghna	0.34	4.88	0.00	0.10	0.00	0.04	2.09	0.21	0.49
Confluence	1.86	2.13	11.62	0.18	-	0.61	1.79	1.09	3.19
Lower Meghna	7.96	10.18	7.60	0.00	-	1.18	4.99	1.52	4.50
Total	1.53	3.90	6.11	0.09	0.00	0.76	2.49	1.01	2.47

Source: FAP 16 Field Survey Mauza Estimates Apportioned by Predominant Charland Type 1993

Table B.22 Number of Mauzas with Primary School

River Reach	Unprotd Mainland West	Attached West	Island Char	Attached East	Detached Mainland	Unprotd Mainland East	Sub Total Attached	Sub Total Unprotd Mainland	Total
Upper Meghna	13	11	30	15	46	16	26	29	131
Confluence	25	25	21	6	0	17	31	42	94
Lower Meghna	2	9	31	5	0	12	14	14	59
Total	40	45	82	26	46	45	71	85	284

Source: FAP 16 Field Survey

Table B.23 Number of Mauzas with High School

River Reach	Unprotd Mainland West	Attached West	Island Char	Attached East	Detached Mainland	Unprotd Mainland East	Sub Total Attached	Sub Total Unprotd Mainland	Total
Upper Meghna	4	1	4	6	10	6	7	10	31
Confluence	5	9	4	1	0	7	10	12	26
Lower Meghna	1	2	3	2	0	2	4	3	10
Total	10	12	11	9	10	15	21	25	67

Source: FAP 16 Field Survey

Table B.24 Number of Mauzas with Health Care Facilities

River Reach	Unprotd Mainland West	Attached West	Island Char	Attached East	Detached Mainland	Unprotd Mainland East	Sub Total Attached	Sub Total Unprotd Mainland	Total
Upper Meghna	7	0	6	2	10	5	2	12	30
Confluence	6	6	3	0	0	3	6	9	18
Lower Meghna	1	0	2	2	0	4	2	5	9
Total	14	6	11	4	10	12	10	26	57

Source: FAP 16 Field Survey

Table B.25 **Number of Households with Agriculture as their Main Occupation in 1993**

River Reach	Unprotd Mainland West	Attached West	Island Char	Attached East	Detached Mainland	Unprotd Mainland East	Sub Total Attached Mainland	Sub Total Unprotd	Total
Upper Meghna	4535	2986	6383	4719	14077	4913	7705	9449	37613
Confluence	5035	8314	4604	1129	-	7517	9443	12552	26600
Lower Meghna	436	1298	8426	1556	-	6929	2854	7366	18646
Total	10007	12599	19413	7404	14077	19359	20002	29366	82858

Source: FAP 16 Field Survey Mauza Estimates Apportioned by Predominant Charland Type 1993

Table B.26 **Percentage of Households with Agriculture as their Main Occupation in 1993**

River Reach	Unprotd Mainland West	Attached West	Island Char	Attached East	Detached Mainland	Unprotd Mainland East	Sub Total Attached	Sub Total Unprotd Mainland	Total
Upper Meghna	51	48	44	54	54	60	51	55	52
Confluence	44	46	41	29	-	41	43	42	42
Lower Meghna	42	31	48	36	-	36	34	36	40
Total	47	44	45	44	54	42	44	43	45

Source: FAP 16 Field Survey Mauza Estimates Apportioned by Predominant Charland Type 1993

Table B.27 **Number of Households with Fishing as their Main Occupation in 1993**

River Reach	Unprotd Mainland West	Attached West	Island Char	Attached East	Detached Mainland	Unprotd Mainland East	Sub Total Attached	Sub Total Unprotd Mainland	Total
Upper Meghna	1054	1215	2222	1381	2855	1226	2596	2280	9954
Confluence	888	3053	3152	815	-	1616	3868	2504	9523
Lower Meghna	290	1602	4702	1664	-	7716	3266	8006	15975
Total	2232	5869	10076	3861	2855	10558	9730	12790	35452

Source: FAP 16 Field Survey Mauza Estimates Apportioned by Predominant Charland Type 1993

Table B.28 **Percentage of Households with Fishing as their Main Occupation in 1993**

River Reach	Unprotd Mainland West	Attached West	Island Char	Attached East	Detached Mainland	Unprotd Mainland East	Sub Total Attached	Sub Total Unprotd Mainland	Total
Upper Meghna	12	19	15	16	11	15	17	13	14
Confluence	8	17	28	21	-	9	18	8	15
Lower Meghna	28	38	27	38	-	40	38	39	34
Total	10	21	23	23	11	23	21	19	19

Source: FAP 16 Field Survey Mauza Estimates Apportioned by Predominant Charland Type 1993

228

Table B.29 Percentage of Households with Fishing as Second Occupation in 1993

River Reach	Unprotd Mainland West	Attached West	Island Char	Attached East	Detached Mainland	Unprotd Mainland East	Sub Total Attached	Sub Total Unprotd Mainland	Total
Upper Meghna	12	15	17	11	7	16	13	14	12
Confluence	5	10	22	13	-	11	10	9	11
Lower Meghna	32	21	31	36	-	30	29	30	30
Total	9	13	24	18	7	20	15	16	16

Source: FAP 16 Field Survey Mauza Estimates Apportioned by Predominant Charland Type 1993

Table B.30 Main Occupation (Percentages of Households) by Char Types

Main Occupation	Island Char	Attached Char	Unprotected Mainland	Detached Mainland	Total
Cultivating	44.8	43.9	43.4	54.1	45.4
Fishing	23.3	21.4	18.9	11.0	19.4
Agric.Labour	17.5	16.3	17.7	14.4	16.8
Non Agric Labour	5.1	5.7	5.9	4.6	5.5
Transport	1.5	2.8	3.3	1.9	2.5
Petty Business	3.0	4.9	5.4	4.5	4.5
Large Business	.6	.6	.7	.5	.6
Service	2.5	1.4	2.2	7.1	2.8
Paid HH Work	.8	1.9	1.1	.7	1.2
Remit.From Abroad	.6	.4	.6	1.0	.6
Others	.0	.2	.1	.1	.1
No Livelihood	.3	.6	.7	.2	.5
Total	100.0	100.0	100.0	100.0	100.0

Source: FAP 16 Field Survey Mauza Estimates Apportioned by Predominant Charland Type 1993

Table B.31 Cropping Intensities (percentage of cultivable land cultivated in a year)

River Reach	Unprotd Mainland West	Attached West	Island Char	Attached East	Detached Mainland	Unprotd Mainland East	Sub Total Attached	Sub Total Unprotd Mainland	Total
Upper Meghna	170	120	133	176	147	133	184	156	155
Confluence	157	131	164	194	0	238	125	188	145
Lower Meghna	160	133	149	166	0	124	142	127	150
Total	163	138	147	175	147	156	143	159	150

Source: FAP 16 Field Survey Estimates Apportioned by Predominant Charland Type
Note: 2 Mauzas with Missing Data.

Table B.32 Average Percentage of Sandy Land Reported

River Reach	Unprotd Mainland West	Attached West	Island Char	Attached East	Detached Mainland	Unprotd Mainland East	Sub Total Attached	Sub Total Unprotd Mainland	Total
Upper Meghna	40	31	28	21	9	13	24	27	21
Confluence	21	34	61	27	0	20	33	21	37
Lower Meghna	9	26	9	20	0	15	25	13	12
Total	28	31	29	22	9	15	28	22	24

Source: FAP 16 Field Survey Estimates Apportioned by Predominant Charland Type
Note: 2 Mauzas with Missing Data.

Table B.33 Cropping Pattern (percentage of cultivable land under main crops)

Crop	Island Char	Attached Char	Detached mainland	Unprotected mainland	Upper	Conflu -ence	Lower	Total
Kaon	1.7	3.3	3.0	2.3	2.8	1.8	2.9	2.5
Groundnut	3.1	1.3	1.5	2.1	4.9	1.2	0.4	2.1
Dhal	4.3	8.6	2.9	4.4	2.6	10.1	3.4	5.4
Onion	2.1	2.9	1.9	0.8	3.0	3.7	2.0	2.9
Til	3.5	3.2	9.9	3.0	6.4	3.0	2.6	4.0
Chilli	6.7	6.4	5.3	8.6	5.7	7.2	7.9	6.9
Wheat	4.5	10.4	10.3	8.5	8.4	11.1	3.8	7.8
Potato	2.7	7.0	8.1	10.8	13.1	6.3	0.8	6.7
Sweet Potato	3.6	3.5	5.3	7.3	7.1	3.7	3.4	4.7
Mustard	2.0	4.0	9.4	5.2	7.2	3.7	1.8	4.2
L Boro	30.0	15.2	5.1	9.4	6.5	10.1	33.8	16.8
HYV Boro	17.3	11.4	19.7	14.2	20.9	6.0	18.4	14.9
Aus	13.9	22.4	9.3	23.5	10.8	30.1	13.3	18.3
Jute	5.0	8.4	10.4	12.2	11.9	8.3	5.0	8.4
B Aman	19.4	22.9	34.7	27.4	27.6	27.8	16.8	24.1
TL Aman	23.7	8.2	3.6	6.3	6.3	5.4	25.5	12.4
HYV Aman	4.4	2.1	0.6	4.8	4.3	2.0	3.9	3.4
Sugarcane	0.4	0.4	0	1.1	0.3	1.1	0.1	0.5
Dhaincha	2.3	1.2	2.4	2.1	2.3	1.7	1.9	1.9
Others	1.3	1.6	4.7	1.3	2.8	0.7	1.6	1.6
Total	151.9	144.4	148.1	155.3	154.9	145.0	149.3	149.5

Source: FAP 16 Inventory Survey

890

Table B.34 **Mean Yields (tn/ha) of Main Crops**

Crop	Island Char	Attached Char	Detached mainland	Unprotected mainland	Total
Kaon	1.26	1.65	1.44	1.41	1.44
Groundnut	2.31	1.82	1.85	2.02	2.01
Dhal	0.87	1.17	1.16	1.20	1.08
Onion	7.34	7.61	6.71	6.59	6.97
Til	0.90	1.26	1.12	1.35	1.14
Chilli	1.21	1.96	0.89	2.00	1.58
Wheat	2.07	2.05	2.20	2.02	2.07
Potato	19.85	24.92	18.20	19.28	20.38
Sweet Potato	21.07	20.14	19.27	19.51	20.03
Mustard	1.24	1.35	1.12	1.41	1.30
L Boro	2.87	2.47	2.09	2.56	2.62
HYV Boro	5.08	4.16	4.26	4.22	4.52
Aus	1.85	1.87	1.44	1.79	1.76
Jute	1.95	1.93	2.41	1.74	1.95
B Aman	2.34	2.12	2.17	1.93	2.13
TL Aman	3.26	2.55	2.22	2.57	2.79
HYV Aman	4.21	2.62	1.68	2.55	3.03

Source: FAP 16 Inventory Survey

Table: B.35 **Number of Mauzas Which Have Faced Problems of Land Disputes/Allocation**

River Reach	Unprotd Mainland West	Attached West	Island Char	Attached East	Detached Mainland	Unprotd Mainland East	Sub Total Attached	Sub Total Unprotd Mainland	Total
Upper Meghna	11	10	17	12	19	13	22	24	82
Confluence	28	21	26	11	-	18	32	46	104
Lower Meghna	2	9	82	4	-	12	13	14	109
Total	41	40	125	27	19	43	67	84	295

Source: FAP 16 Field Survey Mauza Estimates Apportioned by Predominant Charland Type 1993
Note: 4 Mauzas Have Missing Data.

Table B.36 Total Number of Large Livestock in 1993 Dry Season

River Reach	Unprotd Mainland West	Attached West	Island Char	Attached East	Detached Mainland	Unprotd Mainland East	Sub Total Attached	Sub Total Unprotd Mainland	Total
Upper Meghna	5516	3083	8405	7818	28464	13607	10901	19123	66893
Confluence	12794	9719	4644	2333	0	10110	12052	22904	39600
Lower Meghna	503	1898	19044	720	0	4829	2618	5332	26994
Total	18813	14700	32093	10871	28464	28546	25571	47359	133487

Source: FAP 16 Field Survey Estimates Apportioned by Predominant Charland Type
Note: 2 Mauzas with Missing Data.

Table B.37 Total Number of Large Livestock in 1992 Monsoon Season

River Reach	Unprotd Mainland West	Attached West	Island Char	Attached East	Detached Mainland	Unprotd Mainland East	Sub Total Attached	Sub Total Unprotd Mainland	Total
Upper Meghna	3400	2237	5631	6599	22750	11157	8836	14557	51774
Confluence	8470	6773	3649	2235	0	8181	9008	16651	29308
Lower Meghna	438	1620	18111	574	0	3455	2194	3893	24198
Total	12308	10630	27391	9408	22750	22793	20038	35101	105280

Source: FAP 16 Field Survey Estimates Apportioned by Predominant Charland Type
Note: 2 Mauzas with Missing Data.

Table B.38 Large Livestock per Cultivated km Square in 1993

River Reach	Unprotd Mainland West	Attached West	Island Char	Attached East	Detached Mainland	Unprotd Mainland East	Sub Total Attached	Sub Total Unprotd Mainland	Total
Upper Meghna	89	83	109	180	219	370	136	194	173
Confluence	180	61	37	198	0	232	70	200	96
Lower Meghna	85	27	93	24	0	55	26	56	68
Total	136	55	79	127	219	169	73	154	112

Source: FAP 16 Field Survey Estimates Apportioned by Predominant Charland Type
Note: 2 Mauzas with Missing Data.

Table B.39 Large Livestock per km Square Dry Season Land in 1993

River Reach	Unprotd Mainland West	Attached West	Island Char	Attached East	Detached Mainland	Unprotd Mainland East	Sub Total Attached	Sub Total Unprotd Mainland	Total
Upper Meghna	88	80	104	175	217	365	131	191	169
Confluence	178	58	30	197	0	229	67	198	88
Lower Meghna	84	27	91	24	0	54	26	56	67
Total	134	53	72	125	217	167	71	152	107

Source: FAP 16 Field Survey Estimates Apportioned by Predominant Charland Type
Note: 2 Mauzas with Missing Data

Table B.40 Number of Large Livestock per 100 Households in 1993

River Reach	Unprotd Mainland West	Attached West	Island Char	Attached East	Detached Mainland	Unprotd Mainland East	Sub Total Attached	Sub Total Unprotd Mainland	Total
Upper Meghna	62	49	58	89	109	165	73	112	92
Confluence	111	53	42	61	0	55	55	76	63
Lower Meghna	48	45	108	17	0	25	31	26	58
Total	88	51	74	64	109	62	56	70	73

Source: FAP 16 Field Survey Estimates Apportioned by Predominant Charland Type
Note: 2 Mauzas with Missing Data

Table B.41 Total Number of Small Livestock (Goat/Sheep) in 1993 Dry Season

River Reach	Unprotd Mainland West	Attached West	Island Char	Attached East	Detached Mainland	Unprotd Mainland East	Sub Total Attached	Sub Total Unprotd Mainland	Total
Upper Meghna	8249	5167	11513	9393	36549	13684	14560	21933	84555
Confluence	12112	8112	4954	2373	0	9417	10485	21529	36968
Lower Meghna	258	1665	6366	1950	0	3478	3615	3736	13717
Total	20619	14344	22833	13716	36549	26579	28660	47198	135240

Source: FAP 16 Field Survey Estimates Apportioned by Predominant Charland Type
Note: 2 Mauzas with Missing Data

Table B.42 Density of Small Livestock in 1993 to Dry Season Land Area

River Reach	Unprotd Mainland West	Attached West	Island Char	Attached East	Detached Mainland	Unprotd Mainland East	Sub Total Attached	Sub Total Unprotd Mainland	Total
Upper Meghna	131	135	143	210	279	368	175	219	214
Confluence	169	49	32	201	0	214	59	186	82
Lower Meghna	43	24	30	64	0	39	36	39	34
Total	146	54	51	158	279	156	79	152	108

Source: FAP 16 Field Survey Estimates Apportioned by Predominant Charland Type
Note: 2 Mauzas with Missing Data.

Table B.43 Ratio of Small Livestock to 100 Human Households in 1993

River Reach	Unprotd Mainland West	Attached West	Island Char	Attached East	Detached Mainland	Unprotd Mainland East	Sub Total Attached	Sub Total Unprotd Mainland	Total
Upper Meghna	93	83	79	107	140	166	97	128	116
Confluence	105	45	44	62	0	51	48	72	58
Lower Meghna	25	40	36	45	0	18	42	18	29
Total	96	52	53	81	140	58	63	70	74

Source: FAP 16 Field Survey Estimates Apportioned by Predominant Charland Type
Note: 2 Mauzas with Missing Data

Table B.44 Total Number of Poultry in 1993

River Reach	Unprotd Mainland West	Attached West	Island Char	Attached East	Detached Mainland	Unprotd Mainland East	Sub Total Attached	Sub Total Unprotd Mainland	Total
Upper Meghna	26432	21674	38110	19880	81355	26793	41554	53225	214244
Confluence	31757	25893	17244	6575	0	34328	32468	66085	115797
Lower Meghna	970	5938	35840	5450	0	10098	11388	11068	58296
Total	59159	53505	91194	31905	81355	71219	85410	130378	388337

Source: FAP 16 Field Survey Estimates Apportioned by Predominant Charland Type
Note: 2 Mauzas with Missing Data

Table B.45 Ratio of Poultry Per 100 Human Households in 1993

River Reach	Unprotd Mainland West	Attached West	Island Char	Attached East	Detached Mainland	Unprotd Mainland East	Sub Total Attached	Sub Total Unprotd Mainland	Total
Upper Meghna	297	347	262	227	312	325	277	311	295
Confluence	275	142	154	171	0	186	147	220	183
Lower Meghna	93	142	204	126	0	52	134	54	125
Total	275	189	211	188	312	154	187	193	213

Source: FAP 16 Field Survey Estimates Apportioned by Predominant Charland Type
Note: 2 Mauzas with Missing Data

Table B.46 Number of Non-Mechanized Boats in 1993

River Reach	Unprotd Mainland West	Attached West	Island Char	Attached East	Detached Mainland	Unprotd Mainland East	Sub Total Attached	Sub Total Unprotd Mainland	Total
Upper Meghna	2211	1752	4656	1133	3418	378	2885	2589	13548
Confluence	1999	1229	1165	397	0	941	1626	2940	5731
Lower Meghna	137	428	1720	265	0	527	693	664	3077
Total	4347	3409	7541	1795	3418	1846	5204	6193	22356

Source: FAP 16 Field Survey Estimates Apportioned by Predominant Charland Type
Note: 11 Mauzas with Missing Data.

Table B.47 Households Per Non-Mechanized Boat in 1993

River Reach	Unprotd Mainland West	Attached West	Island Char	Attached East	Detached Mainland	Unprotd Mainland East	Sub Total Attached	Sub Total Unprotd Mainland	Total
Upper Meghna	4	4	3	8	8	22	5	7	5
Confluence	6	15	10	10	0	20	14	10	11
Lower Meghna	8	10	10	16	0	37	12	31	15
Total	5	8	6	9	8	25	9	11	8

Source: FAP 16 Field Survey Estimates Apportioned by Predominant Charland Type
Note: 11 Mauzas with Missing Data.

298

Table B.48 **Number of Mechanized Boats in 1993**

River Reach	Unprotd Mainland West	Attached West	Island Char	Attached East	Detached Mainland	Unprotd Mainland East	Sub Total Attached	Sub Total Unprotd Mainland	Total
Upper Meghna	247	164	478	150	408	114	314	361	1561
Confluence	311	180	296	38	0	93	218	404	918
Lower Meghna	33	86	241	107	0	221	193	254	688
Total	591	430	1015	295	408	428	725	1019	3167

Source: FAP 16 Field Survey Estimates Apportioned by Predominant Charland Type
Note: 2 Mauzas with Missing Data.

Table B.49 **Households Per Mechanized Boats in 1993**

River Reach	Unprotd Mainland West	Attached West	Island Char	Attached East	Detached Mainland	Unprotd Mainland East	Sub Total Attached	Sub Total Unprotd Mainland	Total
Upper Meghna	36	38	30	58	64	72	48	47	47
Confluence	37	101	38	101	0	198	101	74	69
Lower Meghna	32	49	73	41	0	88	44	81	68
Total	36	67	43	57	64	108	63	66	58

Source: FAP 16 Field Survey Estimates Apportioned by Predominant Charland Type
Note: 2 Mauzas with Missing Data.

Table B.50 **Number of Human Deaths (Indirect and Direct) from the 1988 Flood**

River Reach	Unprotd Mainland West	Attached West	Island Char	Attached East	Detached Mainland	Unprotd Mainland East	Sub Total Attached	Sub Total Unprotd Mainland	Total
Upper Meghna	85	11	126	15	100	34	26	119	371
Confluence	43	49	10	4	0	3	53	46	109
Lower Meghna	0	51	28	37	0	68	88	68	184
Total	128	111	164	56	100	105	167	233	664

Source: FAP 16 Field Survey Estimates Apportioned by Predominant Charland Type
Note: 3 Mauzas with Missing Data.

Table B.51 **1988 Floods Deaths per 100,000 People (1993 Population)**

River Reach	Unprotd Mainland West	Attached West	Island Char	Attached East	Detached Mainland	Unprotd Mainland East	Sub Total Attached	Sub Total Unprotd Mainland	Total
Upper Meghna	99	25	118	27	59	71	26	9	73
Confluence	67	54	8	17	0	3	47	27	26
Lower Meghna	0	217	32	148	0	68	182	65	77
Total	83	71	50	54	59	41	64	57	57

Source: FAP 16 Field Survey Estimates Apportioned by Predominant Charland Type
Note: 3 Mauzas with Missing Data.

Table B.52 Number of Human Deaths from Epidemic Disease 1988-92

River Reach	Unprotd Mainland West	Attached West	Island Char	Attached East	Detached Mainland	Unprotd Mainland East	Sub Total Attached	Sub Total Unprotd Mainland	Total
Upper Meghna	256	118	125	92	351	151	210	407	1093
Confluence	205	158	57	33	0	95	191	300	548
Lower Meghna	22	69	205	93	0	193	162	215	582
Total	483	345	387	218	351	439	563	922	2223

Source: FAP 16 Field Survey Estimates Apportioned by Predominant Charland Type
Note: 2 Mauzas with Missing Data.

Table B.53 Death From Epidemic Disease in 1988-92 per 100,000 People (1993 Population)

River Reach	Unprotd Mainland West	Attached West	Island Char	Attached East	Detached Mainland	Unprotd Mainland East	Sub Total Attached	Sub Total Unprotd Mainland	Total
Upper Meghna	299	270	117	167	207	316	213	305	215
Confluence	320	175	43	143	0	87	168	174	131
Lower Meghna	437	294	236	372	0	194	334	206	243
Total	312	219	119	211	207	172	216	225	191

Source: FAP 16 Field Survey Estimates Apportioned by Predominant Charland Type
Note: 2 Mauzas with Missing Data.

Table B.54 Percentage of Area Flooded at Peak Flood Time 1987

River Reach	Unprotd Mainland West	Attached West	Island Char	Attached East	Detached Mainland	Unprotd Mainland East	Sub Total Attached	Sub Total Unprotd Mainland	Total
Upper Meghna	95	89	96	78	78	60	83	82	84
Confluence	77	91	60	80	0	78	91	78	81
Lower Meghna	22	65	16	100	0	99	76	94	52
Total	82	84	44	86	78	85	85	84	72

Source: FAP 16 Field Survey Estimates Apportioned by Predominant Charland Type
Note: 4 Mauzas with Missing Data.

Table B.55 Mean Days Duration of Flooding 1987

River Reach	Unprotd Mainland West	Attached West	Island Char	Attached East	Detached Mainland	Unprotd Mainland East	Sub Total Attached	Sub Total Unprotd Mainland	Total
Upper Meghna	186	139	76	45	27	22	80	111	72
Confluence	35	35	55	37	0	40	35	36	40
Lower Meghna	6	21	6	33	0	36	24	26	13
Total	91	56	37	41	27	31	50	66	48

Source: FAP 16 Field Survey Estimates Apportioned by Predominant Charland Type
Note: 19 Mauzas with Missing Data.

Table B.56 Percentage of Area Flooded at Peak Flood Time 1988

River Reach	Unprotd Mainland West	Attached West	Island Char	Attached East	Detached Mainland	Unprotd Mainland East	Sub Total Attached	Sub Total Unprotd Mainland	Total
Upper Meghna	100	100	100	100	100	100	100	100	100
Confluence	100	100	96	99	0	100	100	100	99
Lower Meghna	32	93	24	100	0	100	95	96	61
Total	97	98	57	100	100	100	99	99	87

Source: FAP 16 Field Survey Estimates Apportioned by Predominant Charland Type
Note: 3 Mauzas with Missing Data.

Table B.57 Mean Days Duration of Flooding 1988

River Reach	Unprotd Mainland West	Attached West	Island Char	Attached East	Detached Mainland	Unprotd Mainland East	Sub Total Attached	Sub Total Unprotd Mainland	Total
Upper Meghna	205	156	92	58	41	35	92	127	86
Confluence	32	41	44	43	0	46	41	37	40
Lower Meghna	12	26	7	42	0	44	31	33	16
Total	98	65	42	53	41	41	60	74	56

Source: FAP 16 Field Survey Estimates Apportioned by Predominant Charland Type
Note: 5 Mauzas with Missing Data.

Table B.58 Percentage of Area Flooded at Peak Flood Time 1991

River Reach	Unprotd Mainland West	Attached West	Island Char	Attached East	Detached Mainland	Unprotd Mainland East	Sub Total Attached	Sub Total Unprotd Mainland	Total
Upper Meghna	87	77	94	71	67	28	74	65	73
Confluence	67	84	44	58	0	52	83	61	66
Lower Meghna	23	51	14	85	0	99	61	94	47
Total	74	75	39	74	67	71	74	73	62

Source: FAP 16 Field Survey Estimates Apportioned by Predominant Charland Type
Note: 3 Mauzas with Missing Data.

Table B.59 Mean Days Duration of Flooding 1991

River Reach	Unprotd Mainland West	Attached West	Island Char	Attached East	Detached Mainland	Unprotd Mainland East	Sub Total Attached	Sub Total Unprotd Mainland	Total
Upper Meghna	141	112	75	33	16	15	66	84	60
Confluence	30	31	28	28	0	26	30	29	29
Lower Meghna	4	15	5	34	0	32	21	23	11
Total	71	46	26	32	16	23	41	50	37

Source: FAP 16 Field Survey Estimates Apportioned by Predominant Charland Type
Note: 60 Mauzas with Missing Data.

Table B.60 Percentage of Area Flooded During 1989-92

River Reach	Unprotd Mainland West	Attached West	Island Char	Attached East	Detached Mainland	Unprotd Mainland East	Sub Total Attached	Sub Total Unprotd Mainland	Total
Upper Meghna	88	77	91	69	57	16	73	61	68
Confluence	59	71	49	61	0	54	70	57	61
Lower Meghna	23	50	13	79	0	78	59	75	41
Total	70	66	39	71	57	58	68	64	57

Source: FAP 16 Field Survey Estimates Apportioned by Predominant Charland Type
Note: 2 Mauzas with Missing Data.

Table B.61 Mean Days Duration of Flooding 1989-92

River Reach	Unprotd Mainland West	Attached West	Island Char	Attached East	Detached Mainland	Unprotd Mainland East	Sub Total Attached	Sub Total Unprotd Mainland	Total
Upper Meghna	139	109	71	35	14	13	65	87	59
Confluence	30	30	38	29	0	28	30	29	32
Lower Meghna	4	14	5	26	0	26	18	18	10
Total	71	45	28	32	14	21	40	51	37

Source: FAP 16 Field Survey Estimates Apportioned by Predominant Charland Type
Note: 63 Mauzas with Missing Data.

Table B.62 Percentage of Houses which are all Kutcha

River Reach	Unprotd Mainland West	Attached West	Island Char	Attached East	Detached Mainland	Unprotd Mainland East	Sub Total Attached	Sub Total Unprotd Mainland	Total
Upper Meghna	25	29	24	24	23	42	26	33	26
Confluence	48	51	64	43		27	50	35	45
Lower Meghna	45	64	68	21		19	42	20	42
Total	38	48	52	27	23	26	40	30	37

Source: FAP 16 Field Survey Mauza Estimates Apportioned by Predominant Charland Type 1993

Table B.63 Number of Households per Radio by Reach and Char Type

River Reach	Unprotd Mainland West	Attached West	Island Char	Attached East	Detached Mainland	Unprotd Mainland East	Sub Total Attached	Sub Total Unprotd Mainland	Total
Upper Meghna	4.7	6.1	4.0	7.4	6.3	8.6	6.8	6.0	5.7
Confluence	6.4	11.7	6.9	12.2	-	8.0	11.8	7.3	8.3
Lower Meghna	3.8	11.3	8.6	11.5	-	33.4	11.4	23.9	12.8
Total	5.4	9.7	6.0	9.1	6.3	12.0	9.5	8.7	7.6

Source: FAP 16 Field Survey Mauza Estimates Apportioned by Predominant Charland Type 1993

Table B.64 Percentage of Houses Flooded in 1987

River Reach	Unprotd Mainland West	Attached West	Island Char	Attached East	Detached Mainland	Unprotd Mainland East	Sub Total Attached	Sub Total Unprotd Mainland	Total
Upper Meghna	93	74	75	60	66	50	65	74	70
Confluence	25	27	31	45	0	48	31	32	32
Lower Meghna	4	39	9	75	0	77	49	52	25
Total	50	41	35	58	66	56	48	52	48

Source: FAP 16 Field Survey Estimates Apportioned by Predominant Charland Type
Note: 3 Mauzas with Missing Data.

Table B.65 Percentage of Houses Destroyed by Flood 1987

River Reach	Unprotd Mainland West	Attached West	Island Char	Attached East	Detached Mainland	Unprotd Mainland East	Sub Total Attached	Sub Total Unprotd Mainland	Total
Upper Meghna	9	3	24	16	31	13	11	11	20
Confluence	5	6	4	6	0	6	6	5	5
Lower Meghna	3	7	3	31	0	30	13	21	8
Total	6	5	10	15	31	14	10	10	13

Source: FAP 16 Field Survey Estimates Apportioned by Predominant Charland Type
Note: 3 Mauzas with Missing Data.

Table B.66 Percentage of Houses Flooded in 1988

River Reach	Unprotd Mainland West	Attached West	Island Char	Attached East	Detached Mainland	Unprotd Mainland East	Sub Total Attached	Sub Total Unprotd Mainland	Total
Upper Meghna	99	98	96	98	97	96	98	98	97
Confluence	100	100	93	99	0	99	100	100	98
Lower Meghna	25	75	13	100	0	96	82	72	37
Total	93	93	54	98	97	97	95	95	82

Source: FAP 16 Field Survey Estimates Apportioned by Predominant Charland Type
Note: 3 Mauzas with Missing Data.

Table B.67 Percentage of Houses Destroyed by Flood 1988

River Reach	Unprotd Mainland West	Attached West	Island Char	Attached East	Detached Mainland	Unprotd Mainland East	Sub Total Attached	Sub Total Unprotd Mainland	Total
Upper Meghna	29	20	49	39	50	29	33	29	41
Confluence	42	48	35	24	0	20	42	35	37
Lower Meghna	19	35	7	55	0	52	40	41	20
Total	35	38	26	38	50	31	38	33	34

Source: FAP 16 Field Survey Estimates Apportioned by Predominant Charland Type
Note: 3 Mauzas with Missing Data.

Table B.68 **Mean Percentage of Houses Flooded 1989-92**

River Reach	Unprotd Mainland West	Attached West	Island Char	Attached East	Detached Mainland	Unprotd Mainland East	Sub Total Attached	Sub Total Unprotd Mainland	Total
Upper Meghna	14	7	6	5	2	11	6	13	7
Confluence	3	8	10	15	0	13	10	6	8
Lower Meghna	0	11	4	55	0	54	23	36	14
Total	7	8	6	14	2	22	11	14	9

Source: FAP 16 Field Survey Estimates Apportioned by Predominant Charland Type
Note: 4 Mauzas with Missing Data.

Table B.69 **Mean Percentage of Houses Destroyed by Flood 1989-92**

River Reach	Unprotd Mainland West	Attached West	Island Char	Attached East	Detached Mainland	Unprotd Mainland East	Sub Total Attached	Sub Total Unprotd Mainland	Total
Upper Meghna	1.1	0.0	0.7	1.3	0.6	2.4	0.8	1.7	1.0
Confluence	0.6	0.1	0.3	3.2	0.0	0.8	0.9	0.7	0.7
Lower Meghna	0.4	3.3	1.3	20.2	0.0	18.4	7.9	12.4	4.7
Total	0.8	0.9	1.1	4.3	0.6	5.6	2.3	2.8	1.8

Source: FAP 16 Field Survey Estimates Apportioned by Predominant Charland Type
Note: 4 Mauzas with Missing Data.

Table: B.70 **Area Eroded in 1987 by Reach and Char Type (Hectares)**

River Reach	Unprotd Mainland West	Attached West	Island Char	Attached East	Detached Mainland	Unprotd Mainland East	Sub Total Attached	Sub Total Unprotd Mainland	Total
Upper Meghna	28	16	109	47	90	79	64	107	369
Confluence	57	112	72	25	0	166	137	223	432
Lower Meghna	4	2	334	125	0	182	126	186	646
Total	89	130	514	197	90	427	327	516	1447

Source: FAP 16 Field Survey Mauza Estimates Apportioned by Predominant Charland Type 1993

Table: B.71 **Area Eroded in 1988 by Reach and Char Type (Hectares)**

River Reach	Unprotd Mainland West	Attached West	Island Char	Attached East	Detached Mainland	Unprotd Mainland East	Sub Total Attached	Sub Total Unprotd Mainland	Total
Upper Meghna	62	35	279	153	185	207	188	269	921
Confluence	75	195	385	46	-	183	241	258	885
Lower Meghna	-	40	765	138	-	332	179	332	1276
Total	137	270	1429	338	185	722	608	860	3082

Source: FAP 16 Field Survey Mauza Estimates Apportioned by Predominant Charland Type 1993

Table: B.72 Area Eroded From 1989 to 1992 by Reach and Char Type (Hectares)

River Reach	Unprotd Mainland West	Attached West	Island Char	Attached East	Detached Mainland	Unprotd Mainland East	Sub Total Attached	Sub Total Unprotd Mainland	Total
Upper Meghna	84	71	403	73	137	61	144	145	828
Confluence	510	717	762	54	0	181	771	690	2223
Lower Meghna	18	1	178	121	0	22	123	40	341
Total	612	789	1342	248	137	264	1037	876	3392

Source: FAP 16 Field Survey Mauza Estimates Apportioned by Predominant Charland Type 1993

Table: B.73 Homesteads Eroded in 1987 by Reach and Char Type

River Reach	Unprotd Mainland West	Attached West	Island Char	Attached East	Detached Mainland	Unprotd Mainland East	Sub Total Attached	Sub Total Unprotd Mainland	Total
Upper Meghna	40	33	168	100	148	38	133	78	527
Confluence	29	52	67	10	-	75	62	104	233
Meghna	1	1	97	27	-	67	28	68	193
Total	70	86	332	137	148	180	223	250	953

Source: FAP 16 Field Survey Mauza Estimates Apportioned by Predominant Charland Type 1993

Table: B.74 Homesteads Eroded in 1988 by Reach and Char Type

River Reach	Unprotd Mainland West	Attached West	Island Char	Attached East	Detached Mainland	Unprotd Mainland East	Sub Total Attached	Sub Total Unprotd Mainland	Total
Upper Meghna	121	76	529	225	306	115	301	236	1372
Confluence	31	88	157	31	-	248	119	279	555
Lower Meghna	-	41	189	50	-	200	91	200	480
Total	152	205	875	306	306	563	511	715	2407

Source: FAP 16 Field Survey Mauza Estimates Apportioned by Predominant Charland Type 1993

Table: B.75 Homesteads Eroded From 1989 to 1992 by Reach and Char Type

River Reach	Unprotd Mainland West	Attached West	Island Char	Attached East	Detached Mainland	Unprotd Mainland East	Sub Total Attached	Sub Total Unprotd Mainland	Total
Upper Meghna	184	102	561	149	144	41	251	225	1181
Confluence	284	376	194	43	-	154	419	438	1051
Lower Meghna	29	-	57	34	-	10	34	39	130
Total	497	478	812	226	144	205	704	702	2362

Source: FAP 16 Field Survey Mauza Estimates Apportioned by Predominant Charland Type 1993