2.5 Water Quality

Biological contamination of shallow groundwater has been identified in some areas. This is of concern for the extended development of FCD, FCDI and I schemes, particularly where there is also the growing use of fertilisers and potentially dangerous agro-chemicals. There is an insufficient data base to assess the regional problems of water quality for potable and other uses. From groundwater there are some cases of iron, boron and bromide problems which affect both crop production and human health. These have been recorded from the field surveys and other sources in the Kurigram, Lower Karatoya and Mohananda basins. The problems related to surface water sources are from industrial pollution, agro-chemical pollution, eutrophication in stagnant pools, low available oxygen due to enrichment and pollution with sewage and waste effluent, and the health risks from poor sanitation and drainage conditions, both inside and outside FCD schemes. Figure 2.4 provides a regional view of some of the potential source areas of industrial, urban and agro-chemical pollution and Figure 2.5 locates the main types of industry and mining which might have to be considered in the feasibility surveys. Considerably more survey and monitoring work is required to make proper regional or pro-ect planning responses to these problems. The needs for monitoring and surveys are discussed later.

2.6 Biological Environment

2.6.1 Land Use and Crop Diversity

The gross area of the NWR is 3.4 million hectares comprising a net cultivated area (NCA) of 2.5 million hectares. 0.9 million hectares are taken up by water bodies. The breakdown of the region by depth of flooded land and crop are shown in Table 2.2 while the cultivated area of the floodplains most relevant for potential FCD planning is given in Table 2.3.

Table 2.2 Land Use in the North West Region (million hectares)

Gross area : 3.4 (m. ha)		Cultivable area: 2.5 (m. ha)	
Area flooded to different levels (m. ha):			
F0: 0-30 cm	1.3	F1: 30-90 cm	0.8
F2: 90-180 cm	0.2	F3,4 & 5: 180 cm	0.1

Crop	%	Yield t/ha	Crop	%	Yield t/ha
Rice: HYV boro	26	5.0	Wheat	8	2.7
Aus	6	4.0	Jute	7	1.8
Aman	28	4.0	Oilseeds	6	0.6
Local Boro	1	2.5	Sugarcane	5	47.5
Aus	20	1.3	Pulses	3	0.8
T. Aman	28	2.3	Vegetables	2	NA
Aus/Aman	5	1.8	Others	8	NA
B. Aman	5	1.7			
Rice	119%		Others	38%	Total 158%

Source: Bangladesh Bureau of Statistics (BBS) and MPO.

N.B.: Sugarcane yield is the average between plant and ratoon crop.

Figure 2.4

Potential Source Areas & Flows of Industrial, Urban & Agro-Chemical Pollution (1984 Data Base)

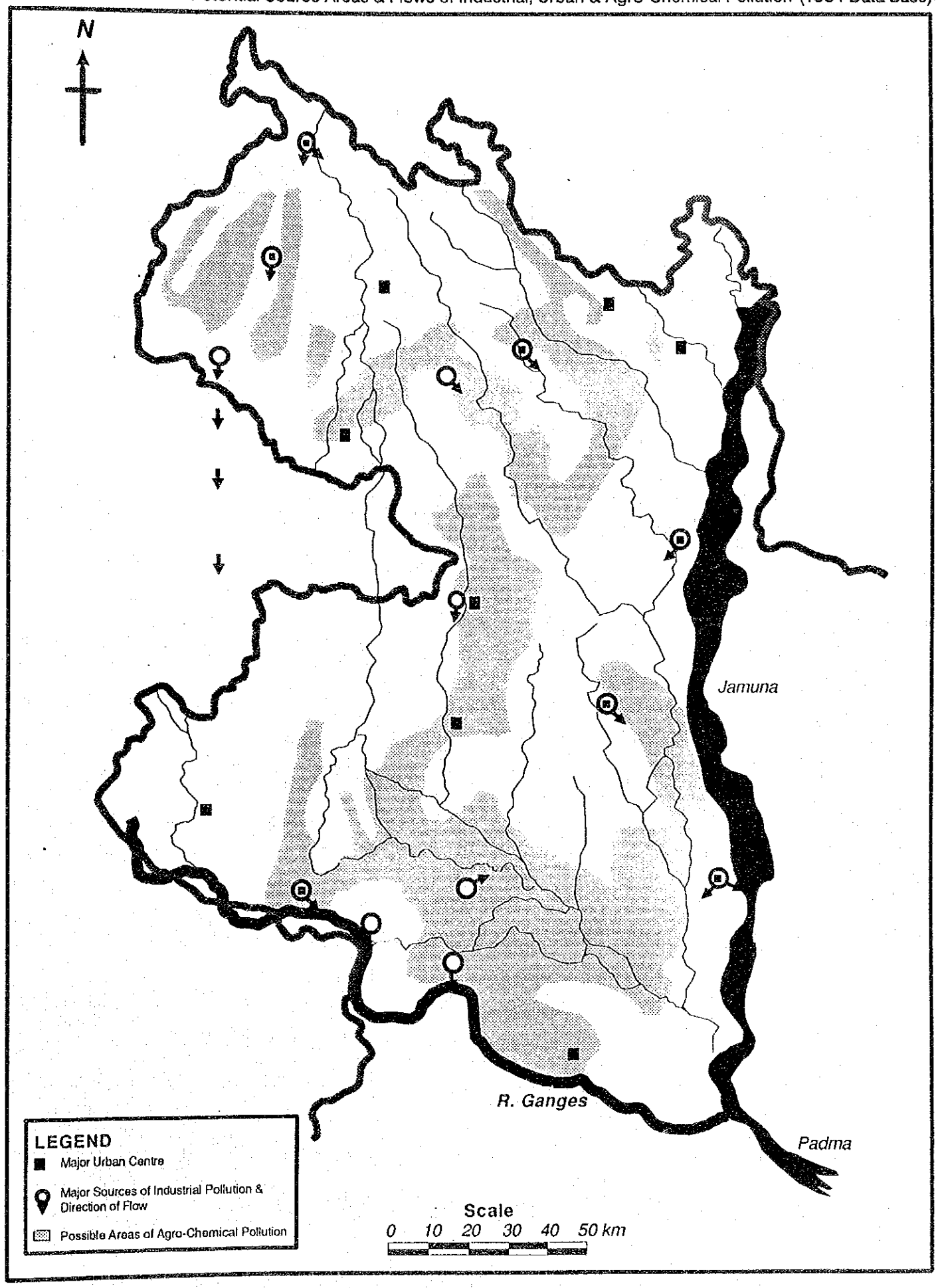


Figure 2.5

LOCATION OF INDUSTRIAL SITES AND MINING RESOURCES

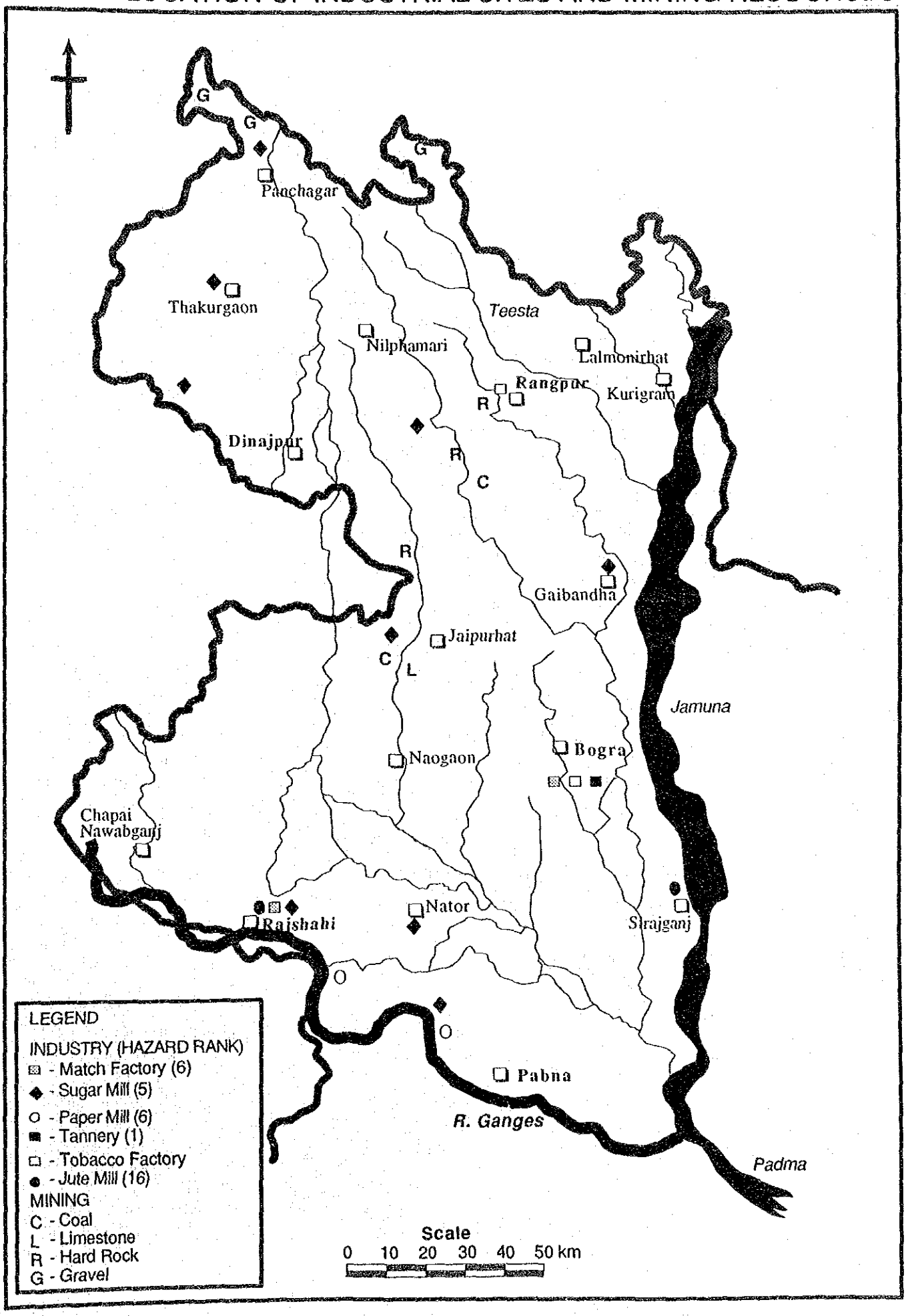


Table 2.3 Cultivated Area of the Flood Plains (million hectares)

Area	Million Hectares
Teesta	1.03
Karatoya-Bangali	0.26
Lower Atrai	0.08
Active Brahmaputra	0.14
Lower Purnabhaba	0.13
Gangetic Floodplain	0.80
Total gross area	2.44
of which cultivable	1.63

Source: Land Resources Appraisal if Bangladesh For Agricultural Development; Report 2; Agro-ecological Regions of Bangladesh; UNDP/FAO, 1988).

Rice predominates the farming system particularly in the floodplains where similar water loving crops are not so popular. The kinds planted are either broadcast (b) or transplanted (t); either local (l) or HYV. Almost the entire area of boro is HYV. Local varieties are only grown in low-lying areas that would flood too early for HYV to be successful, or where the water levels are too high for HYV boro. In case of t. aman there is still deliberate decision not to grow HYV in all locations where the water levels would permit it.

The success of HYVs demands more inputs, planting has to be completed earlier than with the local varieties and are often regarded inferior in taste. However, the taste preference is being overruled by the commercial farming value and the loss of access to land by the resource poor. This continuing trend means that HYV t. aman will in the near future occupy as much land as the commercial farmers' other resources and the timing and extent of monsoon flooding of his land will allow. This process will be further accelerated by the photo-sensitive HYVs recently released by IRRI which will flower with diminishing daylight, and not a set time after planting, thereby to a large extent overcoming the danger of pollen sterility.

Low input local varieties are more cold resistant and, because they are transplanted two to three weeks earlier, stand deeper water because of their taller stature. The boro varieties ratoon readily if flooding in the monsoon is not deep or delayed. The ratoon will not produce grain but its fodder value is important. The local aus is usually broadcast. It is a short-term, low-yielding, risky "hungry gap" crop which provides food before the main aman harvest.

Jute has faced considerable international competition from artificial fibres, but has sustained this pressure by its wide applications in a range of different industrial use. It is used within the household for ropes and the sticks remaining after the fibres have been stripped are a valuable fuel.

Many species of barley are grown but since the early 1970's have lost much of their importance and this loss will affect the genetic diversity conditions for future plant breeding. It is only grown under poor soil conditions. In contrast, the wheat area has increased considerably: at present it just about equals that of jute.

Sugarcane is extensively grown but is not increasing. Smallholder outgrowers supply several commercial sugar mills. Other uses are for jaggery gur making and for chewing, perhaps the biggest and most continuous year-round market.

A large number of other minor crops are also grown, in localities that tend to be defined as much by marketing facilities as by soil conditions. Two kinds of millet (*Setaria italica* kaun and *Panicum miliaceum* chena) are grown as a late rabi/early spring "hungry gap" crops in areas not vacant soon enough to plant pulses or oilseeds. Yields are low but farmers obtain good fodder. Buckwheat, denshi, is a similar crop more common in the more northern areas. Its advantage over the millets is its higher protein and mineral content.

A large number of different pulses are grown, mostly in the rabi but some, notably mungbeans, also in the late monsoon. Pigeon peas, the least widespread of the pulses, is a perennial or at least a 12-month crop. It is grown for its seeds, pods and the fuel value of its stems. It is seen extensively around homesteads. The common rabi pulses are chickpeas, lentils and vetches. This latter is also a fodder crop, in that it produces relatively large amounts of stover. Groundnuts are occasionally grown to be eaten without further processing.

The main oilseed Brassicas are sesamum and safflower tishi. Other grown in the region include rape tori and mustard rai. Potatoes are grown mainly in areas where there are cold storage facilities. The Mohananda basin is a key supply centre. Sunnhemp used to be a popular crop for the making of fishnets but the use of nylon nets has reduced demand.

Tobacco is especially popular in the Rangpur area but is also grown elsewhere. There are many kinds of rabi and monsoon vegetables and spices, including betel leaves, usually near the larger towns like Rajshahi or where transport to major markets is readily available: near Pabna for the Dhaka and Chittagong markets;

Sesbania sesban, doncha. is a perennial shrub but is often grown as an annual. Both the leaves and the stems are dried for fuel, usually by the grower but it is increasingly traded. Not only is it grown on field boundaries but often as an alternative to b aus or jute, near homesteads. When grown for sale, it is worth more than Tk 7,000/ha, the buyer doing the harvesting and drying.

Another important crop is the thatching grass, chan. Areas are set aside for it to grow unimpeded, and is usually sold as a standing crop for around Tk 11,000/ha. It is also grown on field boundaries, for use by the grower. On charlands, if planted at the right place it filters out the silt from the river water and can be used to build up and stabilise land.

Village groves and homesteads support the widest diversity of species of tree crops. Mango and banana orchards are widespread, the former mostly on the Gangetic plains. Other important fruits include jackfruit, dates, and coconuts.

2.6.2 Habitat Types and Importance

The ecology of the NWR involves the inter-action between a large number of faunal and floral species and a range of different habitat types. The habitats include both aquatic and terrestrial environments ranging across the altitudes and landscapes described above. The main types of habitats found are mapped in general terms in **Figure 2.6** and include the sites discussed below. **Figure 2.7** shows the main general locations of bird and fishery uses and **Figure 2.8** the generalised distribution of different major economic tree species.

Figure 2.6

GENERALISED HABITATS (PRE-FCD)

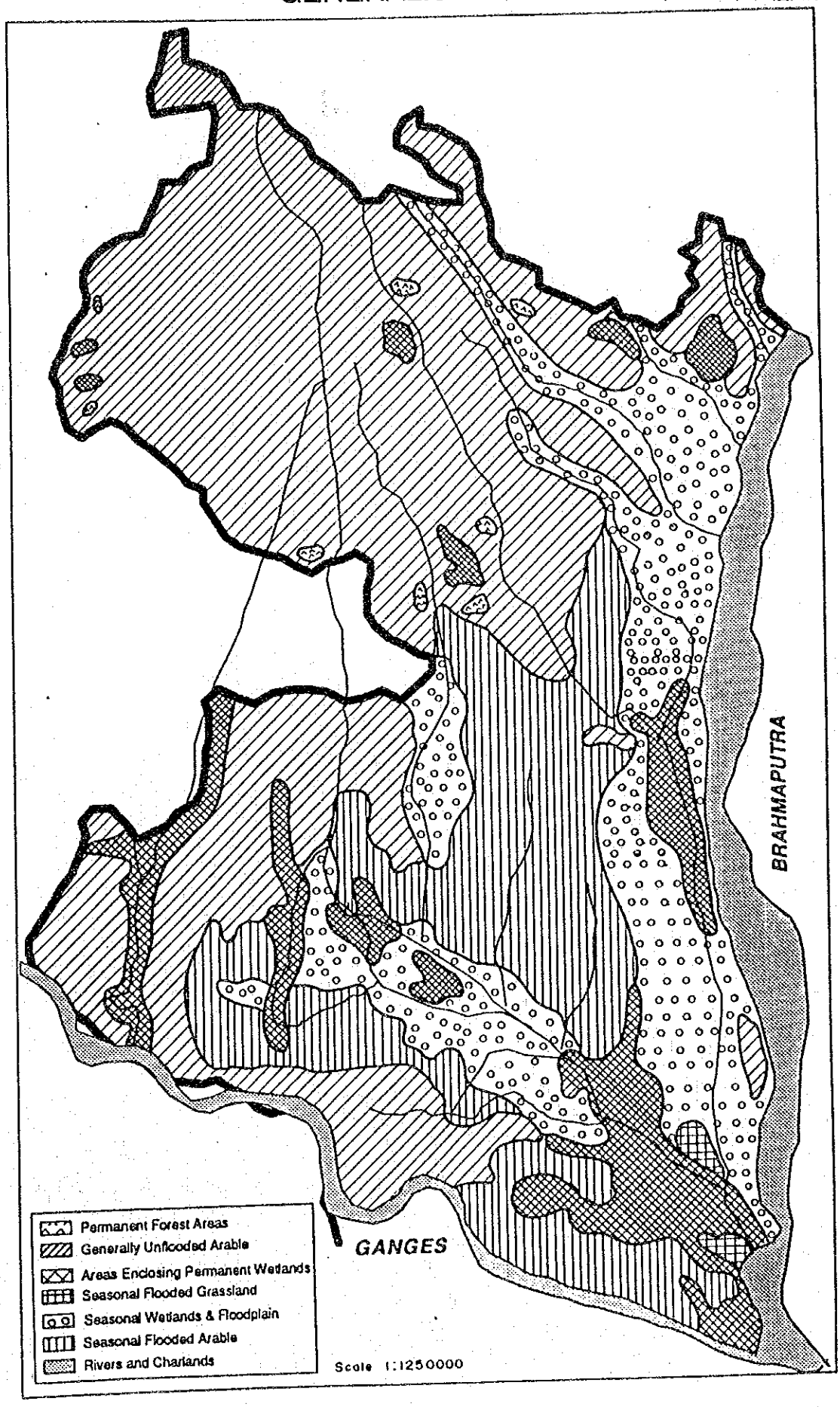


Figure 2.7

FISH AND BIRD HABITATS (PRE-FCD)

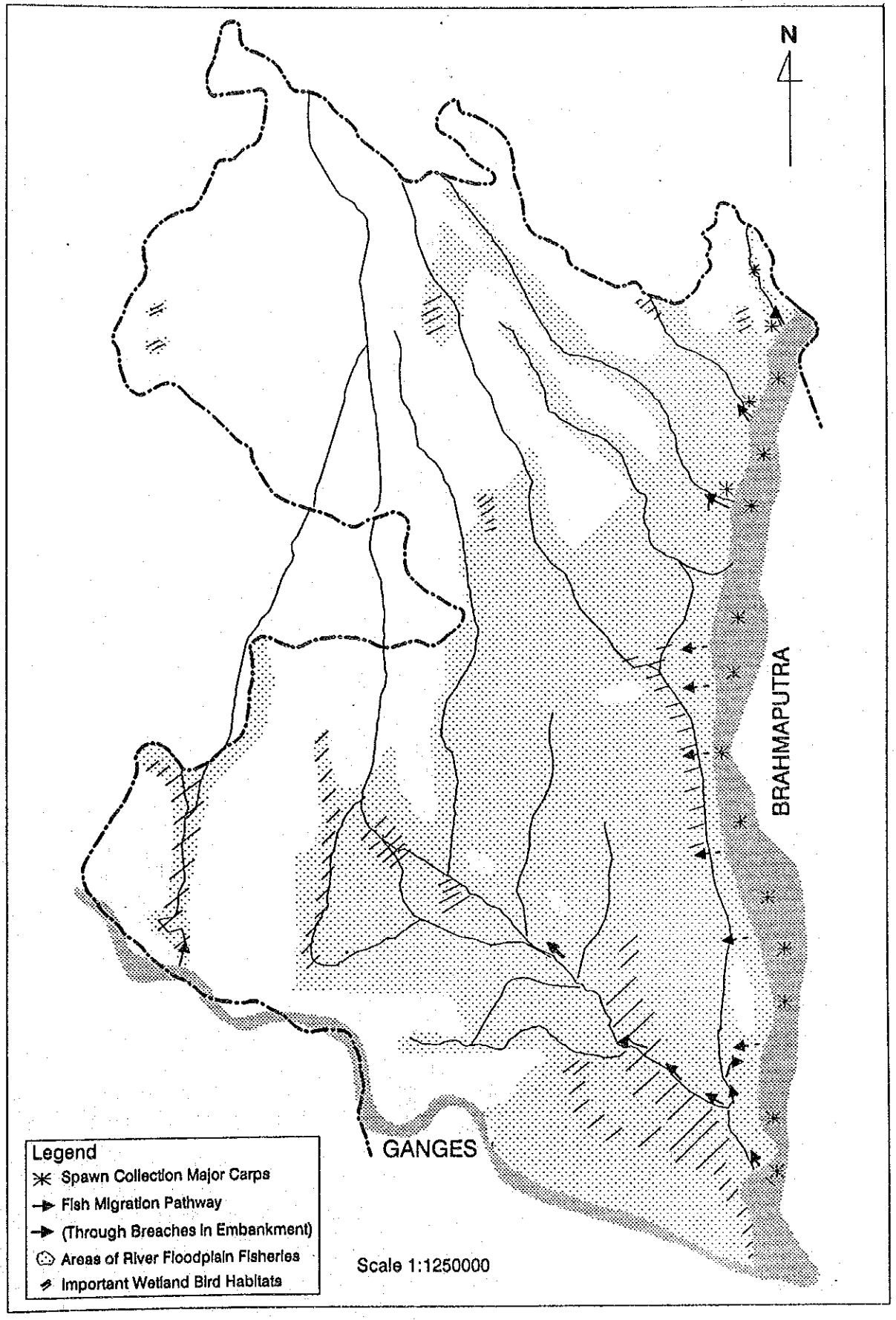
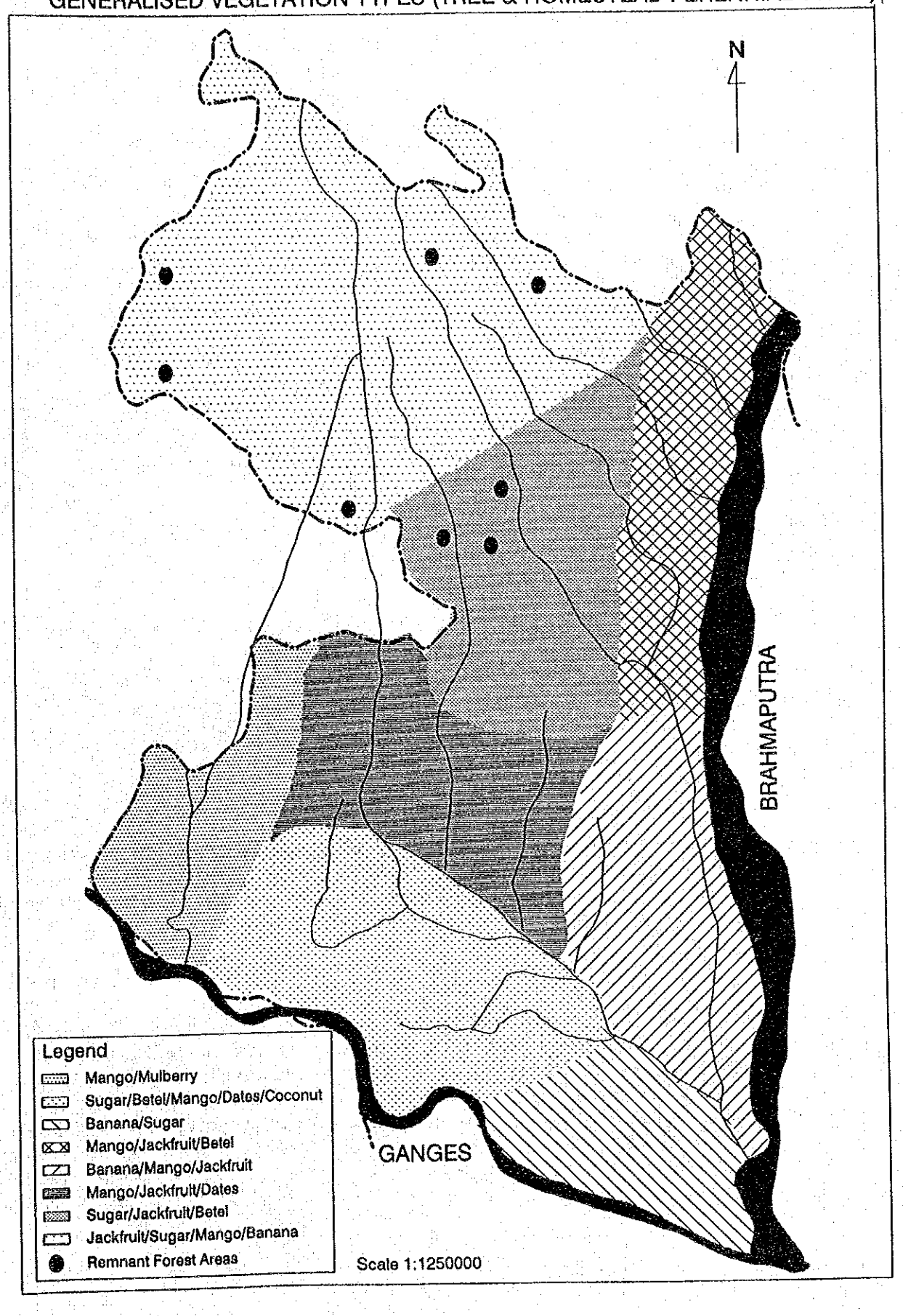


Figure 2.8

GENERALISED VEGETATION TYPES (TREE & HOMESTEAD PERENNIAL TYPES)



Most natural wetland and forest habitats have already disappeared or have been thoroughly influenced by human intervention. Thus, the loss of natural habitats may appear to already be of less significance than the socio-economic impacts on the local communities and the maintenance, through good management, of the habitats which communities now depend on. However, the fact that certain habitats are now critically affected means that this is perhaps the last occasion when conservation measures in the NWR could be undertaken.

Value systems which lead to significant appreciation of the aesthetic value of the landscape are not to be found generally amongst local people. However, the nature of the landscape is integrally linked to lifestyles and a local appreciation and dependency on them. In the last few centuries the landscape of the NWR as a whole has been dramatically transformed into intensive human use for settlement and food production as population has grown. Previously there were always areas where intensive use of natural resources took place around the settlement areas. The difference today is the complete degree to which this exploitation has taken place, at the expense of natural and undisturbed habitats. The original areas of forest cover have been virtually removed altogether. Areas of grassland have also virtually disappeared. Areas of seasonal fallow and wetlands have also been significantly reduced as boro cropping has expanded. Areas of permanent wetlands have been put under stress from FCD and I development, as well as the effects of over-exploitation of aquatic species, the introduction of exotic species of fish and aquatic weeds, and rising levels of agro-chemicals and fertiliser use. These have all impacted on the composition and condition of the flora and fauna in both the terrestrial and the aquatic landscapes. These, in turn, have affected the processes determining local micro-climate, nutrient cycling, pest and disease levels and trophic relationships in the food web.

Each of the major habitats is supported by its own thriving eco-system. These were neither stable nor constant in historical terms but, they offered a wide variety of habitats vital to sustaining the diverse range of human survival strategies. The landscape and natural resource base continue to evolve.

The use of this base are being driven by an ever-increasing human population, commercial and monetary demands that are both local and global in their significance. While the environment has shown considerable resilience to stress and change critical thresholds are being reached. Continued FCDI interventions will impose further pressure and considerable attention is needed to protect and conserve the resources which remain.

Charlands

Charlands are the main feature of the braided channel of the Brahmaputra river and also of the Ganges and Teesta rivers. These chars have distinct successions of natural and managed vegetation, settlement patterns and land use and form an important habitat for birds and livestock.

Homesteads

Throughout the region there is a distinct habitat type which can be found in the immediate vicinity of homesteads. This are managed agro-forestry and pond environment. For small homesteads development these are the primary economic, ecological and social environment mainly under the management of women. Where larger scale tree planting occurs these are more the domain of men. Homesteads are of particular environmental importance as they provide the home and the main environment for children, livestock, minor nutritional and medicinal crops (including green leaf vegetables which are crucial sources of vitamins) and tree crops (which provide women's and family income, nutrition, shade and cover for other fauna). The habitat provides nesting, breeding and

feeding sites for a host of locally important insects, birds, and small fauna; some of which have direct linkages to the ecology, health and productivity of the field ecology which surrounds the homestead, as well as the ponds where aquaculture and a range of other facilities are provided for washing and bathing. The homestead environment is thus a vital link in the social, economic and ecological systems which bind the whole landscape, ecology, economy and society together. There are a number of key impacts which FAP projects could have on these systems which should be given careful consideration during the feasibility studies.

Wetlands, Lowlands and Water Bodies

The whole planning area of concern to FAP falls under this category. The IUCN, the Asian Wetland Bureau (AWB) and the MPO have used a number of different sub-classifications based on landscape and hydrological types, flood depths and agricultural use. They form a vital link in the chain of landscape formation, maintenance of species diversity, cycling of nutrients, sustenance of the food chain, and in the control of pollution. The aquatic and seasonal terrestrial flora and fauna which they support are the basis of the survival strategies of many people. Adverse impacts on the poorest and minority groups dependant on these habitats are significant issues to be addressed by planning. The wetlands contain important habitats for migratory birds and also provide the habitats for a number of potentially threatened or endangered species of significance internationally or in Bangladesh.

Two types of water body habitats can be distinguish - natural and man-made. The natural systems include the intricate network of perennial and seasonal drainage channels which contain a wide variety of differing aquatic environments and ecologies (the river channels, the beels, khals and floodplain). The man-made areas include the ponds, borrow pits and impeded drainage areas in low-lying ground which are affected by structures for roads, railways and FCD(I) projects. These too exhibit a wide range of different ecological, social and economic features.

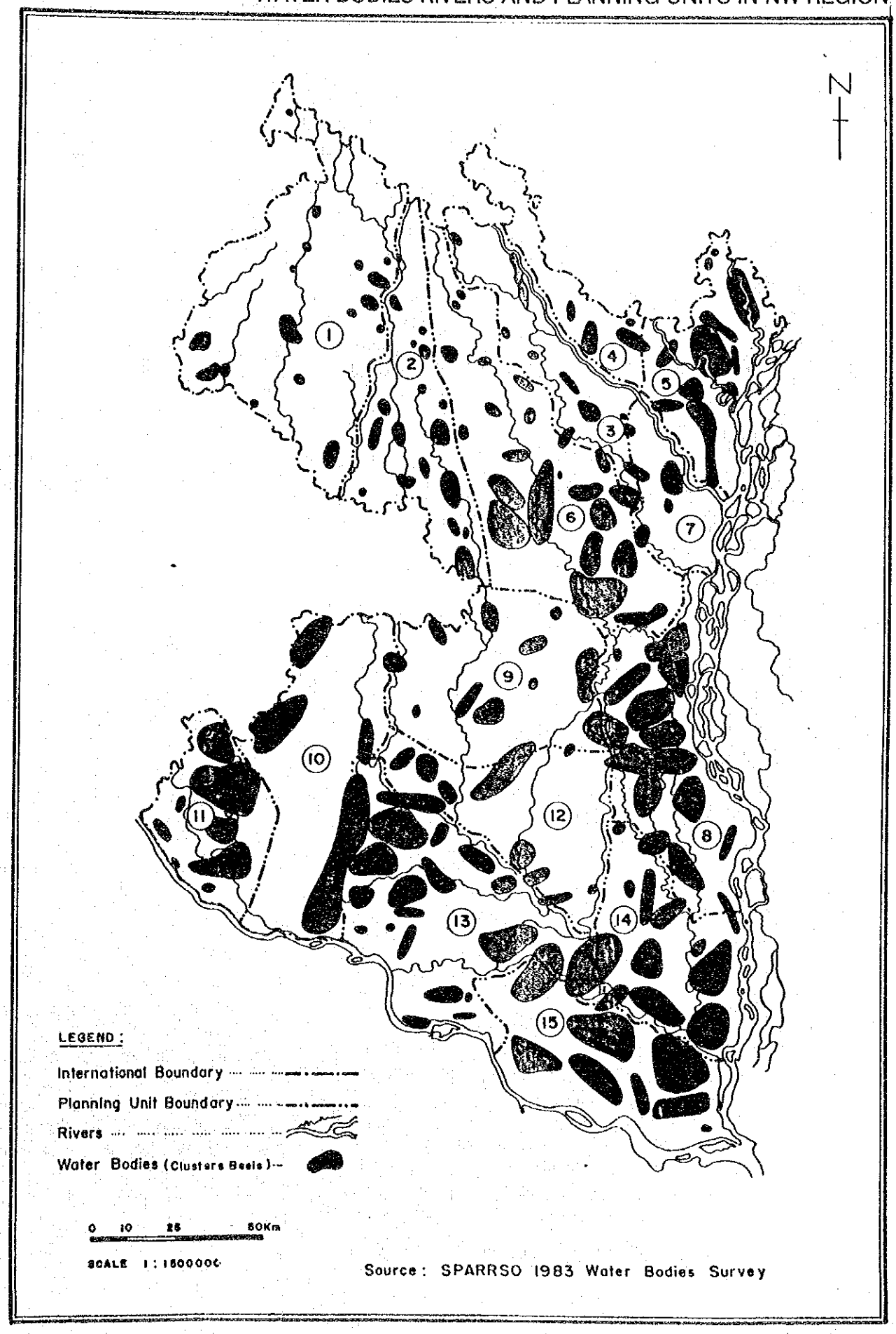
The linkages between the lowlands, wetlands and water bodies are vital for the reasons described above. Understanding how they work and the services they provide is the key to appreciating the environmental management planning approach. Figure 2.9 shows the location of the main perennial water bodies and Planning Units.

Field and open country

The main agricultural areas today virtually coincide with the wetland and lowland areas described above. Some higher dryland systems do exist above the lowland levels and which would fall within projects. The flooded fields seasonally become part of the aquatic drainage and ecology system linking wetlands and homesteads. Even when drained, or on dryland, the linkages between different areas are also significant and poorly researched. The primary areas of interest are the linkages between the habitats for rice (and other crops) pests and predators in the fields, in the wetlands, in the water bodies and in the homesteads. There are basic relationships of feeding patterns, predation and maintenance of habitats and processes on which the productivity of the agricultural system depends. This not only affects pest and disease relationships, but also soil fertility and pollution levels. These have impacts which can occur locally, across schemes, and outside to downstream areas. The system is integrated with indivisible linkages across space and time and is already managed by human decisions. The linkages are discernible in any field of study, whether physical, chemical, biological, social, political and economic. At present, the management of the system is ad hoc and simply the outcome of a whole range of unplanned and uncoordinated human activities in the urban and rural areas.

Figure 2.9

WATER BODIES RIVERS AND PLANNING UNITS IN NW REGION



Source : SPARRSO 1983 Water Bodies Survey

Grasslands

There are only small areas remaining of the grasslands which were once extensive in the Hurasagar and Mohananda basins and in extreme north west areas. These have been mostly taken over for cultivation. The only remaining floodplain zone is located near the confluence of the Atrai and Karatoya. Less extensive seasonal grassland located around standing water bodies have also been taken over extensively for boro cultivation.

Highlands on the Barind Tract

The rolling higher ground of the Barind Tract and the north west of the region are not part of FAP study and are being dealt with under NEMAP planning. Nevertheless, there are again probably important ecological, physical, social and economic linkages to the floodplain of which little is currently known. These issues have not been considered further.

Forested Areas

The NWR once was covered in a dense network of dryland and wetland forest, swampy vegetation and grassland of which little now remains. The last sites of forested ares small and shown in **Figure 2.8**. Even the current status of these areas is not clear.

2.6.3 Flora and Faunal Ecology

Bio-geographically Bangladesh lies at the juncture of the Indian Peninsula, Himalayan and South East Asian systems and thus has had a rich diversity of species. It has been the loss of habitat through increasing human settlement and population which has led to a decline in the biological resources.

In the NWR the major winter wetland areas were alongside the Brahmaputra, the Atrai and Mohananda rivers. Through the development of the Brahmaputra right embankment, the embankments along the Ganges, the polder schemes of the Lower Atrai and Karatoya basins, together with the Pabna FCDI scheme, the natural flora and fauna habitats have been taken over for cultivation or have been significantly adapted due to the changing seasonal hydrological conditions. This has meant less flooding in some areas where protection has been achieved, and increased flooding where poor drainage, breaches and downstream impacts have resulted.

The adoption of HYV varieties has led to a decrease in the numbers of local rice varieties. The numbers of local varieties are not accurately known, but some estimates have put the figure at 10 000. The numbers remaining are not known. National efforts to create germ plasm banks have acquired around 4 500 varieties which can only be maintained for a period of 15 years unless seed bulking programmes are carried out.

To rely solely on an institutional ability to maintain the gene pool would be extremely short-sighted. Not only are there the physical and biological limits on storage systems, there are a whole range of logistical, financial, geographical and biological complexities involved in maintaining genetic diversity in this form. The most appropriate and reliable system is in the countryside habitat and management niches which reflect the rationale for the existence of the diversity in the first place. This raises fundamental questions of the overall social, economic and technological environment affecting local resource managers. FCD is just one part of this environment. Little can be done within FCD planning itself to stem the loss of bio-diversity and increased pollution problems. This requires a wider macro-

framework to keep the control of environmental management in the hands of local people. This would only be effective if it were also fully reflected in the market and pricing mechanisms which create the incentives and dis-incentives on which local decisions on technology and farming systems are made.

Due to the combined effects of loss of habitat and hunting (for sport, food and skins) and the increased settlement and population density, the once rich wildlife status of the area has been severely impacted. This has affected birds, reptiles, amphibians, fish and mammals alike. This process started in centuries past, has accelerated over the last 200 years and become critical in the last 30 years. The most dramatic losses have been of large mammals and ungulates, birds of prey, water fowl and certain reptiles and amphibians.

Those species dependent on the habitats which will be directly affected by FAP interventions are the most vulnerable. This includes the water bodies, wetlands and lowland shrub and grassland.

The IUCN Red Data Book of remaining endangered species is not area specific, neither are most of the other easily available data sources which allow an appreciation of the general levels of species diversity. The study surveys were very restricted in their extent but have provided a wealth of data which is presented in full in Volume 15.

Appendix A provides a list of rare faunal wildlife. **Appendix B** gives the tentative list of threatened vascular plants. A list of birds and their habitats found in the NWR was available and is given in **Appendix C**. None of these lists can be regarded as complete, as relatively little detailed field survey and identification has been completed.

Flora

A general indication of distribution of the main vegetation types is given in **Figures 2.6** and **2.8**. The NWR has been divided into seven major zones in terms of dominant habitat type which will each have its own variations of vegetation cover. There are various limiting factors, such as soil types, depth of flooding or topography. In most of the region mixed areas of homestead and field vegetation exist which do not show variations in species composition and which cannot be easily mapped without detailed field surveys.

At the more detailed scale of mapping there are important variations in habitats where differences in species composition are important. The most important distinction would be between the aquatic and terrestrial species. These different habitats would include river banks, permanently waterlogged swampy and marshy ground, seasonally waterlogged marshy ground, cultivated fields, uncultivated field borders and sides of embankments, stagnant ponds and standing water bodies, flowing minor drainage channels, the major flowing streams and river channels and charlands.

Of the estimated 5 000 floral species of Bangladesh it is not known how many are to be found in the NWR or the full ecological and economic significance of the diversity of the remaining natural flora. The predominance of the cultivated crops and tree crops means that the landscape across the majority of the area is primarily of economic significance for society. The field surveys did not identify any threatened species of flora.

The main planning focus should address the inter-relationships which exists between these different areas in providing habitats suitable for pests and diseases. The changes which FCDI can bring about will have implications for the ecology in the homesteads systems, the field systems and most importantly on the species composition, trophic relationships and inter-actions of species and nutrient transfer from the wetland and natural floodplain flora and micro-flora into the new agricultural systems under FCDI.

From the perspectives of the agricultural and economic planner the total economic production lost to pests and diseases is seen as bio-mass which can potentially be reclaimed for human consumption and profit. This is only achievable by denying this bio-mass to the flora and fauna which also depend on it for their survival. But beyond the immediate pests is an inter-connected network of species up and down the food chain which feed on the pests and diseases organisms themselves and are the basis on any biological control programme.

The era of agro-chemicals has tried to remove pest species from the eco-system with the result that many knock-on effects have adversely affected the other species in the food web. It is only those species with resilience and resistance to this human and chemical onslaught that remain. Since the only habitats that are left are field crops, and increasingly rice crop, it is rice pests that dominate the flora and faunal composition of the ecology. But by promoting the diversity of species and habitats a range of free sources of pest control would exist and the trade-off is that the farmer would wish to live in a symbiotic relationship, foregoing some of the biomass to support these habitats and other demands on bio-mass in return for the biological controls on pest populations which go hand in hand with this approach. Any examination of traditional Bangladesh farming systems would show that this is precisely what rural people have been promoting for centuries past and, only in recent times has the incentive environment for this been taken away by modern commercial, monetary and technological pressures.

The current trends are reasonable clear from the national statistics on the direction the farming systems are taking. Fertiliser and agro-chemical usage has at least doubled over the last decade with the rapid conversion to HYVs. FCDI projects have continued to be implemented and increased population density in rural areas continues to reduce the diversity of habitats. Both loss of grazing areas and fodder biomass, and the loss of alternative fuel supplies, which again involves FCDI project and population growth impacts, is reducing the total animal manure produced and diverting it from use as an organic matter addition to the micro-ecology of life in the soil. The soil ecology is also affected directly by the use of agro-chemicals.

These trends are indicated by some of the recent EIP surveys in the NWR as shown in Table 2.4.

Table 2.4 Threats to Species and Habitats by Expansion of Intensive Agriculture Associated with FCDI

INPUT	PROJECT					
	Bhedra Beel			Bhitabari Damash		
	Pre-	Post-	Change	Pre-	Post-	Change
	(Percentage of Area with Input)					
Chemical Fertiliser	25	65	40	30	90	60
Cowdung Compost	50	25	-25	45	20	-25
Pesticides	10	45	35	10	55	45
Irrigation	6	25	19	13	35	22
HYV Seeds	7	35	28	20	50	30
Local Seeds	95	70	-25	80	50	-30

Aquatic Weeds

Most of the common aquatic flora have been recorded in the watercourses around the region. The most important potential problem is water hyacinth and the blockage to navigation channels it can create. In heavy concentrations it can lead to de-oxygenation of the water body, threaten the viability of aquatic flora and flora (particularly fish) and create human health problems. These sites are often associated with nutrient enriched water, areas of poor drainage and where obstructions impede flushing. Otherwise, various species are present in water bodies throughout the region, but are flushed out with the annual floodwater and die and decays rapidly in the saline water of the estuaries.

In spite of its voracious growth characteristics and classification as a problem weed which is virtually impossible to eradicate, it also has many existing productive and future potential uses. It is used for livestock fodder, organic fertiliser, floating seedbed nursery and fuel. Its high cellulose content makes it useful as a raw material for industry. Its ability to rapidly absorb nutrients and chemicals (including heavy metals) in the water system give it a potentially important role in controlling the over-enrichment of water bodies. It could also be used for the extraction of some industrial pollutants at source and allow for their safer disposal.

In productive and navigation areas, and in water routes controlled by structures, it is important to control its presence. The current system is based on hand removal and the natural flushing of drainage channels in the floods. Any system which blocks these routes will inevitably face the problems of removing the backup of floating weed vegetation. Either the drainage systems have to be designed to let this flow of material through directly or through a bypass channel, or else specific development projects should be sited at these blockage locations to make use of the material which will accumulate there. These could be small-scale industries either making fertiliser or creating the raw material for composting, craft materials or industrial cellulose purposes. Research, education and a support programme for economic utilisation of prolific water weeds could be designed at the feasibility stage.

Birds

The birdlife of Bangladesh occupies a very important position in the worldwide avifauna distribution, and particularly in South and Central Asia. The 660 species recently definitely recorded in Bangladesh represents about 50 percent of the South Asian species and just more than 7 percent of the globally known species. The reason for this is the unique geographical position of Bangladesh between the different bio-geographical regions. Of these there are some 220 which depend on forest habitats and a similar number which are migratory and 170 which are associated with wetlands. Over 70 of the water fowl are now rare or rarely seen in Bangladesh. There are 110 resident and migratory species which have been definitely recorded in the NWR. Of these, six have been classified as rare or endangered in Bangladesh. Of these the White Spoonbill is a migrant and internationally important and is dependant on the river and charlands for its habitat. The rare resident species and the habitats include the Grey Heron (wetlands), the Black Winged Kite (Open country), Pallas's Fish Eagle (wetlands and large rivers), the Grey Headed Fish Eagle (wetlands) and the Pheasant Tailed Jacana (wetlands).

The wetland and charland habitats are of importance for the migratory birds, particularly of northern Asian origin. These include two type; those that over-winter in Bangladesh; and those passage on route west to the Malayan Peninsular, the Indonesian Archipelago and the Australian sub-continent, and to the south and west to India and Sri Lanka. Another group of migrants come seasonally from the Himalayan and Burmese hill and mountain ranges. The typical habitats for these winter migrants

are the seasonally flooded agricultural lands, the winter wetlands, forest remnant areas and the lower chars of large rivers. The rapidly disappearing grasslands are also an important habitat. The main important habitat areas are shown in **Figure 2.7**.

From the total number of species 47 species might be affected by loss of habitat due to FAP projects. The significance of birds in planning is their diverse range of feeding habits and species. While some are pests and consume grain and food crops, many are insect and sediment feeders which consume considerable amounts of biological material. This plays a large part in the control of pest population numbers and preventing imbalances in the food chain.

Mammals

Records suggest that from over 200 species of mammal that were once common in Bangladesh over half have now disappeared or are seldom found. The primary impacts were seen in the floodplain in the last century and through to the 1970s. The loss of habitats has been so significant that little can now be done to restore the balance in the areas. This study does attempt to highlight the few last remnant systems which need urgent consideration and planning for conservation under FAP. The focus of current attention has shifted to the remaining forested and hill tract areas and to the Sundarbans.

The few mammals which remain in the NWR are mainly small mammals adaptable to the new habitats created by human disturbance and, thus, is increasingly concentrated on those which are seen as pests. The planning significance of mammals relates to their position near the top of the food chain, their role as predators on a range of smaller animals, and their feeding on crops in the field and in storage. The most significant are the rats, mice, squirrels, jackals, foxes and rabbits. The role of rats in creating a network of burrows in embankments has been directly associated with creating erosion routes for drainage water and destabilising them leading to breaches. This has been noted in the Meghna Dhonagoda project in the south east region but has not been reported as a problem from the NWR.

Amphibians and Reptiles

19 species of amphibian have been recorded in the country which includes ten species of frogs and toads. These have regularly been exploited. In recent years the problems of export of frog legs has led to a ban on trade in some species. Frogs and toads play an important role as predators on field pests. Research in BRRI has found this to be economically and ecologically significant. When taken together with the role of other fish and insect predators, the biological pest controls possible form the basis of an integrated pest management programme. This provides the major alternative to or second line of strategic approach to the agro-chemical approach to contemporary farming. This is the main avenue whereby pollution problems and wider loss of bio-diversity can be avoided. Many of these biological predators can also form productive sale assets in their own right, making the system a multi-purpose farming system. These issues were raised with the agricultural planning team, but little attempt was made to include this as an alternative at this pre-feasibility stage of planning. These issues need to be taken up more seriously in the feasibility stage and evaluated more rigorously in the economic analysis.

There are 150 reptile species recorded nationally, including 31 turtles and tortoises. 24 of these are freshwater species, four are marine species and three are terrestrial. There are three species of crocodile of which one is found in saltwater and two in freshwater. There are 18 known species of lizards and skinks, and 78 species of snake.

Snakes are believed to have been the major causes of death amongst those who died during the floods of 1987/88. This was due to snakes and people alike heading for the high ground. It is reported that, in the last decade, there has been a considerable decline in the snake population in FCDI schemes. The cause of this is not known but is most likely to have been a combination of factors involving loss of habitats, agro-chemical pollution or disease induced by environmental stress in a rapidly changing environment.

Fish

There are 260 freshwater species which utilise the nation's rivers and floodplain and ponds. In addition there are 475 marine species which depend upon the inter-action between the land drainage system, the estuarine ecology and the marine nutrient and habitats systems. There have been 13 exotic species of freshwater fish introduced. It is estimated that there may be 200 species to be found in the NWR. Around 110 species are known to be marketed in the NWR and another 40 are thought to be of local economic or social importance. Five species are already extinct and about 10 are threatened.

The wide diversity of fish species also reflects a wide range of habitats and feeding requirements from bottom feeders, herbivores, carnivores, omnivores. Fish in ecological terms sit at the top of the aquatic food chain. Their various feeding patterns also lead to controls on aquatic weeds, secondary disease vectors and crop pests. They are a vital link in the food chain and maintain the integrity of the floodplain and river habitats for other species and for human use. In the food chain they provide humans with a concentrated form of protein, oils and vitamins. In the context of free access to a common property resource, poor people and fishing families depend on these sources for the survival strategies, both in terms of nutrition and income. Many of these dis-advantaged groups also utilise the minor species which have less commercial value. Any loss of access to these free resources would be virtually impossible for FAP projects to effectively mitigate; for the list of reasons which have been clearly identified under the FAP 12 and previous evaluations.

Fish, as well as crustaceans are sensitive to contamination of their environment, and are thus good indicators. The outbreaks of Epizootic Ulcerative Disease since 1988 has not been definitively researched or understood. But, like some cancers in humans, may be associated with background disturbances in the food web, low thresholds having been crossed in water pollution which are difficult to detect by simple causal-effect analysis, and a general increase in the level of environmental stress caused by pressure on habitats and lifestyles.

The planning for fisheries is discussed in further detail in Volume 12. **Figure 2.7** shows some of the more important fish habitats areas in the NWR.

Crustaceans and Bivalves

Both marine, brackish and freshwater crustaceans have a long history of extensive exploitation in Bangladesh which has seriously depleted stocks this century. There are 20 species of freshwater prawn, 11 species of marine crab and four freshwater species. There are also a minimum of 10 marine and freshwater bivalves. The potential economic possibilities of crustaceans are discussed later in **Chapter 5**.

Insects and Fungi

There is very little information available on the diversity and role of insects and fungi, other than data on field pests available from BRRI and BARC. Elsewhere, it is known that there are notable symbiotic relations involving fungi and bacteria which have economic significance in tree and field cropping. Fungi play a crucial link in the decomposition, and the formulation of plant nutrients and a healthy soil environment. These are areas of vital research which are severely lacking in the floodplain and wetland circumstances of Bangladesh. This makes environmental assessment very difficult at this stage.

The key aspect for planning is the recognition that the linkages between the various aquatic and terrestrial habitats, and species of all kinds, has great value in the issues of pollution, bio-diversity, pest and disease control and maintenance of soil fertility, amongst others.

Micro Flora and Fauna

The primary basis of the food chain and nutrient cycling is controlled by micro-organisms, in both the aquatic and terrestrial environments. All human activity is thus directly dependent on them. The role of micro-fauna and micro-flora in aquatic ecology in wetlands, beels, ponds, stream, and flood deposits from upper catchment which, given its key significance, is very poorly researched. The major external contribution of nutrients, apart from atmospheric sources, are brought into the floodplain by the annual floodwater. Of more significance are the in-situ species which undertake the processes of nutrient fixation. There is no data to assess these relative processes and the impact which FCDI will have. The quantities of biological material will probably have key seasonal peaks which are of significance. The role of this material in the food chain, nitrogen fixation and dynamic soil process has been researched BRRI and IRRI. This has implications for the disease-pest-predator-population relations affecting crop and human health conditions. The floods also act as a biological control mechanism limiting habitat conditions and nutrient/pollution build up. This not only determines the nature of the micro-organisms in ecology, but also the habitats and population dynamics of larger animals like rats, mosquitos and insects.

Recent international research is also identifying the importance of nematodes. While nematodes have long been recognised as a source of potential crop damage, it is now apparent that there may be more nematode species worldwide than insects. They also are known to play a most important role in the breakdown of soil and benthic pollutants. Some research suggests that species diversity in contaminated soils can be higher than in unpolluted soils as a result of the response of nematodes. This would place questions on using indices of species diversity as a reliable indicator of the degree of degradation of some environments.

Until there can be some concerted field research to examine all these issues there is little concrete assessment that can take place. The approach to this research must also be carefully designed and well-executed in the field and laboratory if it is to be of value. These areas are the single most important area of biological change that will likely come about as a result of FCDI. Given the reliance that human survival has on this little known world, it would be wise to address these issues seriously before major investments, and perhaps irreversible changes, were embarked on. There are already sufficient warning signals available from degraded environments and loss of species to provide the justification for proper research resources to be allocated to the study of the floodplain and wetland ecology.

Seasonality and Synchronicity

In biological processes, there are critical times in each annual cycle in which the success or failure of a process depends almost entirely on the timing at which a specific environmental change occurs. Examples are

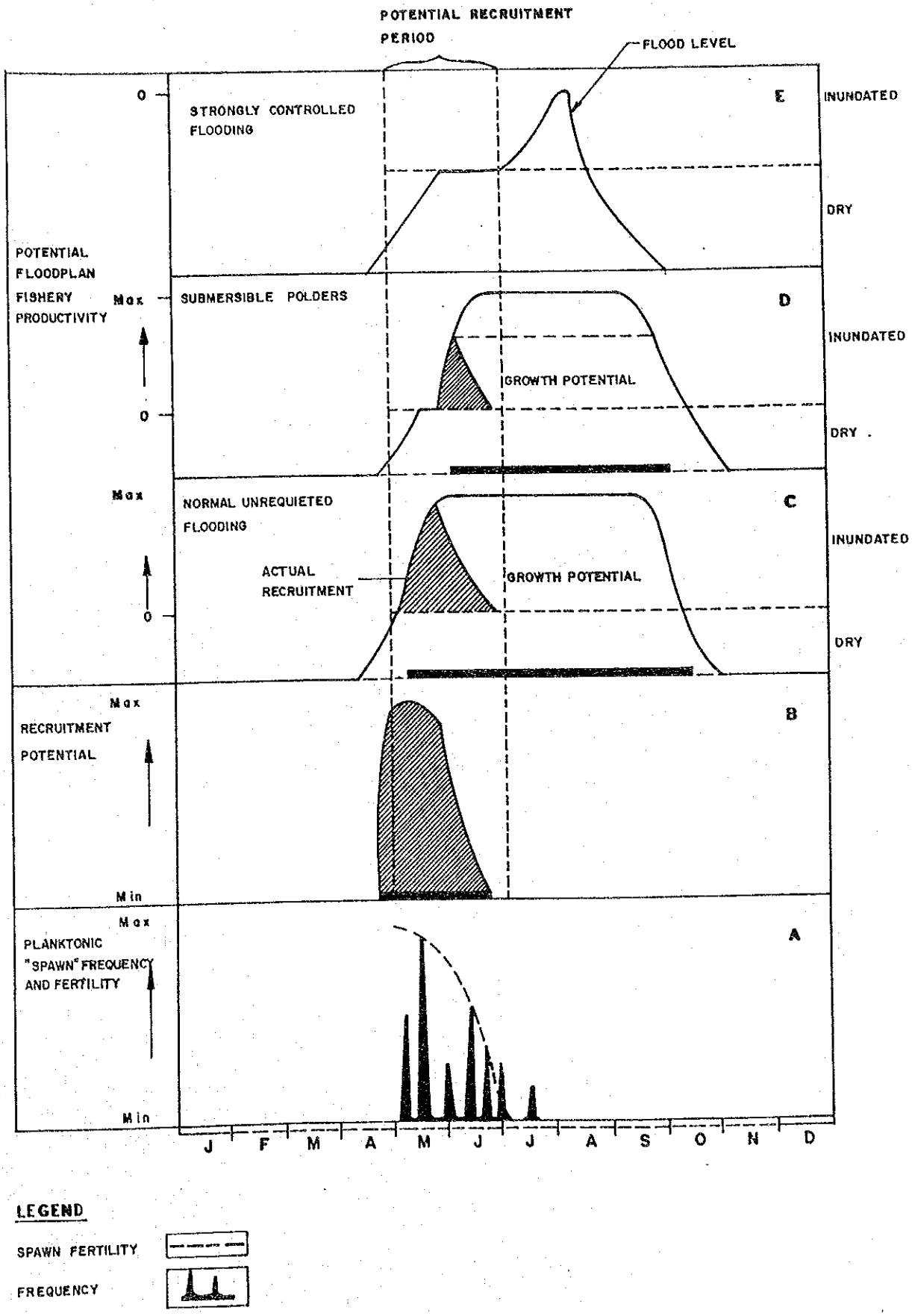
- the release of wind-dispersed crop pollen before the rains commence,
- the dispersal of planktonic fish fry over the floodplain as the waters rise
- the sudden change in the nutrient status of fresh waters during the dry season, caused by the annual bloom of phytoplankton in response to the increase in daylight intensity, which exceeds the critical threshold level for photosynthetic activity.

If the timing of a critical environmental change is altered by FAP interventions, then some processes may fail completely. Yet the importance of such coincident events appears to be unappreciated. FAP interventions have the capacity to alter the timing of major environmental processes, sometimes profoundly. Unless these processes are understood and taken into account in setting the limits of acceptable changes, then major and irrevocable resource losses may develop extremely rapidly.

Figure 2.10 indicates the influence of different flood regimes on the recruitment and growth of floodplain fish. The final table in Appendix F shows the seasonality of breeding for a range of capture fish species in the NWR.

Figure 2.10

POTENTIAL RECRUITMENT AND GROWTH OF FLOODPLAIN FISH STOCKS UNDER NORMAL AND MODIFIED FLOOD REGIMES



LEGEND

SPAWN FERTILITY

FREQUENCY

CHAPTER 3

THE HUMAN ENVIRONMENT

3.1 Social and Cultural Environment

3.1.1 Historical Background and Settlement

The earliest references to the history of the area are mythological. In the ancient literature 'Aytareya Bhraman' mention is made of a ruler named 'Pundra' who lived in North Bengal. The first historical accounts derive from the fourth century B.C. and the main archaeological remains start to arise from the 7th century A.D. onwards.

Although Palaeolithic fossil stone tools and Neolithic remains have been identified in the Lalmai Hills in the south east region there is no similar evidence for the NWR. As the Barind area is older than south-east region and there is a good possibility of finding palaeolithic and near neolithic remains in the north-west region.

The site of the earliest city-state known in Bangladesh is Pundranagar (Mahastan). Pundranagar was a province of the Maurjan empire, which was located just north of Bogra, on the bank of the Karatoya. The citadel is located just north of Bogra on the banks of the Karatoya. It has yielded remains going back to between the 2nd and 4th centuries B.C. and includes the regions earliest written records of this era.

In a later period it was ruled by the Guupta dynasty. In the late 6th century, after the Guuptas, the north-west region became an independent kingdom with the name of Gaur (mainly present Rajshahi district). The Kingdom of Gaur became important during the reign of Sasanka (603-63 A.D) who was an independent monarch. He successfully countered Harsha, the emperor at northern India. After Sasanka, not only Gaur, but the history of Bengal as a whole is not much known.

About the middle of the eighth century, an unknown person named Gopala of Pundra Bhardan was made king of Bengal by the people of the country. He laid the foundation of the Pala empire which lasted until 1160 A.D.. The Palas, along with Bengal, ruled also a large part of north India for a while. The Palas were the last powerful Buddhist monarchs in the Indian sub-continent. The Pala period was one at extensive conquests as well as a period of considerable developments in art and architecture and widespread trade and missionary activities. The largest single Buddhist temple south of the Himalayas is located at Paharpur in Rajshahi district. This was built by the Pala King Dharmapal in the 8th century A.D. The Pala art had immense influence in Orissa, Kashmir, Nepal, Tibet, Burma, Thailand, Sumatra and Java.

After the collapse of the Pala Empire, the Sena dynasty came to power and finally the Muslims. During the Sultanate period (1204-1576 A.D) the centre of power in Bengal was centred on the borders of the present Rajshahi district, where Firozabad, the capital of the northern and the western regions, was situated for a long period. This place was visited both by the famous Arab traveller Ibna-Batutar in 1345 and by the Chinese ambassador M. Huan in 1406. In the Sultanate period a large number of buildings were made in the Rajshahi area and their architectural designs were very distinctive. Sultan Shamsuddin Ilias Shah, one of the independent ruler at this period, countered the invasion of the emperor of Delhi, Firoz Shah Tugluk, from Ekdala fort which was situated in present Dinajpur district.

At the end of the Sultanate period the north-west region along with other parts of Bengal came under the Mughal rule. Finally, the British took over the whole region. The history of the north-west region have always been significant from ancient to modern times in the history of Bengal.

The 78 known sites of archaeological and historic interest which could be easily located on a regional mapping scale are shown in Figure 3.1 and a more detailed list of 71 other sites is provided in Appendix E. While many of these sites are located in towns and villages, there are a significant number which are not and virtually all remain unexcavated.

Without more detailed knowledge on the specific location of project infrastructure it is difficult to say definitively as to whether there will be any loss of important sites of national heritage as a result of the regional projects. A separate study was completed for the GIP and did find significant sites in the areas of proposed construction. Elsewhere the situation has not been surveyed but the indications from the GIP are that there should be studies made for every future feasibility study. Given that the study was able to document some 150 sites in the NWR without field survey, reconnaissance surveys of the areas selected for feasibility study should be carried out. This work can only be done by a trained archaeologist and is required under legislation.

During the 13th to 18th centuries the rural areas are believed to have been sparsely settled, apart from some isolated towns and villages. Settlement was characterised by considerable influxes of immigrants, including Turks, Arabs, Paktuns, Persians and muslims of many other extractions. This mixed background characterises the current majority of the population who are non-tribal people. The NWR is the home to a number of minority tribal peoples. The rapid increase in population pressure in the south and east of the country has lead to flows of migrants into the north-west for both permanent settlement and seasonal labouring.

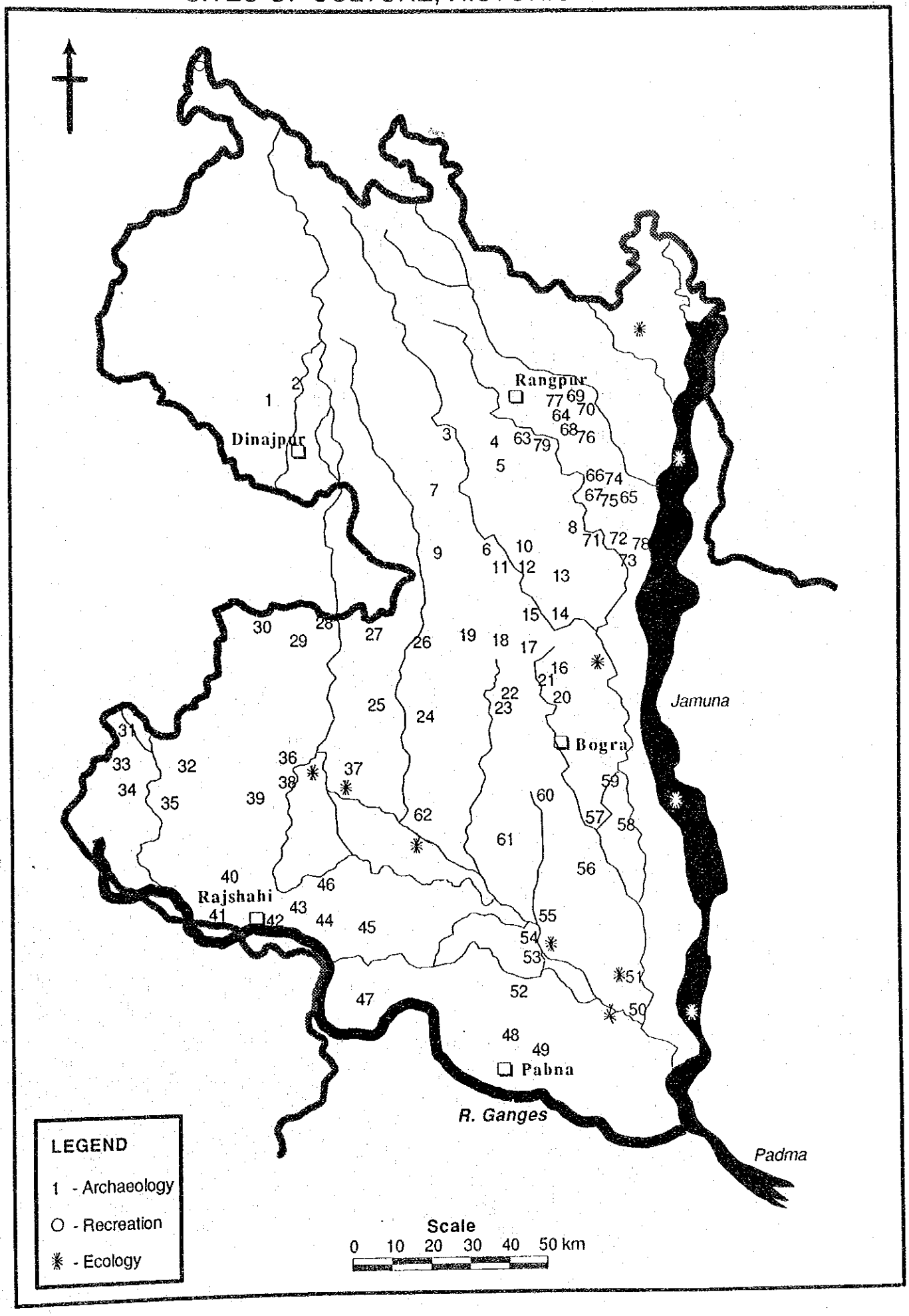
3.1.2 Cultural Facets

The basis of local culture is rooted both in recent and ancient history. Many of the cultural facets of life have been considered as unimportant planning issues in the past. At the pre-feasibility level it has not been appropriate to introduce these as anything other than a topic to note. These cultural features are changing fast in contemporary society under many political, religious, commercial and environmental pressures. FCDI developments are just one of the factors which have already contributed to these changes. The most notable impact has been on traditional Hindu fishermen forced out of their traditional way of life as FCD projects have impacted on the floodplain fisheries and boating capacities. Other key linkages noted relate to the importance of the many different rice varieties. These have a great significance to the lifestyles of different social, ethnic, religious and occupational groups. These varieties also have great genetic significance. These aspects of cultural heritage have often been handed down from generation to generation and contain within them great knowledge and understanding of the natural environment. The symbolic relationship associated with the diversity of the natural world also help establish cultural norms and act as a cohesive force. As these links to the past are broken so to is the chain of knowledge and social cohesion.

The local network of water-based transport play a large part in the contact of social and domestic affairs. Water and boat festivals also are traditional features of this area of rural life. Change brought about through the insensitivities of FCD planning cut across these social values and have deeper ramifications in the roles and arrangements surrounding marriages and economic relationships.

Figure 3.1

SITES OF CULTURE, HISTORIC & SCIENTIFIC INTEREST



3.2 Regional Demography

The unadjusted census returns for 1991 show that out of a national population of nearly 108 million people the NWR comprised just over 23 percent of the total; in numerical terms the estimated size was 25,432,000 millions. The annual linear growth rate was calculated at 2.01 percent. With a population density of 751 per square kilometre it was below the national figure which was estimated to be 781 per square kilometre. By division (Rajshahi division is the NW Region) the key indicators in 1991 were as follows:

Table 3.1 Key Indicators by Division 1991

Location	Area Sq.Km (000)	House holds (000)	Popu-lation (000)	HH Size	Literacy All ages	Density Sq.km.
Bangladesh	134	19,617	104,766	5.34	24.82	781
Rajshahi	33	4,923	25,432	5.17	20.47	751
Khulna	28	3,715	19,966	5.37	20.47	714
Dhaka	30	6,220	32,270	5.19	27.83	1,070
Chittagong	42	4,758	27,096	5.69	25.83	640

Increases in population put pressure on land and this has consequences for flood action planning since land becomes fragmented under such pressure making the acquisition of it for flood control purposes difficult. A rich peasant with over ten acres is far more likely to be willing to sell a few bighas for an embankment or a berm than is a marginal farmer who is trying to make a living from one acre.

Jansen (1987) demonstrated that at the start of the twentieth century there was one person per acre of rural land while now the figure is four and may rise as high as eight per rural acre by the year 2000. At liberation from Pakistan very few families owned no farm land while nearly twenty years later although official statistic for the landless are 62 percent a more realistic observation might be nearer 75 percent.

In the NW region the population has increased by over four millions between 1981 and 1991 forcing population density up over the same period from 630 to 751 per square kilometre. While population growth in the NWR has contributed to pressure on land it is also true that for flood action planning purposes the disappearance of land into the Brahmaputra and Teesta also creates problems.

Table 3.2 presents a comparative picture of the various districts comprising the NWR.

Table 3.2 Population by District NW Region, 1991

District	Area Sq.Km	House holds (000)	Popula-tion (000)	HH Size Rate	Literacy M/F All Ages	Sex Ratio	Density (sq.Km)
NW Region	35,592	4,923	25,431	5.17	20.47	105.1	751
Panchagarh	1,405	138	696	5.04	23.65	105.5	495
Thakurgaon	1,774	189	978	5.16	21.61	106.5	551
Dinajpur	3,438	429	2,182	5.08	22.45	106.6	634
Nilphamari	1.641	264	1,339	5.06	17.00	106.0	816
Lalmanhirat	1,241	181	920	5.08	18.21	106.1	741
Rangpur	2,300	422	2,107	4.98	20.64	106.2	916
Kurigram	2,237	307	1,557	5.07	17.32	101.7	696
Gaibandha	2,179	379	1,855	4.89	18.35	102.0	851
Joypurhat	965	152	736	4.83	23.44	107.4	763
Bogra	2,659	516	2,565	4.96	22.04	105.5	964
Naogaon	3,418	404	2,058	5.09	21.95	103.8	602
Natore	1,883	244	1,296	5.30	20.43	105.2	688
Nawabganj	1,602	196	1,146	5.85	17.63	102.8	715
Rajshahi	2,026	360	1,882	5.22	23.43	104.9	929
Sirajganj	2,455	412	2,243	5.44	18.42	105.8	918
Pabna	2,369	323	1,863	5.77	20.86	107.0	786

Source: BBS, 1991.

3.3 Farming Systems

3.3.1 Land Organisation

Micro-elevations, because of the risk of excess water from rainfall or the rivers, exert a major influence on agriculture. Farmers operating in flooded areas endeavour to farm also at higher elevations. Flood-free land is necessary for survival in exceptionally wet years when the crops like b. aman would be damaged or destroyed. Farmers aim to operate on many parcels, located at different parts of the landscape, to escape the hazards inherent in any one elevation. Highlands suffer from drought in years like 1992 and lowlands from destructive flooding in years like 1987 and 1988. The cropping sequences adopted by the farmers for each elevation are clearly identifiable and show the clear strategy of dispersed cropping in a variety of elevations to spread risks. Farmers go long distances from their homesteads to achieve this diversification.

The surveys found average farm area at 1.26 ha with an average number of four parcels. 84% owned their land, 37% were share croppers and 7% leaseholders. Many owned as well as rented land. Payments by share croppers were usually 50%. Leases, where the lessee provided all the inputs except the land, were a fixed share of the produce, about one third of a normal crop. Cropping intensities averaged 152%, ranging between 187% and 142%. A few exceeded 200% with triple cropping on some of their land.These were those who either owned draft animals or had a two-wheel tractor or power tiller. They were also well organised to obtain labour to safeguard their harvest simultaneously with planting the next crop.

3.3.2 Agro-chemical Use

Bangladesh uses about 1.6 m tonnes of urea (46% N), triple super-phosphate (TSP, 46% P2O5) and muriate of potash (M/P, 60% K2O). Small quantities of lower-analysis fertilisers are also used, like ammonium sulphate (21% N) and single superphosphate (SSP, 16% P2O5). Fertiliser use in Bangladesh is about 50 kg/ha nutrients. There has been a 16-fold increase since Liberation. Fertilisers are applied to all the more productive crops: boro rice, t. aman, local or HYV, sugarcane if grown on flood-free land and the small area of irrigated wheat. The high-value crops - potatoes, vegetables, spices and orchards - usually receive generous doses of fertiliser. Broadcast aus and aman get small amounts of nitrogen. Fertilizer mixes for all the common crops usually contain gypsum to combat sulphur deficiency. They should also contain zinc sulphate, at the rate of about 10-15 kg/ha. Table 3.3 shows the current application rates.

Table 3.3 Approximate Present Fertilizer Application Rates (kg/ha)

	N	P_2O_5	K_2O
HYV Boro rice	120	60	35
T. Aman	90	45	30
Local boro	40	20	10
T. Aman	35	15	10
Floating rice	25	0	0
Wheat	35	20	15
Mustard	25	0	0
Sugarcane	90	40	60

Source: District Agricultural Staff and Farmer Interviews.

Pesticides, mostly insecticides, are regularly applied to rice, particularly boro and transplanted aman, local or HYV. Both granular and liquid formulations are used. Aerial spraying, common at one time, is by now much reduced and in line with modern pest management practices. There is still continued use of many banned or adulterated chemicals through the illegal trade networks that exploit the positions of the poorer farmers. Indigenous local pest control practice are still used but are now less effective because of the loss of fallow, the loss of crop mixes and the loss of inter-cropping. Providing perches for insect-eating birds is still widespread.

3.3.3 Livestock and Draft Power

Shortage of draft power has been reported by many farmers. This may make a rapid change-over between boro and TDW aman, or mustard and pulses to boro, difficult. Most surveys indicate that standards of land preparation are declining. This is causing considerable concern. Land traditionally ploughed and laddered (a form of harrowing) four, five or even six times in preparation for a transplanted rice crop is now only ploughed and laddered perhaps three times. Shortage of draft power may well delay the full exploitation of improved conditions expected from FCD projects. The use of two-wheeled tractors is very limited. Farmers were not satisfied these machines did not control weeds as well as the traditional plough, nor did they prepare land for non-rice crops as well.

The chronic and increasing fodder shortage was highlighted in the course of the survey. The need to graze and feed water hyacinth at times is indicative of the problem. This practice has risks if not supplemented by other forage, as it contains potentially toxic oxalic acid. Farmers regularly harvest parts of the rice flag leaf for fodder, indicating the positive trade off in terms of reduced grain yields. Wherever the floods came late and were shallower than usual, the boro stubble produce ratoons and abundant fodder which cattle and buffaloes graze. The availability of cattle feed is not likely to increase substantially: increased fodder production could only take place at the expense of human food production.

The shortage and constraint of draft power for land preparation, has been identified as a problem as far back as 1928 and has continued to increase. Animal feed is getting scarcer as more land has to be devoted to grow human food. The only potential source are the byproducts from intensified arable crop production which would be made possible by FCD projects. However, the byproduct will be rice straw which is not a good fodder. Furthermore, with HYV's taking over from local varieties produce less and poorer quality straw. More significantly the high quality seasonal grasslands have now been replaced by HYV boro. The loss of land preparation capacity is not from choice, but necessity.

Two-thirds of the respondents had draft cattle with only a very few keeping buffaloes. Only three people had two-wheeled tractors. Renting animals is not a problem. Around half the farmers could get someone to plough their land within a few days of a request. Over half the owners of draft animals, and all owners of power tillers, did contract work. Others who owned animals either, had too much of their own land to work for others or, their animals did not have the strength to undertake additional work. Only one third could meet all requests made on them. Local animals do not work every day when doing land preparation, and when they work it is only for 4 or 5 hours. Everyone emphasised rest days indicating that work animals are weak and underfed.

Buffaloes are stronger and always in better condition than cattle and are mainly used for haulage. All draft animals were used for threshing. 6% threshed for others, 13% were used for transport by their owners; less than 2% did contract transport. Most of the contractors were in Rajshahi and Nawabganj districts, where sugarcane is a major crop and has to taken to the factory collecting centres. The alternative would be either bicycle rickshaws or carrying goods on shoulder-poles. This low usage of draft animals for transport is surprising but is corroborated by the very few animal-drawn vehicles seen on the regions roads, and the even fewer carts, compared to elsewhere in the country.

Cattle and buffaloes are fed rice straw, weeds, oil cakes and wheat chaff. The pods of trees, mainly those of *Acacia arabica* (babla) and *Leucaena leucocephala* (ipil-ipil) are also fed. Both are common on roadsides. Over 70% kept all the rice straw they produced with only a little used for fuel. 13% sold part of their production and 14% had to give a share to the landlord. 45% purchased one or more kind of fodder which were mostly oil cakes, some rice straw or wheat chaff. A few feed weeds pulled up by people other than the owner.

Crop residues would become increasingly important as stock feeds, but they also form an important resource for thatching and fuel. The straw of b. aman, which is the least palatable, is used for fuel, With the increasing scarcity of village fuel supplies that even if the total volume produced increased that this increase would be reflected in increased livestock production. There is also some evidence of an expanding demand for straw in the manufacture of strawboard. The industrial market for straw develops in areas that have a ready access to cheap river transport. This develop will create linkages between farmers and those in industry and will further put pressure on the rural energy resource base.

3.3.4 Labour

There is evidence of labour shortage in most areas, overcome by the use of migrant labour. While by no means certain, it is assumed that this can continue in the future. There is a significant level of wage paid labour and share cropping in the agricultural system. This is linked to the high level of landlessness and the labour intensive nature of rice farming with very peaked seasonal demands for labour. In addition most artisan work is specialised and carried out as a full time occupation and not in association with farming. Occupations include brick making, paddy husking, fishing, and provision of waterborne and road transport and maintenance. There are complex patterns of movement for work. There is likely to be increased seasonal demand for labour due to the extension of HYV rice cropping, but the amount and location relative to supply and sustainability of these opportunities is uncertain. FAP 12 results indicate that the abundance of labour in land owning households means the likely increase in work available to the landless is quite limited.

Communal labour systems are usual for transplanting, especially the aman crop, but not for other operations. Labour shortages occur at peak times and always have so. About two thirds of farmers would like to harvest faster than they are capable of at present, especially their HYV transplanted aus and aman. The time taken to harvest is important because of weather hazards. Also, rice, especially the HYVs, shatters easily and if the harvest is prolonged, field losses are high. Weather risks are the least with the aman harvest in November and early December. However, the different aman crops occupy by far the largest area and demand a large labour force. This is especially so if the intention is to grow a rabi crop to follow it. This must be quickly planted, to utilise residual moisture, a scarce commodity. Since FCD projects enable farmers to grow more boro, transplanted aus and transplanted floating rice, the labour shortage at harvest would be exacerbated.

Family labour helps virtually all the rice harvests. Two-thirds hired labour and a quarter used harvest contractors. Many farmers use all three sources. Hired labour, either alone or working with family labour, was employed by 68% for other crops, while contractors are little used.

Labour arrangements are mostly based on daily wages. Almost one quarter is by area harvested and 5% was contracted through an agreed share of the crop. Contract labour migrated in from other regions specifically for the harvest work. This movement is made possible by the phased harvesting season compared to the area this labour comes from.

3.4 Natural and Common Property Resource Use

The use of common property resources and their associated rights is of considerable importance to a large proportion of the population, particularly the landless and resource poor. These resources which provide free goods include the capture fisheries which contribute protein, minerals, vitamins and oils to the diets of these households. The role of fish is under study by FAP 16.

Common resource rights also apply to the grazing and collection of fodder from publicly owned land, the picking of fruits and gathering of thatching and other vegetative matter, all of which have a multitude of household uses. The degree of access to land is determined by the owners. The intensity of cultivation and exploitation determines the degree to which this is carried out and is sustainable. As cropping intensifies and loss of habitats has accelerated these sources of livelihood and survival strategies have become scarcer.

A small survey was carried out in the Lower Atrai to determine the extent of use of various natural resources that could either be sold or which could be used to avoid cash expenditures. The multitude of multi-purpose products that exist confirms an important set of survival strategies. 48 different species were recorded in the survey of 18 households. Many of these are found within the management system of the homestead groves and other from the floodplains. Table 3.4 summarises the survey results. It can be seen that considerable levels of savings are involved and that a wide range of functional, artisanal, social and cultural utilities are served.

Table 3.4 Values of Natural Resources in Use for Multiple Purposes

Uses	% of Species	% of H.H. Using	Value (Tk) Sales	Value (Tk) Saving	Total (Tk) Value
Medical	25	78	-	50	50
Food	62	100	35	425	460
Cultural	4	11	-	1	1
Construction	16	50	110	190	300
Fuel	41	94	20	190	210
Crafts	4	33	25	35	60
Religions	2	6	-	1	1
Fodder	8	22	-	19	19
Others	6	6	-	10	10
Multiple Uses	60	100	210	885	1095
(n)	(48)	(18)	(18)	(18)	(18)
Sub-Total:			400	1810	2210

* Rounded to nearest Tk. 5.00

3.5 Quality of Life

3.5.1 Human and Animal Health

Water-Related Diseases and Public Health Issues

A brief review was carried out for FAP 2 by a local NGO. Their findings are reported on in Volume 15. The ecological surveys in Volume 14 also shed light on the likely issues of concern. Close liaison was also maintained with related studies under FAP 16 and FAP 17 into various issues of biological controls, nutrition and disease vectors. In studying the issues of health, disease and disease vectors it is to be remembered that this is as important for fish, livestock and other flora and fauna, as it is for humans. Without adequate planning considerable economic loss and strains on future productivity could occur.

The major human health considerations in the NWR are water-related diseases, nutrition and a wide range of public health considerations. The health problems of the NWR are generated mainly by the poor socio-economic status of the population. The proposals for future FCD will affect the distribution, timing, depth and duration of the flooding and recession of water across the monsoonal and dry season landscape. This will change the habitats conditions for a number of existing or potential disease vectors and water-related diseases. The annual flood regime exerts an important influence in controlling the habitats of pests and diseases and is a biological control mechanism on population levels of some diseases and disease vectors.

The history of public health is characterised by recurrent epidemics of water-related diseases. The prominence of water in the environment in the deltaic conditions of Bangladesh have both advantages and disadvantages. The changing pattern of disease and vector profiles can usually be directly related to changing landscapes and seasonal environmental features associated with irrigation, changes in drainage patterns, impediments to drainage and to changing conditions of endemic poverty, poor water quality and sanitation.

Indian and Sri Lankan experience has shown that diversification of the cropping pattern and crop rotations might be necessary to break the stagnation of the background habitats and environmental conditions that encourage vector breeding habitats and cycles and lead to widespread corridors of transmission in the mono-cropping systems that have become dominant in the landscape.

Water-related disease can be carried through different transmission routes including water-borne, water-washed, water-based or through a water-related insect vector. The known vector risks include existing endemic diseases such as malaria (mosquito vector), kala azar (sandfly vector), filariasis (mosquito vector), japanese encephalitis (mosquito vector) and dengue (mosquito vector). New diseases requiring vectors that are not present but could pose a risk would be schistosomiasis transmitted through snail vectors. The water-related diseases include diarrhoea, dysentery, cholera, hepatitis and typhoid are all related to polluted sources of drinking water and to oral-faecal contact. The water-washed diseases include scabies, yaws, leprosy, typhus, trachoma and conjunctivitis.

Malaria

The primary endemic regions for malaria in Bangladesh are in the Chittagong area and in the hill areas close to the border in India which would include those areas on the left bank of the Teesta. The natural process of flooding is known to act as a physical control on the extent and permanence of habitats suitable for the breeding of mosquito vectors. Any disruption to this pattern needs to be taken seriously.

The national statistics show almost that the numbers of detected cases in the NWR has oscillated between 250 in 1988 to around 2 800 in 1981. The focus of attacks appears to be in the Rajshahi and Rangpur areas, although cases are apparent throughout the region.

Since the availability of prophylactics malaria became rarely fatal. However, its debilitating effects, resistance to prophylactics and its combine effects with other illness is a significant factor in overall mortality. In spite of extensive campaigns since the 1950s malaria remains endemic in the NWR. National eradication programmes during the 1950s failed to eliminate the anopheline mosquito vectors. As resistance to DDT developed, both BHC and Malathion spraying became routine, but more expensive pesticide strategies. By the mid 1970s the eradication of vectors had become an impossible task and control programmes have shifted their emphasis to reducing morbidity and preventing mortality. Resistance to chemicals in both the vectors and malarial agents has led to a resurgence of outbreaks of malaria in many parts of the world and partly in the Indian sub-continent and ares of the NWR.

The common reasons for the spread of the vectors are waterlogging in surface waters, loss of adequate flow rates, poor design and maintenance of engineering structures and poor irrigation practices. Dense stands of water hyacinth also provide suitable habitats for Anopheles mosquitos. The increased use of agricultural and public health pesticides also eliminated many of the main mosquito predators which otherwise offered varying degrees of biological control. While in urban areas the problem has been dominated by the rise of developing resistance to prophylactics the rural areas have experienced the evolution of a succession of new species that have been associated with the increased use of fertilisers and pesticides. The development of the canal irrigation systems from barrage offtakes on the Teesta and the proposals for compartmentalisation in the GIP both involve considerable risks of enhancing the habitats suitable for vector breeding. The long standing existence of intra- and inter-regional seasonal migration of labour, and the international migration to and from India, again confirm the high priority which must be attached to serious mitigation efforts to prevent the spread of malaria.

The primary vectors are species of Anopheline mosquito. The same vectors in the sub-continent are known to be carriers of filariasis and japanese encephalitis. Of the 51 anopheline species in the sub-continent, six are primary vectors and four others are only of regional importance. *Anopheles culicifacies* is the main continental vector responsible for up to 70% of cases. Research has shown that vector capacities are complex as there is considerable variation found in different areas, including differing paddy cultivation zones.

The vector carriers for malaria in Bangladesh are still not completely researched or understood. It has more recently been established that *A. aconitus* is also a vector in Bangladesh in the NWR. Historically in Bangladesh it was transmitted through a relatively fragile species (*Anopheles philippinenis*). FAP 16 studies indicate that malaria transmission is also occurring via the more common species (*Anopheles aconitus*) which is more robust and a cause for concern. The northern and western parts of the NWR appear to be the most prevalent malarial areas although cases alone the Ganges high ground are also recorded. The GIP area can be regarded as a place of historical endemism and of medium risk for the environmental modifications that will be associated with the scheme as currently designed.

The early DDT spraying campaigns were particularly effective in making the vector rare. The later introduction of chloroquine also provided a cheap and effective prophylactic. Integrated biological and environmental control programmes have proved themselves worldwide to be particularly cost effective. This require the authorities to fully mobilise and involve local communities to remove or purposively manage habitats suitable for vector breeding (i.e. small ponds, tanks and borrow pits), encouraging drainage and water flows in areas where stagnant pools could otherwise develop, cleaning ditches and introducing inedible and edible larvivorous fish into the remaining permanent water bodies, ponds and troughs.

Kala Azar (Visceral Leishmaniasis)

Kala Azar has had a history of sweeping epidemics since the 1880s in Bengal and Bihar (Ward, 1992). Kala Azar was once thought to have disappeared after the DDT spraying programmes in the 1950s. It is currently under-going a resurgence in India and in Bangladesh where it has an apparently important focus in the NWR. It is endemic in parts of Assam and West Bengal in India and in the northern regions of Bangladesh. Recent assessment has speculated that there may be between 20-50 000 annual cases nationally, and rising. This compares with the 2 360 Kala azar cases were recorded officially nationally in 1990. It is the subject of an in-depth ongoing study by FAP 16; the results of which are not sufficiently analysed to allow proper evaluation at this point in time.

Most of the recorded cases occur in the NWR. They have a focus around Sirajganj, Pabna, Rajshahi and Natore. The main foci are close to the Chalan Beel Polders C and A and in areas in Pabna District on the Ganges levee. The risk of spread of this disease is not yet assessed, but its known epidemic proportions mean that it cannot be regarded as a localised issue. It is vital that the mechanisms of environmental manipulation to control the sandfly vector are made known and integrated into planning for the NWR, and elsewhere.

The disease is carried by a sandfly vector (*Phlebotomies argentipes*) that breeds in decaying organic matter and requires humid conditions or moist, organically-rich soil conditions as its habitats. The sites of focus of the disease indicate a diversity of potential conditions in which spread of the vectors might occur. It relationships to the FCD and I developments in the Lower Atrai are not yet understood clearly. Issues such as changing settlement patterns and flood regimes may be implicated. The reduction in the DDT campaigns is certainly a factor, as is the migrations and regular movement of people to and from endemic sites in India. One hypothesis would associate changes to the major alterations in livestock, grazing and dung management. Whereas livestock previously would have spent the dry season grazing on grasslands around beels; today these beels are heavily cultivated for boro. Dung, that would have been flushed with the flood, today is collected and brought into a central focus around the homesteads for fuel. Similarly, the concentrations of people into the linear settlement and poor sanitation have again intensified the breeding habitats close to the home for this vector.

Filariasis

Bancroftian filariasis is transmitted by the mosquito vector *Culex quiquefasciatus*. This is generally associated with breeding sites in insanitary waters. This disease which causes swelling of the hands and legs and is difficult to treat effectively. It has spread alarmingly in recent decades in West Bengal and Assam. India now has an estimated 21 million carriers. Its focus in Bangladesh is concentrated in the northern regions in both rural and urban areas. Thakurgaon, Dinajpur and Rangpur are known foci. Around 14 000 cases of Filariasis were recorded nationally in 1990 and about 5 000 are recorded cases in the NWR. These numbers have been increasing rapidly. A filaria research institute set up in Thakurgaon in 1967 by WHO has since closed down due to a lack of funds. The control of the vector sites and the limitations on endemicity is influenced by seasonal monsoonal flushing of habitats. Seasonal migration flows and poor environmental management under FCD influence will all be directly influential in the rate of increase of this disease. The GIP area will be at risk from this problem.

Japanese Encephalitis

Japanese encephalitis or brain fever is new to the sub-continent and entered in the mid-1950s from Japan and Southeast Asia into Southern India into the Ganges-Brahmaputra plains after an epidemic in West Bengal in 1973. It is commonly associated with rice cultivation and is carried by the Culex vishnu group of mosquitos, especially *C. triaeniorhynchus* which is common and breeds in paddies and other deep water bodies in warm humid climates. The vector transmits to pigs which would make pig breeding areas under non-muslim communities more susceptible to epidemics. A far more potent carrier are certain groups of water birds which also act as transmission hosts. The cattle egrets and pond herons are known hosts.

Schistosomiasis (bilharzia)

Schistosomiasis is carried by specific types of snail as its vector. The nearest focus of infection is in the Narmada Basin and in Maharastra in W. India. The degree of risk is thus small but cannot be ruled out altogether. Recent advances in research into indigenous prevention and control measures have identified locally used medicinal methods in both Ethiopia and China that appear to have opened up considerably cheaper methods of treating this disease in endemic areas.

Dengue Fever

Dengue fever is also transmitted by a mosquito vector (*Aedes aegypti*). It is mainly restricted to urban areas where vector breeding occurs in water tanks and cisterns associated with cooling systems. No association with environmental changes induced by FCD or I are suspected.

Water-borne Disease and Parasites

The main diseases in this group comprise the faeco-oral disease. Diarrhoea, dysentery, cholera, hepatitis and typhoid are all related to polluted sources of drinking water and to oral-faecal contact. Contamination of shallow handpumps and poor sanitation and the practical problems of sources of drinking water taken from rivers, canals, beels and khaors means that proper protected water supplies, community health education, sewage disposal and sanitation programmes are the only solution.

Diarrhoeal outbreaks have been shown to be closely correlated with areas of groundwater irrigation where draw-down of the dry season water table goes beyond the suction limit of shallow hand tubewell technologies. In these areas the reliance on alternative water sources in the dry season leads to a rapid increase in cases. Where FCD projects lead to impeded drainage in small localised areas and decrease the areas of open water in standing water bodies pollution concentration and contamination of water sources has been noted in some areas.

Statistical data on the prevalence of these diseases is generally inadequate (partly because the presence in Bangladesh of cholera is officially not acknowledged). Nevertheless, an estimated 30-50,000 die of cholera in Bangladesh annually.

Two biotypes of the cholera-causing bacterium *Vibrio cholerae* exist; the "el tor" strain, which generally prevails in regions of Bangladesh north of Dhaka; and "classic cholera" which seems to be limited to estuarine zones south of Dhaka. Whilst *V. cholerae* organisms appear in the aquatic environment throughout the year, the disease itself is predominantly reported during the monsoon months suggesting that ecological factors may determine its appearance and etiology. The ecology of *V. cholerae* does not appear to depend upon networks involving the presence, reproduction or transmission route of humans.

The available research studies suggest that various crustacean zooplankters (copepods), which themselves feed on algae and other phytoplankton, act as primary reservoirs of activated and pathogenic *V. cholerae* bacteria. Why the disease is effectively suppressed by monsoonal conditions is not clear. Various reasons have been put forward. First, the high turbidity of the early river flooding, which limits algal photosynthesis and results in a decline in phytoplanktonic density, could lead to a drop in the populations of grazing copepods. Second, predation may also be a limiting factor of which the larvae, fry, and juveniles of many species floodplain fish are likely copepod predators. This shows another possible important objective that proper management of capture fisheries stocks might achieve.

These two reasons if substantiated by adequate research would lead to inferences that the construction of major embankments may lead to a worsening cholera situation by the reduced turbidity of floodwater and the impeded reproduction, transport, and recruitment of floodplain fishes.

Another hypothesis suggests that more intensive agriculture could be largely responsible for rising cholera levels. This mechanism is causally linked to anthropogenic eutrophication induced by the use of chemical fertilizers. This augments the production of phytoplankton which is followed, in turn, by a bloom in cholera-carrying copepods.

Water Washed Diseases

Water-washed diseases include the skin and eye infections, such as scabies, yaws, leprosy, typhus, trachoma and conjunctivitis. They are water-washed and transmitted from person to person due to a lack of water for personal sanitation. Over one million cases of skin diseases were recorded nationally in 1990. They take a particularly heavy toll on pregnant women and young children.

A particularly important problem is bacillary dysentery. This is caused by the highly invasive *Shigella spp.* bacterium. *Shigellosis* is a prominent cause of diarrhoeal deaths of young children and is spread by direct contact without any intermediate aquatic phase. Treatment requires intensive use of antibiotics, and is minimally responsive to oral rehydration therapy, unlike cholera. Sanitation and the availability of water for washing, rather than its quality is the key issue.

These health problems are poverty and environment related and work in conjunction with malnutrition to amplify poor health conditions. These will be less influenced by FCDI, but are still integrally linked to the hydrological and drainage changes which FCD brings about. In particular the need to plan for embankment dwellers and their quality of life means that investment to cover these problems must be included.

Good public health programmes closely tied to community participation are one aspect of solving these problems. Proper sanitation, health education, good water and environmental management, careful planning, epidemiological studies and disease hazard mapping and monitoring are essential to be integrated into the main water development programmes, such as FAP.

Public Health and The Need for Clean Water

The condition of any river depends on a dynamic balance being maintained between the quality and quantity of flow, on the seasonality of sedimentation and on seasonal ecological and bio-chemical processes taking place within this system. The Ganges transports some 83 million tonnes of dissolved solids annually compared to an estimated 35 million tonnes in the Brahmaputra. The Ganges is twice as saline as the Brahmaputra. Estimates for the other rivers of the region are not available.

The critical time for planning for water control and management is the conditions in the low flow season when flushing and assimilation capacity is least. While rivers with large flows may be resilient, complacency in relying on the natural cleansing capabilities of the water networks would be a dangerous development approach lacking responsibility for this and future generations. The action plan already enacted for cleaning up the Thames and the Ganges has shown the degree to which health can be restored to a river and how this can be maintained.

The extremely poor distribution of access to clean water, sanitary latrines, and the rising water tables and flood conditions from rainfall and river sources in the monsoon, leads to a distinct seasonal pattern in increase in gastro-intestinal and parasitic infection levels. When overlain on the impaired health already prevailing from the nutritional disorders, due to vitamin deficiencies and a lack of perennial diversity of food intake, the amplification effect is far more serious than the effects of both added together. The implications for the economic and social capacity for development are already devastating and debilitating. Vast development potential is lost. The costs for correcting the problems are also staggering. Based on the per capita figures the difference between the investments currently made for Bangladesh compared to that required to achieve the levels found in America would be orders of magnitude different.

Domestic water supplies are taken from a number of sources and, even when tube wells have been installed, surveys have found that families continue to use a variety of other surface supplies, either for drinking water supplies, but more commonly for other uses, such as bathing and washing.

Major drains and FCD have a number of effects which might affect homestead water supplies and would require a mitigation planning in feasibility planning. There are important linkages between the farming and homestead systems on high ground and the degree and seasonality of soil moisture available on the receding flood. The seasonal depth to the water table and the type of technology used to extract homestead water is also significant in assessing FCDI impacts. There are also important local (and possibly wider linkages) which maintain the recharge and water depths in the lower lying wetlands which can be affected by FCD and I. The details of these linkages cannot be differentiated between schemes at this pre-feasibility stage and will require more detailed analysis later. Figure 2.3 indicates the areas where seasonal lowering of dry season water tables beyond the suction lift of domestic pumps has been noted and associated with both FCD and groundwater irrigation.

Under conditions of FCD it will be in the countryside seasonal river systems close to or, downstream of, major urban and industrial centres that the problems will arise. This particular highlights the dangers for the Rangpur and Bogra areas and nationally in the estuarine and marine areas of the Bay of Bengal for the decades to come. All these foreseeable features, already commonplace problems in many places around the world, would suggest that stricter controls, proper and enforced legislation, community awareness and participation, and the enlightened involvement of the commercial and industrial sectors, are the broad front required to ensure that important thresholds are not crossed. The agricultural sector will have to move to controlled use of fertiliser and toxic pesticides and agro-chemicals and begin a move to organic manures, sewage recycling, bio-fertilisers, integrated pest control and management and the creation of more diverse habitats, both for food diversity and controls on pest and disease vectors.

The implications for planning are that agricultural and non-agricultural water supplies, sources and extraction technologies must be given careful consideration in FCDI planning designs and specific mitigation programmes included to deal with the problems.

3.5.2 Quality of Water and Food

Biological contamination of shallow groundwater has been identified in some areas. This is of concern for the extended development of FCD, FCDI and I schemes, particularly where there is also the growing use of fertilisers and potentially dangerous agro-chemicals. There is an insufficient data base to assess the regional problems of water quality for potable and other uses. From groundwater there are some cases of iron, boron and bromide problems which affect both crop production and human health. These have been recorded from the field surveys and other sources in the Kurigram, Lower

Karatoya and Mohananda basins. The problems related to surface water sources are from industrial pollution, agro-chemical pollution, eutrophication in stagnant pools, low available oxygen due to enrichment and pollution with sewage and waste effluent, and the health risks from poor sanitation and drainage conditions, both inside and outside FCD schemes.

The main potential sources of pollution will involve any drainage alterations to discharges from upstream urban, industrial or agro-chemical sources and from local sewage disposal and agro-chemical use.

Industrial, agro-chemical and urban discharges as well as agro-chemical use have risen steadily in recent decades. Public health use of pesticides has generally declined as bans on DDT and other toxic chemicals have been introduced. In practice there use and illegal import from Indian still continues unofficially. These processes and the likelihood that they will continue to increase is causing concern given the potential public health risks and the degradation and pollution of the soil, water, fisheries and ecological processes.

Confinement of channels and drainage routes will both stop upstream pollutants from entering the floodplain, but also prevent those from within getting out. Drainage alterations may route these pollutants in more concentrated forms to other downstream areas. The final arrangement of schemes selected must be given careful consideration to analyze the implications for proper monitoring and response priorities at the feasibility stage.

Water, sediments and pollutants all flow into Bangladesh from across its borders. Many issues of cross border water regulation, land use, population density and discharge of pollutants into the main rivers and streams are outside of local control. Planning can only proceed on the understanding that there international cooperation will be promoted in monitoring and resolving important issues. The details of monitoring inside the NWR are dealt with in Chapter 6. The monitoring programme would establish and assess the importance of any changes which might be cause for concern. The main problems might be the failure of upstream structures or the rise in toxic discharges or general sewage pollution.

3.5.3 Nutrition

The problems of poor nutrition for humans and animals are widespread. It is a complex area of research which the environmentalists have had few resources and insufficient time to appraise properly at this stage.

There is a significant prevalence of goitre and the high incidence of cretinism in some areas in the NWR which has been associated with iodine deficiency in free draining soils and the high rainfall and leaching associated with the wider Himalayan catchment. The areas noted for this problem are in Rangpur, Dinajpur, Bogra and Pabna. Health problems associated with iron toxicity resulting from use of groundwater have also been noted in the Lower Karatoya and Atrai basin and Pabna areas. However, the uneven intensity of the problem suggests that there may be some plant resource which is capable of accumulating iodine, and some effort should be made to investigate this; particularly in view of the administrative problems of distributing iodised salt to the more isolated parts of the Region and the economic problems preventing its uptake in the community.

The current access to common property resources, particularly fish, and the diversity of food and tree crop types, have been identified as important dietary implications which ought to be integrated into the agricultural planning. These features of the current system all provide the basic nutritional

complements to the main dietary consumption of rice. The diversity of protein, minor nutrients, vitamins and oils provided from these other sources are essential to conserve under the FAP planning if the basic minimum levels of nutrition are to be maintained at current levels, and if any hope of providing the minimum basic needs to all in society in the future. This fundamental need cannot be adequately represented in the economic analysis of projects, or necessarily in the planning considerations of the agriculturalists, given their background, training and planning perspectives. These limitations need to be considered carefully in the next stage of the FAP planning. It would be recommended that both public health and nutrition are given specific specialist inputs in future feasibility studies.

The current debate in FAP over the significance of the lack of fish protein should be more positively focused at the realities of widespread malnutrition that is a real problem. The fact that there has been a continuous and unacceptable decline over recent decades, and the knowledge that fish provide a more diverse source of vitamins, minerals and oils, in addition to protein, should be addressed. This is the more so as vitamin deficiency dis-orders are a additional problem in the population health profiles.

The extended nature of the decline in the consumption of food and its effect on nutrient intake is indicated in Table 3.5. The effect this decrease in intake of principal food has on nutrition is shown in Table 3.6.

Table 3.5 Trend of Consumption of Principal Food Item (1937-1982) Per Capita per Day in grams

Food	1937	1962-64	1975-76	1982
Animal Food	45.0	56.5	44.0	17.0
Pulses	40.0	28.0	23.8	17.3
Vegetables	284.0	142.0	125.7	120.1
Milk	88.0	19.3	16.7	14.3
Fish	51.1	27.7	22.3	17.7

Source: Health Policy and Planning: 3(4) 325-328, OUP, 1988)

Table 3.6 Trend of Nutrient Intake in Bangladesh (1937-1982) Per Capita per Day

Nutrient	1937	1962-64	1975-76	1981-82
Calories	2743	2251	2094	1943
Protein (g)	78.4	57.5	58.8	48.4
Fat (g)	19.7	17.7	12.2	9.8
Carbohydrate	562	476	439	412
Calcium (mg)	470	304	305	260
Iron (mg)	72	9.7	22.2	23.4
Vit A (IU)	1850	1590	730	763
Vit B1 (mg)	-	1.47	1.65	1.38
Vit B2 (mg)	1.42	0.5	0.5	0.68
Vit B6 (mg)	-	22.8	22.21	13.15
Vit C (mg)	86	39.6	9.5	13.26

Source: ibid

Nutrition related morbidity, goitre in pregnant and lactating women and anaemia in children had increased enormously during the period as a result of diminishing intakes of healthy food. In the NWR the decrease in capture fisheries may accelerate this trend if flood action planning does not cater for the communities who make a living from capture fishing in beels and rivers.

Various proposals for creating more balanced diets include different protein types (e.g. poultry and small stock) and vegetables. However, the low socio-economic level of the affected population make these difficult to implement and remain sustainable. It requires specifically targeted, welfare orientated approaches to tackle this problem along with nutritional education programmes. The incidence of famine in the area is related to post severe flood situations where food storage is inadequate, standing crops are lost and wage paid employment temporarily ceases. A major aim of any project should be to address this issue by flood control and/or flood proofing measures, including the consideration of emergency food reserves at household or village level.

The lack of calorie intake for many, despite the area being a major producer and exporter of rice confirms known trends in Indian of the dangers of the "Green Revolution" and its associated and dispossession of poor people from the rural resource base.

The international terms of trade for Bangladesh exports have worsened in recent decades. Also, while the price of domestic rice rises with world prices, this is set in an economy which has a relatively stagnant labour market. The agricultural sector is able to absorb few of the new labourers generated by present population growth. There is also an absence of a healthy industrial sector to employ the surplus labour. With the value of labour falling relative to the price of food those owning sufficient land for subsistence this is not a problem. Larger farmers using hired labour have found this input cheaper, but for the increasing numbers of landless, who form almost the rural majority, it has created considerable problems. Even regularly employed unskilled workers are now so under-valued that they can no longer afford to buy an adequate supply of food. Thus, while rice may flow and soon achieve apparent export status (often equated with self-sufficiency), the "entitlement" to it is not.

However, the primary element of the present nutritional crisis is arguably the extreme reduction food diversity and in the intake of proteins, lipids, vitamins and oils. For social equity and resource tenure, the causal linkages tend to adversely affected the situations of landless, and the professional or incidental fishing people most. They are made generally worse-off by FCD and FCDI projects as their previous open access to a common property resources has been foreclosed. Meanwhile, the situation of some farmers and other absentee land owners is usually bettered, especially those whose present land holdings are further augmented by the official or unofficial acquisition of the khas lands underlying former beels.

Another associated feature of more intensive agriculture and its use of toxic chemicals is the toxicity links through the food chain. The incremental ingestion of chemical residues from fertilisers and agro-chemical and pesticides through the water supply and food chain are well-known to lead to long-term accumulation in vital organs and create serious ailments. An Indian diet is estimated to contain 0.27 mg of DDT with accumulated levels of between 12-31 ppm in certain body tissues. This would rank these close neighbours as the highest anywhere in the world. While input use in Bangladesh is still at low levels the direction of rural change and control of the more influential over the farming resources point to a different future if the economic base improves. The history of DDT use for public health and agricultural campaigns has already left its historical legacy; a little researched subject in Bangladesh.

3.6 Navigation and Country Boats

Details of the study on country boats for the Lower Atrai and GIP are given in Volume 15. The study indicates that the costs to the region have been considerable from the loss of navigation due to previous FCD projects when measured in terms of the loss of low-cost transport networks, loss of livelihoods and loss of employment.

3.6.1 Significance and Routes

The main navigation routes of the region are the boundary major routes supplied by the Jamuna and Padma. Internally there is an intricate network that covers a considerable part of the region in the monsoon season. Large areas of the Lower Atrai and the Jamuna and Teesta floodplains become linked for boats of many sizes and uses. As the flood waters receded the main drainage rivers remain as a more recognisable river system. These include the Atrai, Karotoya, Baral, Barnai, Puran Jamuna with their distributaries and tributaries. The NWR still has to depend to a considerable extent on its water ways.

Country boats are the traditional mode of transport in many areas of the NWR. The railway, road and Government-run water transport are highly subsidized. The importance of country boats has been neglected by government and donors alike until quite recently. This informal sector remains fundamental in transporting cargo, passenger carrying, fishing and social visits. Of the total country boats more than 250,000 carry cargo, and others are used for passengers, fishing and domestic purposes. They provide jobs to millions of rural people and support the livelihoods of millions of others. This completely indigenous sector has the highest value added capacity to the national economy earning 55% to 60% profit and provides the country with a low cost transport facility. Country boats still access to many remote parts while roads and railways still only connect 20-25% of villages.

River boat ambulances and boats mobilised for disasters in more organised ways would have major benefits to rural people already isolated. Both local and national government, the NGOs and donors would all be assisted by such developments, not just for disaster preparedness but also for carrying out rural development activities.

Major navigation routes are classified by the Inland Water Transport Authority (IWTA) for route classification, Least Available Depth (LAD) and length. Navigation along other unrecognized routes includes the khals, canals and shallow lower parts of the rivers which connect the feeder routes and the business centres of the rural area, as well as connecting the villages, village markets and bazaars. The important routes, like Nagarbari-Badalgashi, Nagarbari-Patnitala via Baghabari and Baghabari to Ghoraghat, are degraded during the dry season in spite of their IWT standards.

Table 3.7 Route Classification and Navigation in the NWR

Classification		LAD (M)	National Length (Km)	Regional Length (Km)
I	Perennial Routes that Connect the National Routes, the Sea Port and the Big River Routes	3.60 - 3.90	885	0
II	Perennial Links with the Major Hinterland	2.10 - 2.40	1000	0
II I	Unusual not Perennial Routes, Basically Transit or Feeder Routes Connecting Class 1 and 2 Routes	1.50 - 1.80	1900	15
I V	Basically Seasonal Feeder Routes	1.5	2,400	534

Figure 3.2 dicates the routes as follows:

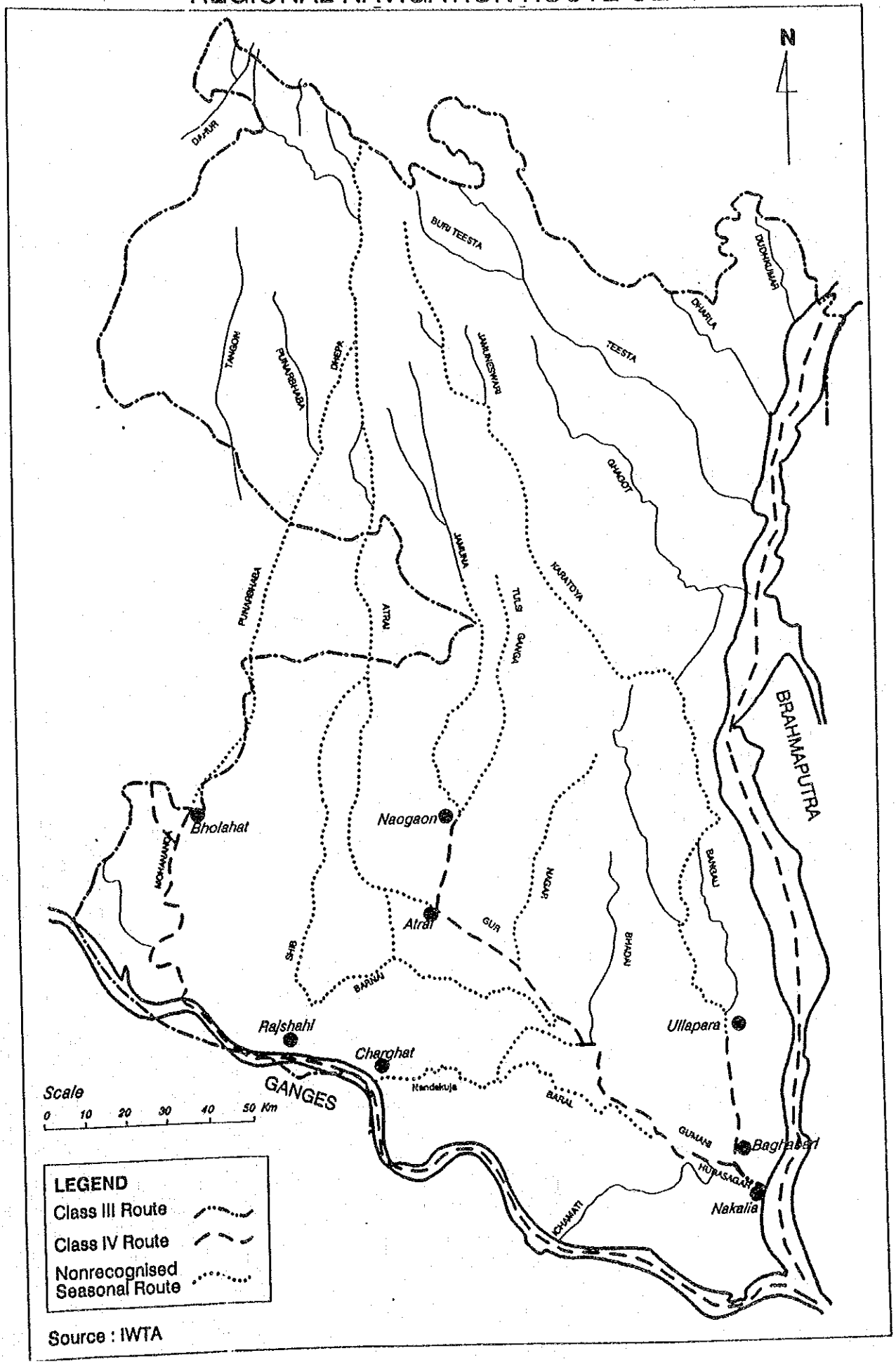
1. Aricha to Bholahat via Rajshahi Godagari through Padma and Mohananda - 307 Km.
2. Aricha to Baghabari via Nagarbari and Nakalia through the Jamuna and Hurasagar 32 Km.
3. Baghabari to Badalgachi through the Baral, Gumani, Atrai and Puran Jamuna - 163 Km.
4. Baghabari to Ullapara through the Karotoya - 32 Km.

The inter-regional commerce and passenger traffic is mainly routed through Bhagarbari. Major vessels plying these routes are going south to Dhaka and are passenger/cargo launches and large mechanised country boats. The classified routes are commercially important, both for passenger and goods traffic. Bhagarbari is regionally the most important port, and nationally ranks 7th in terms of port revenue. The incoming cargo tonnage far outweighs the outgoing cargo and the annual throughput has been in the order of 250 000 tons in the mid 1970s. Most on-going cargo is supplied via road from the port and to a lesser extent by motorised cargo vessels. Country boats up to a capacity of 35 tons serve the upstream hinterland via the Baral and Atrai rivers which have limited depth in the winter.

Nagarbari, Sirajganj and Bahadurabad have BIWTA pontoon stations. There are private ghats along routes which follow the main river channels of the Jamuna and Ganges. These are numerous and cannot be comprehensively mapped. Chilmari is used as a staging port for the Calcutta to Assam steamer which is still operational.

Figure 3.2

REGIONAL NAVIGATION ROUTE CLASSIFICATION



Source : IWTA

Other unrecognised routes/passages are generally along shallower parts of rivers and khals plied by mechanised and non-mechanised country boats, basically serving as feeders to the classified routes. These routes serve the minor regional market centres and other settlements. All of these routes are seasonal.

Non-routed navigation are mainly during the rainy season for inter-village communications and contact. In particular, most of the flooded F3 and F4 land is open to navigation by small or large country boats connecting either commercial centres or different villages especially along the flood plains of the Mohananda, Atrai, Karatoya and the Teesta. A considerable number of social visits, particularly by women, take place during the rainy season. Even if major navigation routes are maintained, closure of minor passages, (by embankments, drains or by reduced water levels), is likely to have a significant effect on many of these visits; poor people in particular are dependent on these routes, since time is often less important than cost. Figure 3.3 indicates the potential extent of this important navigable area.

3.6.2 Freight Cost Comparisons

Table 3.8 shows cargo freight rates by boats and trucks showing that road transport is 30% to 50% more costly. The wet season competition from boats leads to a reduction in the freight rates charged by the truck sector which otherwise has a monopoly in the dry season. Figure 3.4 shows the location of the major hats in the Lower Atrai.

Table 3.8 Freight Cost Comparisons in Lower Atrai

Route	Unit	Dist.	Cost		Cost	
		(Km)	(Tk./maund)		(Tk./maund/km)	
DRY SEASON			Boat	Truck	Boat	Truck
Mohadevpur-Dhaka	Maund Rice	290	14-16	20-24	0.04-0.05	0.08-0.09
Singra-Dhaka	Maund Paddy	240	12-14	20-24	0.05	0.08-0.09
Mohadevpur-Chandpur	Maund Molasses	340	16-18	32-36	0.05	0.09
Naogaon-Naryangonj	Bell Jute	290	40-45	75-80	0.04-0.05	0.09-0.10
Taherpur-Dhaka	Maund Onion	280	12-14	24-26	0.03-0.04	0.06-0.07
Taherpur-Dhaka	Bundle Betel Leaf	280	16	28-30	0.05	0.10-0.11
WET SEASON						
Mohadevpur-Dhaka	Rice	290	10	17	0.03	0.06
Singra-Dhaka	Paddy	240	9	15	0.04	0.06
Naogaon-Narayanganj	Jute	260	12	25	0.05	0.10
Taherpur-Dhaka	Onion	240	-	25	-	0.10
Taherpur-Dhaka	Betel Leaf	240	12	13	0.05	0.13

Figure 3.3

NAVIGATION AND COUNTRY BOAT FEATURES (PRE-FCD)

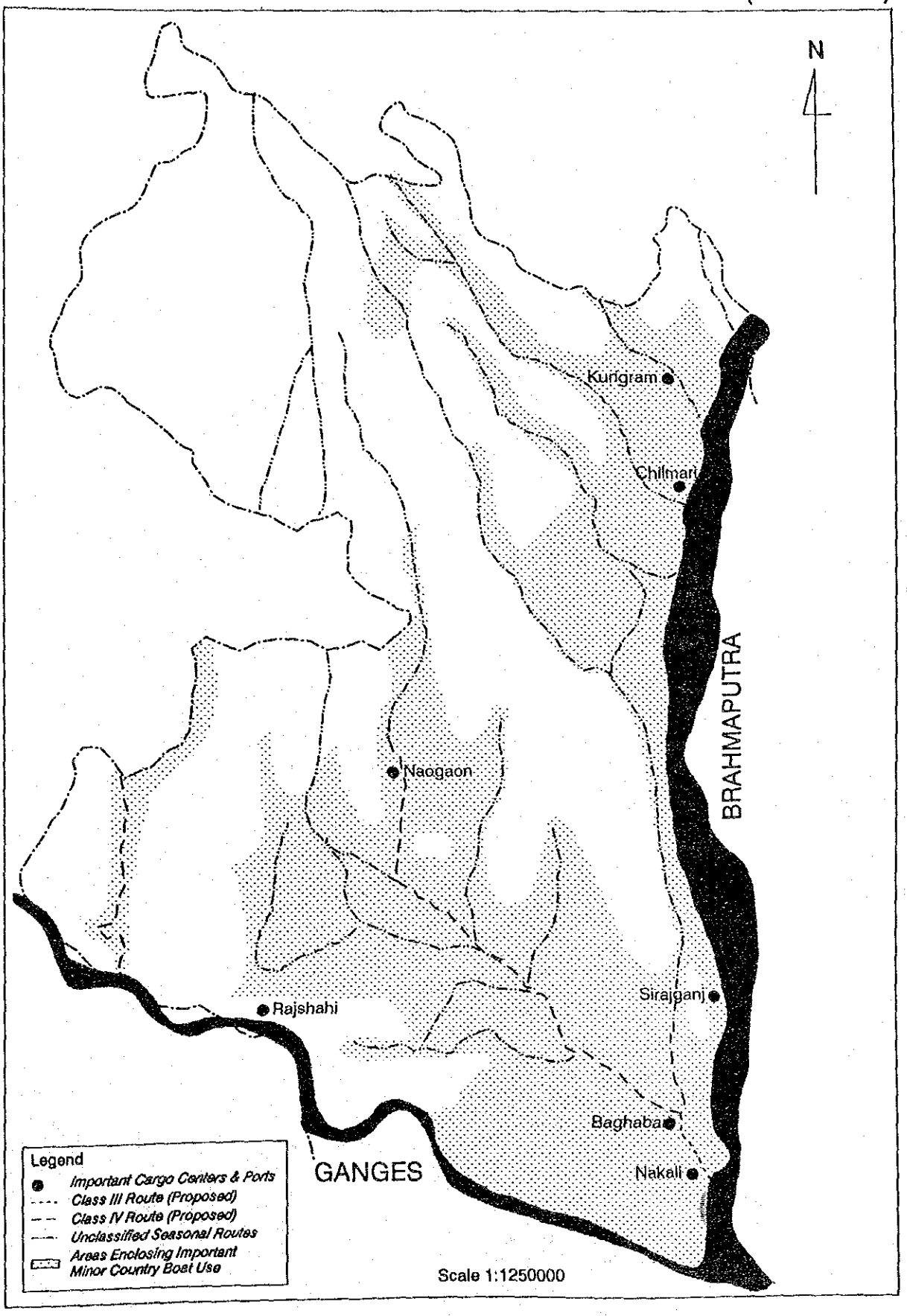
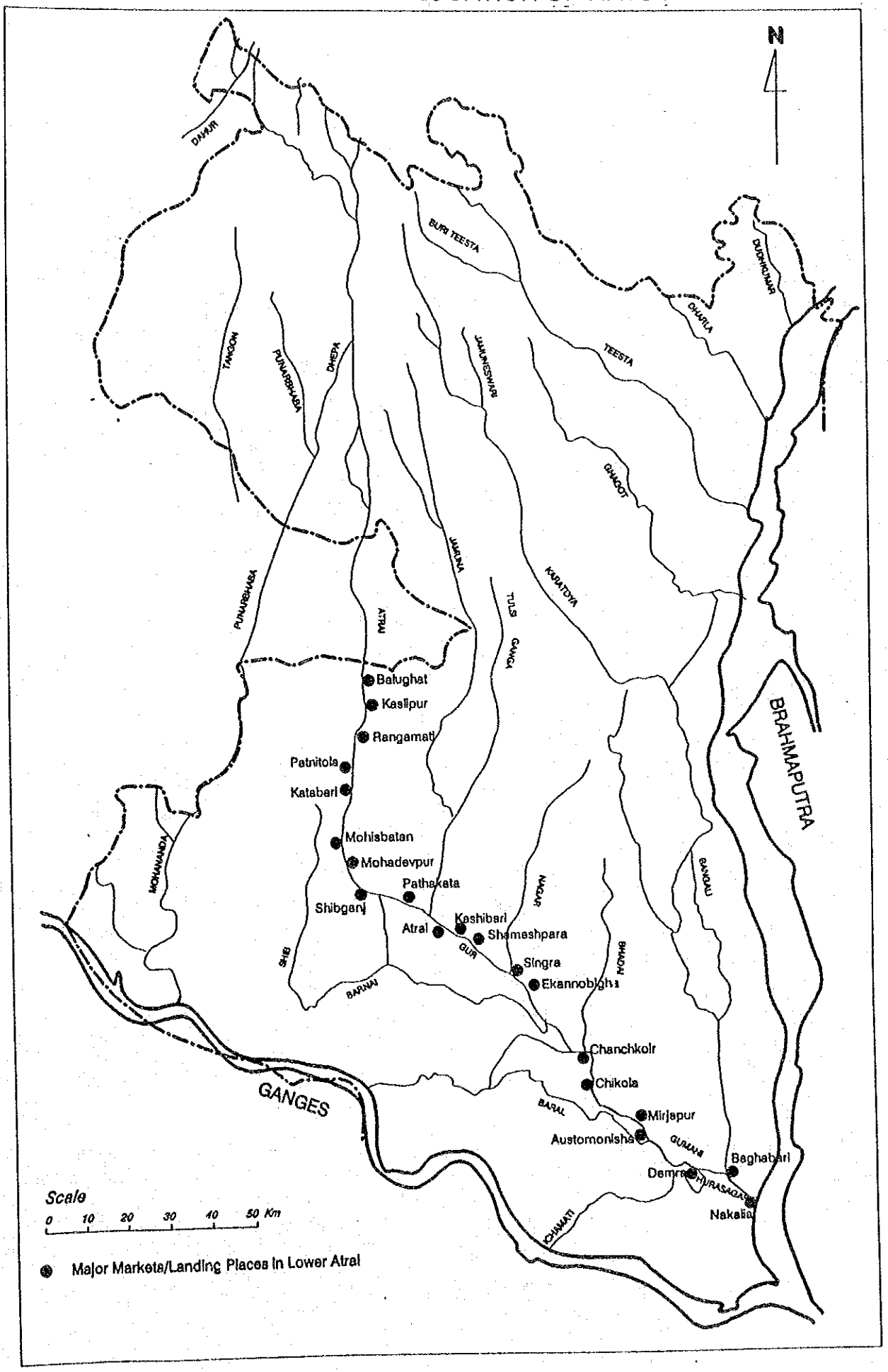


Figure 3.4

LOCATION OF HATS IN LOWER ATRAI



No reliable data exists on the number of boats in the NWR, but the survey indicates that there could be some 60 000 country boats in the NWR. In addition there are probably in the order of 11 000 fishing boats.

3.6.3 Water Transport Planning Issues

No single factor is responsible for problems affecting the sector and navigation. Several factors combine to hamper navigation opportunities. They are:

1. Development of surface and groundwater irrigation.
2. Siltation and river morphology.
3. Cross border issues.
4. Flood control embankments, polders and unplanned roads.
5. The movements of engine boats.
6. Access to construction materials.
7. Competition with road transport.
8. Harassment of boat people.
9. Projects planned in other sectors and IWTA plans

Irrigation by both surface and underground water has negative effects the dry season cross-dams erected across the to feed canals irrigating boro lands. All the various dry season pumping has the effect of reducing the water levels faster than they would otherwise have done so.

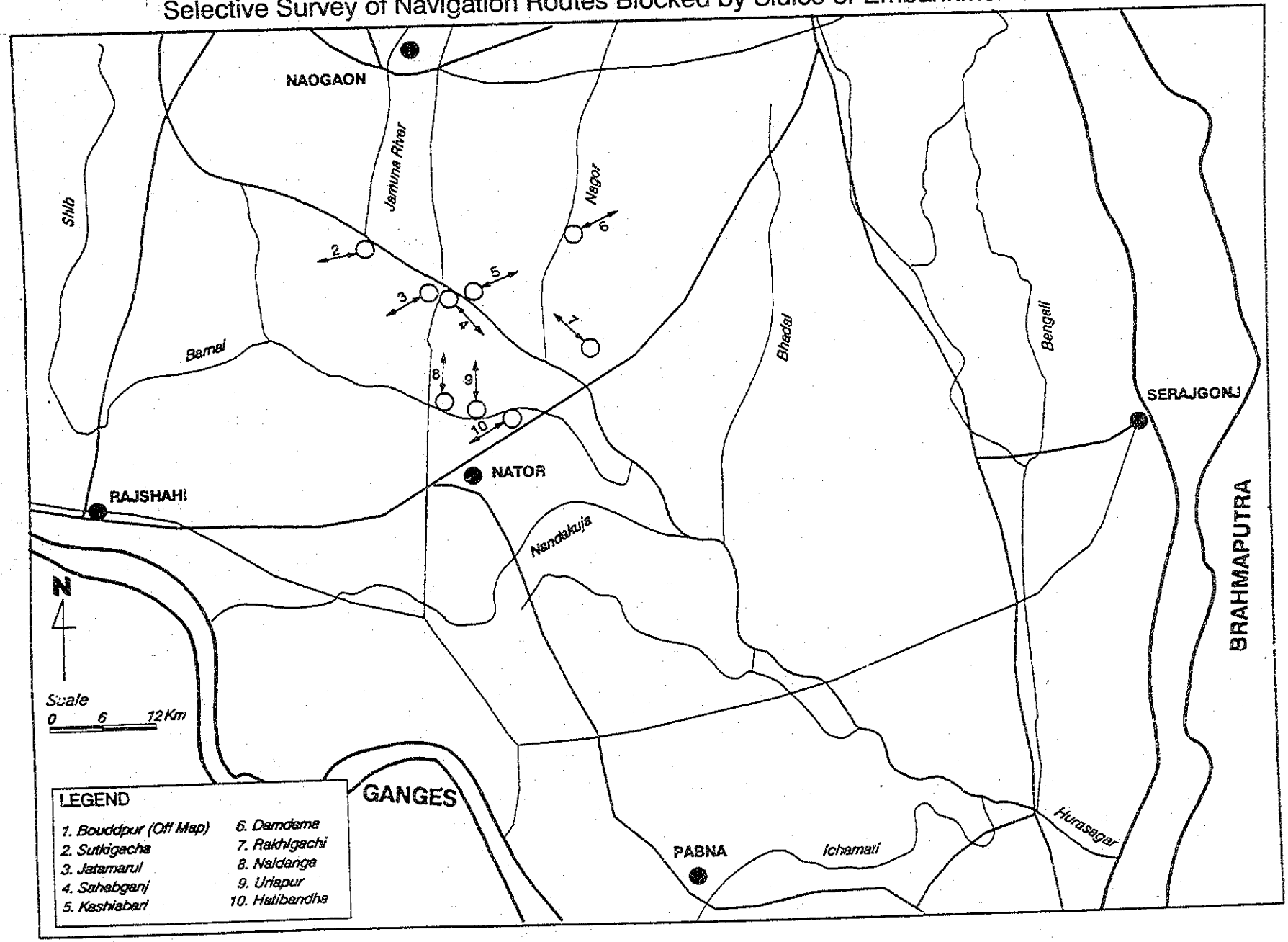
Sedimentation in the Lower Atrai has been occurring rapidly in geological time scale. While some of this is a natural process the increase removal of the natural forest and fallow season grassland has reduced the organic matter content of the soils and increase man induced erosion. This has speeded the siltation of the beels and channels. The continual movement of mechanised boats is itself a major reason creating siltation. The faster mechanised boats create waves that hit the banks and erode them.

Indian barrages on the Padma at Farraka and on the Teesta divert flow for other uses. Seasonal discharges have thus been reduced. The reduced dry season flows limit navigation. Embanking in India and locally on the Atrai and Purnarbhaba may downstream impacts on hydrology and morphology that could affect navigation. Increasing road construction and flood control infrastructure often cut across waterways stopping traffic and also seriously affected internal navigation within the embankment areas. Bridges are often inadequately sized or located and canals along the river Atrai have been blocked by embankments and sluice gates denying boats access to the interior during the monsoon. This has affected cargo carrying traffic, small traders and village commerce, as well as social visits in the unrecognized routes. Also some embankments were built on the river bank and every year are eroded by strong currents causing heavy siltation. The poor and uncertain navigability of rivers, canals and khals are very commonly associated with blockages caused by embankments, earth roads and bridges which often have cumulative effects through the chain of navigation linkages and thus affect the total system. Figure 3.5 shows the effected areas from a selected survey in the Lower Atrai.

Boat owners depend on social forestry to construct their boats. Depleted reserves has increased prices and forced owners to use immature and different species which reduces their life span. This informal sector has to compete with highly subsidized road transport. Boats sometimes fail to attract cargo and have to work at a cheaper freight rate which has reduced the income of the boatmen. Traditional and mechanised country boats are still not recognized by the police who often stop them during operation and collect money forcefully from the boatmen.

Figure 3.5

Selective Survey of Navigation Routes Blocked by Sluice or Embankments in Chalan Beel Area



3.6.4 Project Development in Other Sectors and IWTA Planning

Project development in other sector impact on navigation demands and planning. IWTA plans have indicated supplying limestone from Joypurhat and hard rock from Modhapukur (Mithapukur) along the Atrai-Little Jamuna and Karatoya river systems (National Water Plan) in the period 1990-2005. Any improvement of facilities and capacity along these routes would have direct implications for navigation benefits in the country boats and smaller boat sector and on employment. Under the present terms of reference integrated planning to achieve a full compatibility of objectives and designs for FCD and IWTA long term plans has not been possible. It is recommended that before a future strategy for flood alleviation in the NWR is agreed within the FAP there should be full discussions with to fully integrate long term planning for the two sectors. This may lead to modifications to the basic strategy for flood alleviation taken on its own. The following are some of the main issues which are important:

- Declining numbers of country boats and employment in intimately linked to poor planning of FCD and I.

- Disparity of incomes between water and road sectors has resulted.

- Agricultural prices and market have been adversely affected in Chalan beel. Due to the embankments farmers are unable to carry their summer crops to the big hats to obtain competitive prices and thus loose their incentive of growing more crops.

- Country boat occupy a prominent place in local culture. Seasonally under-employed farmers usually visit their relatives together with all the family in the monsoon. Without access restricted boats have no longer easy access and visiting relatives by boats has become infrequent. Inter-village movement restriction have undermined important elements of rural culture, social visits and domestic activities.

- Boat races are one of the common medium of amusement, symbolic conflict resolution and social cohesion for rural people. In the monsoon, rich farmer traditionally arranged boat race in the beels or currentless river. Race boat (Panshi Nouka) from the surrounding areas participated. Now it is almost impossible to arrange boat race because of embankments.

- Mechanisation of country boats has made a considerable difference to the access and communications on the Jamuna and Teesta charlands particularly at those times of the year when river flows are high.

- Mechanization has substantially improved the speed efficiency and its potential to expand its operational area, while also offering seasonally low-cost transport services by comparison to road transport. To achieve this rivers, canals and pools must be maintained to keep them navigable. This will require dredging, either by technical or by manual means. The cost analyses is very difficult to estimate without a proper in depth survey since the areas and problems cover a vast area. Working out and rationalising routes and inter-connection from field to small navigable channels and principal routes require a considerable level of study beyond the scope of this survey.

3.6.5 Solution Suggested From Public Consultations

Two public sentiments were noted in the surveys. One is completely against the embankments which reflected opinions from the traders, Arotders, country boat owners and operators. Farmers were in favour of embankments wanting strong, high and planned embankments with sufficient sluice gates and gatemen. The following solutions were identified:

1. River dredging by low cost manual methods would create jobs for poor people.
2. Embankments strengthening and retirement
3. Bridges and gates should be wider to pass boats.
4. Establish small transit port on confluences to stimulate low cost service markets and networks benefiting both the commercial and rural sectors.

3.6.6 Conclusion

The selection of water control structures that ignores the requirements of navigation will impose economic, social, and transport disbenefits and hamper development overall. Flood control and navigability are often seen to be in opposition and sometimes inter-related. Simple surveys, re-design or re-sizing of structures is often all that is required. This has proved to be out of normal criteria of the engineers involved in construction of infrastructure whether FCD planning or local roads and bridges. Whatever the improvements they should account for local and regional navigational routes and trade, boatmen and fishermen. These deficiencies can be resolved if the unplanned roads and other local infrastructural programmes are dealt with at the same time. Future developments need to be better coordinated, designed and constructed and approved by local communities. The full involvement of representatives from the boating and fishing sectors would ensure a more rational future approach.

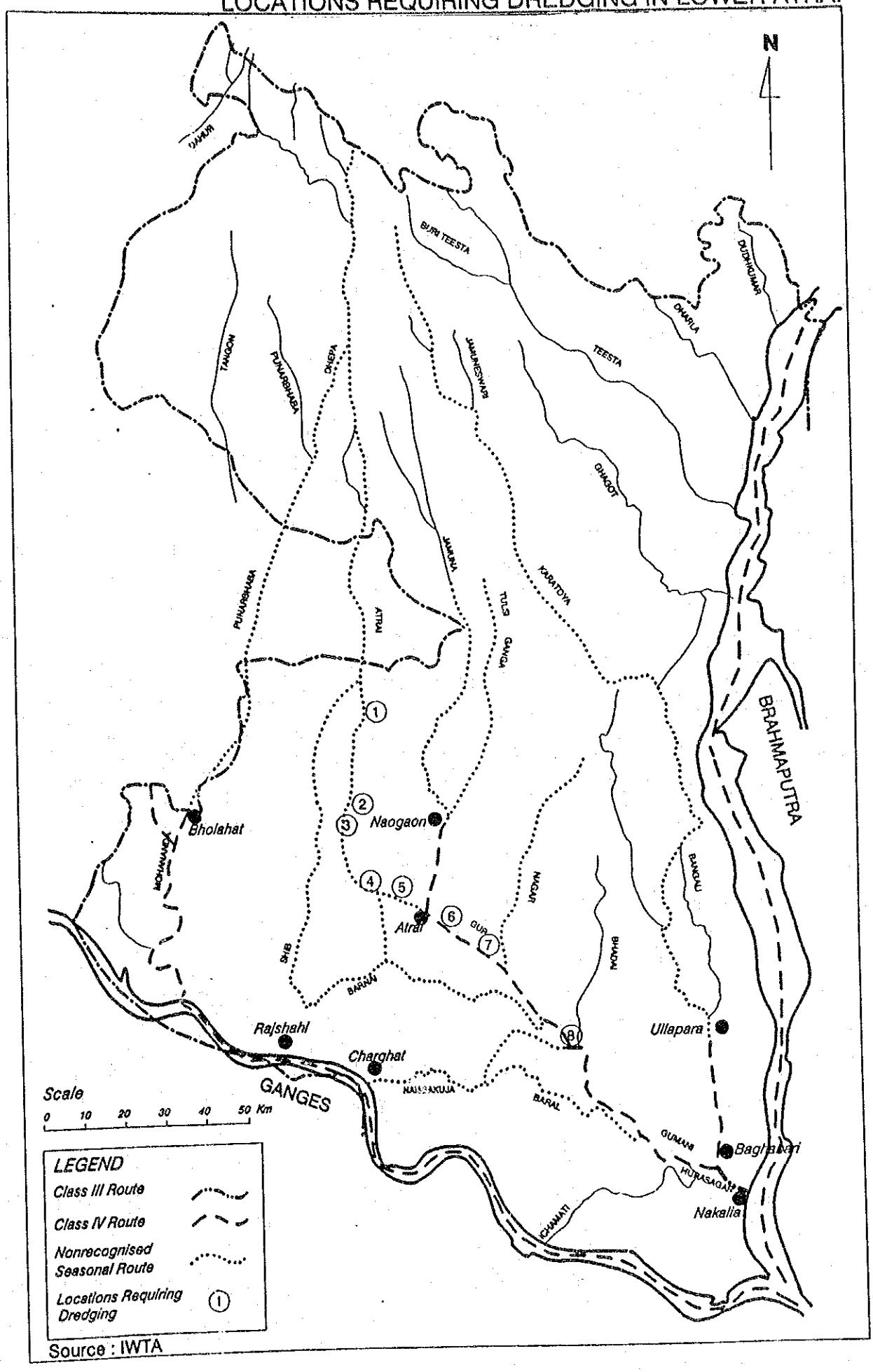
The result of dredging will increase the season by at least three months and around 16,000 commercial and 5,221 fishing boats could benefit. Almost 64,000 people could get jobs for three extra months and 150,000 families will benefit directly. In addition many domestic boats can render local services throughout the whole year. Further if suggestions made in the Health study for government and NGOs to make use of boats for river ambulances and servicing local rural areas by boat were to be considered there would be further benefits accruing to other sector.

The additional depth will provide extra channel storage and delay spillage. This could assist irrigation for those pumping in the dry season. It could also assist the production of fish if this dredging programme were designed to enhance the environment of the river channel and river bank for varied habitats. The rivers of the region are seasonal and the fish follow the receding flood water. Where there is sufficient depth the fish can remain unhindered through to the next season.

Manually dredging would generate a considerable employment. Removal of inappropriate structures would also generate employment by revitalising the low-cost marketing networks. Figure 3.6 shows the main locations requiring dredging in the Lower Atrai.

Figure 3.6

LOCATIONS REQUIRING DREDGING IN LOWER ATRAI



Source : IWTA

CHAPTER 4

ASSESSMENT OF IMPACTS

4.1 General Appreciation

FCD objectives aim to introduce a more controlled water regime, to create a more terrestrial environment on higher ground, and to divert water quicker though the hydrological network. Irrigation objectives seek a moister local climate and soil environment through the dry season and divert water flows from the drainage system or recycle stored groundwater. These physical diversions modify the physical, biological, chemical and human status of the environment inside and outside of projects. With every additional project, the scale of response increases until effects can be seen at a regional level. The physical responses of the hydrological surface or groundwater systems induce changes in the habitats of both terrestrial and aquatic flora and fauna. These then feed into the wide network of socio-economic and ecological processes affecting the food chain and health of economic plants, animals and humans. These interactions and modifications are often complex. Simple causal-effect relationships are only one part of understanding the outcome of FCDI interventions. Complex feedback and long-term accumulative processes are involved. The geographical scale and phasing of development determine which environmental thresholds are crossed and when.

Table 4.1 summarises the numerical totals of the original analysis identified in the Interim Report (October, 1991). This groups impacts in the pre-construction, construction or post-construction phases. In some cases the impacts are specific to either, flood control structures or, to drainage conditions or, to irrigation. In many case the impacts severely affected a selected group of people in localised areas. These can lead onto ramifications that affect very large areas. The surveys of this second phase of study would re-confirm the conclusions from the interim planning. The numerous impacts contain features that potentially contribute to instability in the local society, economy and ecology. In the NWR there have been serious social, economic and biological repercussions. The only means of developing the area now requires basic changes in FCD policy if further damage is to be avoided.