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BANK PROTECTION AND RIVER TRAINING (AFPM) PILOT PROJECT FAP 21/22

DRAFT FINAL REPORT
PLANNING STUDY

VOLUME IV

ANNEX 7 : Socio-Economic and Administrative Assessment
ANNEX 8 : Environmental Assessment
ANNEX 9 : Economic Assessment
ANNEX 10: Navigation Study

DECEMBER 1992

CONSULTING CONSORTIUM FAP 21/22

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BANK PROTECTION AND RIVER TRAINING (AFPM) PILOT PROJECT FAP 21/22

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ANNEX 7

SOCIO-ECONOMIC AND ADMINISTRATIVE ASSESSMENT

DECEMBER 1992

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SOCIO-ECONOMIC AND ADMINISTRATIVE ASSESSMENT

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PART A: INFORMATION ON THE JAMUNA ACTIVE FLOOD PLAIN

1 BOUNDARY CONDITIONS AND FRAMEWORK FOR THE SOCIO-ECONOMIC AND ADMINISTRATIVE ASSESSMENT

1.1 GENERAL

As already stated in the reports of the China-Bangladesh Joint Expert Team (March 1991) the overall basic objective of a long-term River Training Plan for the Jamuna is defined as follows: "to achieve a safe conveyance of the huge flood flows of the Brahmaputra (and not only the Jamuna) down to the Bay of Bengal by channeling it through the Jamuna itself". In that respect "river training works and measures will have to be defined and programmed for the protection of the embankments, infrastructure and population centres on the one hand, and for the reclamation of land in the active flood plain on the other hand. Parallel to structural measures (i.e. embankments, compartments and river training works) there is also a need for non-structural measures, especially in the short and medium terms like flood forecasting and warning as well as flood preparedness". From this general approach one must keep in mind that river training works aimed at controlling/managing river bank erosion are mainly justified as "complementary measures to properly executed and maintained embankments which offer a permanent solution to the age old problems of flooding."

These definitions are also true for the river training/AFPM component of the FAP 21/22 Project. At the moment different Flood Action Plan (FAP) projects and studies are involved in different components of such a general plan for flood protection and combined river training/Active Flood Plain Management (AFPM), namely:

- The study of the China-Bangladesh Joint Expert Team for a general flood control and river training project on the Brahmaputra river in Bangladesh. The Project is based on the protection by "hard points" with river training Active Flood Plain Management (AFPM) measures in between, targeting a stabilized anabranched flood channel in the long run.
- The FAP 1 for a masterplan aiming at developing hard point protection structures in six priority locations on the right bank.
- FAP 2, FAP 3 and FAP 3.1, which are regional FAP projects covering both banks of the Jamuna, and are involved in the design and justification of the rehabilitation/construction of embankments and regulators on both sides of the Jamuna, within the framework of regional development masterplans and related feasibility studies.

The FAP 22 specific approach is complementary to the above components and appears as a supportive technological concept for river training/AFPM measures. It has to be assessed by a series of comparisons between the most likely future situation without the FAP 22 project and the forecast situation with the FAP 22 project. This means that the present socio-economic and administrative assessment has to consider a technological alternative strategy within a general long-term river training scenario, but not the overall river training strategy itself nor the flood protection plan involving embankments. This technological alternative strategy is based on the management of movable low-cost structures aiming at provoking stable accretions of sediments attached to the main land on the one hand, and at narrowing and cutting some channels of the Jamuna on the other hand. Thus the physical area to be considered for the assessment is well and truly the Jamuna Active Flood Plain (JAFP), which can be defined as the area within the limits of the main banks of the Jamuna in a normal peak flood year.

In practice the JAFP corresponds to the area between the embankments on both sides of the river (see Fig. A.7-1 at the end of this Annex) when they exist. Thus from a socio-economic point of view the direct impacts of a FAP 22 strategy will proceed from the analysis of the rearrangement of cultivable/inhabitable lands inside the JAFP (see Section 1.2).

Definition of the "with" or "without" project situation is given in more detail in Part B of the present annex.

1.2 AGRO-ECONOMIC ASPECTS

Structural measures (embankments along the Jamuna river and river training) and non structural measures (such as flood forecasting and warning) must improve livelihoods and socio-economic conditions in the Jamuna Flood Plain area.

But which socio-economic effects are expected from these measures in the charlands system according to various approaches and strategies for river training and active flood plain management ? This appraisal is the essential objective of the present analysis. In the framework of this analysis the effects related to agricultural activities must be particularly taken into account inside the flood plain area located between the main embankments (left and right river sides).

From the definition of the JAFP the following categories of chars may be considered:

- high and low island chars (middle of the river);
- high and low attached chars along the main banks, and
- set-back land (attached chars and chars mixed up with main land of the Jamuna flood plain).

Low lands (low island chars or low attached chars) are uninhabited areas during the monsoon season while high lands can be permanent inhabited areas. Each of these categories can be characterized by different types of land use according to the shapes of landscape (low land, medium low land etc.).

The "value" of a landscape type depends on three interconnected properties related to the land use. These are productivity, stability, and equitability.

Productivity will be defined here, as the value added per hectare in terms of market prices or converted to value in calories. The three basic resource inputs are land, labour and capital, to which may be added technology input such as fertilizers and pesticides.

Stability may be essentially defined as the constance of productivity in spite of flooding, climate fluctuations, financial difficulties.

Equitability is defined as the evenness of distribution of productivity of a given landscape type among the actual or potential human beneficiaries.

Although the three properties described above, are the key properties in determining landscape value, there are many other ways that can be used to characterize a landscape type. Examples include both the biophysical and socio-economic determining factors of agricultural production such as land capability, hydro-agricultural management systems, agricultural development potential, access to market.

It is through this characterization that it will be possible to compare the present situation with each of the proposed strategies in terms of river training and AFPM.

1.3 SOCIAL AND ADMINISTRATIVE FRAMEWORK

From a social and administrative viewpoint the study framework of the assessment cannot be limited to the strict JAFP. In fact two levels of study area must be considered:

(i) First an Envelope Administrative Study Area (EASA) consisting of a strip of the union councils covering the JAFP (the union councils must be considered as they constitute the lower level of political representation of the population; see Table A.7-1 and Fig. A.7-1 at the end of this Annex.

(ii) The actual population living entirely or partly in (i.e. depending socially and economically on) the JAFP.

This population can be defined administratively through a theoretical list of <u>mauzas</u> (Revenue villages) out of which a number have been engulfed into the river but with a population still administratively attached to these previous villages (sometime since 1905, see Chapter 6 below). It is not possible in the framework of this rough assessment to state the detailed list of these mauzas (about 1807 in total for the EASA) but a tentative estimate of the population directly concerned by the JAFP will be attempted hereafter in Chapter 2 from a land use map and relevant ratios applied to categories of landscapes.

Apart from the socio-economic aspects linked with agricultural activities presented above, the other socio-economic and administrative aspects of this assessment will deal with the social and sociological characteristics of the JAFP's population, both from quantitative and qualitative viewpoints, according to available data and considered subjects (socio-demography, anthropological and sociological references, socio-economic infrastructure and services at grassroots level, legal and administrative aspects). The other economic criteria such as transportation facilities, towns and urban centres, and other types of economic infrastructure are dealt with in ANNEX 9.

The envelope administrative area is shown in Fig. A.7-1 and defined in detail in Table A.7-1. It covers 4796.3 square kilometers including 580.6 sq.km of water during the low water level season. The envelope study area is covered itself by 8 zilas and 27 thanas and comprises 139 entire union parishads and 1807 mauzas.

1.4 SOURCES OF INFORMATION

Although rather substantial documentation had been gathered, specific documents and data related to the JAFP are very limited. A comprehensive National Char Land Inventory was undertaken in the framework of FAP 16 and FAP 14 with FAP 19's support and under a common technical management provided by ISPAN. Unfortunately the results of this National Char Land Inventory were not available during the preparation of the present socio-economic assessment of FAP 22. Finally apart from a few quick field trips and interviews made in the JAFP the following two documents constitute the main references:

- The Char Study Report of Jamalpur Priority Project Study (FAP 3.1), which gives the results of one specific socio-economic survey and of some group and individual interviews, and
- The collective work named "River Bank Erosion, Flood and Population Displacement in Bangladesh" which gives quantitative socio-economic data from a few case studies of chars.

2 BENCHMARK SOCIO-DEMOGRAPHIC DATA

2.1 ROUGH ESTIMATE OF POPULATION AND NUMBER OF HOUSEHOLDS RELATED TO THE JAFP

2.1.1 Envelope Administrative Study Area (EASA)

The EASA defined above (Section 1.3) is based on the list of union councils covering the JAFP (details in Table A.7-1). The last population census was conducted in 1991 but the results are yet to be published. At the present stage the only possible way to estimate the population of the EASA's is to project the populations of the 1981 census for each union council concerned. Annual average growth rates between 1981 and 1991 are already available but only by zila, thus the population projection has to be made by zila groups within union councils inside the EASA. The Table A.7-1 shows the population and number of households in 1981 and the corresponding projected figures per zila group in union councils.

Overall results give for the EASA a population of 2,790,726 people in 1981 (488,777 households) and 3,342,946 people in 1991 (585,455 households) with an overall mean annual growth rate of 1.82% and a supposed constant average size of the household of 5.71.

2.1.2 Population Directly Linked to the JAFP

The population living in and from the JAFP (displacees included) has been estimated on the basis of the land use mapping and area measurements achieved in the framework of this assessment (see Chapter 4) combined with population density ratios and population estimates found in FAP 3.1's Char Study.

From these assumptions the present population closely linked to the JAFP would be 809,707 (149,040 households) for a total gross JAFP area of 2639 km^2 (20584 km^2 of lands during March'92 dry season, Jamuna river channels not included). JAFP thus represents about 55% of the EASA area and 24% of its resident population (displacees on the bank line and the embankments included). Details of the calculations are given below.

Results of the FAP 3.1 Char Study	Charland	Set-back Land (attch. chars incl.)	Total
• Study area (ha), March 92 (Jamuna channels not included)	38,744	41,372	80,116
• Population	131,703	179,383	311,066
• Population density	340	434	388
• No. of households	21,583	35,240	56,822
• Size of household	6.1	5.1	5.5
Total JAFP estimates			
• Land area (ha), March 92 (Jamuna channels not included, see Chapter 4 below)	88,987	116,855	205,842
• Population	302,556	507,151	809,707
• No. of households	49,600	99,440	149,040

Table 2.1-1: Estimate of the population and number of households in the JAFP

2.2 TENTATIVE ESTIMATE OF POPULATION EFFECTED BY RIVER BANK EROSION

While detailed analysis of the general physical pattern of bank erosion has been carried out, in particular in the framework of FAP 1, systematic records and follow-up of the human consequences of this bank erosion pattern are still to be consolidated. Which unions along the river have been eroded, and consequently have many people and households been uprooted ? Are the majority of the displaced persons living in the surrounding unions, and if so, in which unions? What proportion of the displacees are living outside the JAFP ? All these questions remain unanswered when a tentative balance of the socio-economic impacts of riverbank erosion over the past decades is attempted.

FAP 14 (Flood Response Study) is conducting a Resource Inventory of chars in the Jamuna, Ganges and Meghna River System in close cooperation with FAP 16 (Environmental Study) and FAP 19 (Geographic Information System, GIS).

An analysis of satellite imagery between 1973 and 1992 performed in the framework of the FAP 3.1 Char Study has provided an estimate of 395 sq km of widening of the Jamuna bed during these twenty years in the corresponding area (part of Jamuna adjacent to Jamalpur district). The widening of the Jamuna over this reach thus represents an average of 150 meters a year since 1973.

In the FAP 1 analysis four major processes of riverbank erosion are distinguished:

(i) The sudden evolution of major aggressive bends with common local erosion rates of 200-250 m/year over a few years.

(ii) The systematic encroachment of the river in the bank line due to the widening of the braid belt. The average rate of corresponding retreat of the bank line has been historically of the order of 50 to 100 m a year, and this may be sustained over 30 or more years.

(iii) The shifting of the char islands system, which appears partly as a cyclic movement and partly as producing attachment of islands (mainly to the left bank over the past decades; see Chapter 4).

(iv) The overall trend of the northern part of Jamuna to move westward.

From this characterization it can be provisionally considered as a simplified hypothesis for the purpose of this assessment, that the average bank erosion rate is around 100 m/year at the level of the bank line (236 sq.km widening on average per year).

Considering the average population density of 434 inhabitants per sq. km (see Table 2.1-1) the number of people displaced or seriously affected could be simply assessed in that way at 10,240 per year.

In addition to this, riverbank erosion in the char islands has to be taken into account. This can be done simply at this stage by a proportional assessment in terms of re-arrangement of charland areas, compared to the average annual set-back land erosion rate and applying the corresponding population density, as is shown below:

$$\frac{23.6 \text{ sq. km}}{1{,}168.55 \text{ (JAFP set-back lands)}} \times 889.87 \text{ (JAFP charlands)} \times 340 \text{ (charland population density)} = 6{,}110 \text{ persons.}$$

In all, it may be assumed that around 16,350 persons a year have been displaced or seriously affected by Jamuna river bank erosion over maybe the last thirty years. The number of these disaster victims represents around 2% of the estimated total population of the JAFP and is of the same order of magnitude as the average annual growth rate of this population.

This means that riverbank erosion in the JAFP contributes naturally but painfully, for the social groups regularly affected, to maintaining the charland social system in equilibrium with the natural resources and their cyclic changes, and also a stable structural social relationship within this system. On the other hand riverbank erosion is provoking permanently disruptive social impacts on the set-back lands, with the rush of disaster victims increasing social inequality and pressure on natural resources.

2.3 SOCIO-DEMOGRAPHIC INDICATORS OF POPULATION STRUCTURE AND ITS EVOLUTION

The knowledge of the JAFP is suffering from the lack of up-to-date and specific socio-demographic data, among other subject matters. Although the last population census was conducted in 1991, published data is expected to be available only in April 1991 at the earliest. At this stage it is only possible to make some comments concerning mainly the EASA of the JAFP.

Density of Population

The overall population density of the JAFP is considered to be 388 inhabitants per sq.km (340 for the charlands and 434 for the set-back lands) according to the results of the FAP 3.1 Char Study. Considering only the cultivable with vegetation lands (bare sandy chars not included) this population density is in fact 937 for the total JAFP (750 for the charlands and 1094 for the set-back lands). The average population density of the JAFP (water and sands not included) is in fact completely comparable to that of the EASA, comprising 45% of mainland. But these overall mean densities conceal a diversity of situations, in particular at the level of each mauza, according to its actual land resources. The distribution of population density over 138 union councils in 1981 (see Table 2.3-1) provides a first picture of such a variation. Summary of distribution of propulation density is given in the following table:

Class of Population Density (1981) (inhabitants per sq.km)	% of Union Councils of the EASA
less than 400	22
400 - 500	11
500 - 700	23
700 - 1000	32
1000 and over	12
Total	100

Table 2.3-1: Distribution of population density

Population Growth Rates

Annual population growth rates (AGRs) between 1981 and 1991 are only available for the moment at zila level. The AGRs of zilas within the EASA vary between 1.0 to 2.13 percent per annum. From the application of these AGRs to the zila sub-total of union councils the AGRs of the total EASA appear to be 1.82%. Considering the estimated effects of riverbank erosion in the JAFP (see Section 2.2) and presuming that the annual natural growth rate of its population might be around 2.2% (mean of the rural areas in Bangladesh) the AGR of the JAFP would be less than +0.4%, indicating a relatively stable population as a result of migration.

Age Structure

At this point data relating to age structure for the year 1991 is not available. A sample survey was conducted (Elahi et al., 1991) in 1985-86 in Kazipur, which is located on the right bank of the Jamuna river, to investigate the socio-economic characteristics of 686 households. This study indicates that 43.4 percent of the population is less than 15 years old, the number of people in the 15-64 age group is 49.7 percent, and only 3.1 percent of the population is aged more than 65. The authors have suggested that the low dependency ratio of 0.87 could be due to out-migration among the working age population.

3 GENERAL ANTHROPOLOGICAL AND SOCIO-ECONOMIC REFERENCES

3.1 HISTORICAL BACKGROUND

The settlement of the present JAFP has undergone a deep upheaval since the year 1787 when the Brahmaputra began to change its course southwards along the Jenai and Konai rivers. After 1830 the move was completed and the Jamuna left its previous bed, the present Old Brahmaputra, and developed its present braided and widening bed. Among the various tentative explanations given since the 19th century, the one considering that the Jamuna has taken its new course according to a subsidence zone between the two large pleistocene blocks of the Barind and Madhupur seems the most likely.

It was not possible in the framework of this study to find documents describing the historical conditions of such an original rearrangement of settlement patterns in the area of the newly arrived Jamuna at that time, between 1787 and 1830, and later during the 19th century. This could have provided an interesting picture of the evolution of the young Jamuna during its first 100 years and of the way people were managing their lifestyle inside its flood plain and in particular in its major bed. It should just be mentioned for the record that this event of the birth of the Jamuna occurred during a period which had corresponded to a turning point of the history of the Bengal (from 1760 to 1820) with:

(i) the decline of the Moghul Empire against the rising British Colonial System and its East India Company, which obtained the *Diwani* responsibility;

(ii) the consequent re-arrangement of the local political powers and the land tenure system with the loss of powers and estates for the Muslim Notables, and the advent of the Hindu *Zamindars* as new landlords (Permanent Settlement Act of 1793, then Resumption Act of 1847). One can imagine that during this first century of the Jamuna's life its evolving active flood plain was an area of already considerable population movement, the old settlers being displaced by the new Jamuna and the whims of its braided channels, and maybe the new settlers, refugees and landless people, due to the rearrangement of land ownership, looking for marginal lands such as isolated islands or new chars.

In fact within a period of around two centuries the Jamuna became an actual physical boundary, dividing the region into two separate zones, economically, politically and even culturally as is shown below through a few simple examples:

- differences in dialects : Dhaka-Mymensingh dialect spoken on the left bank, Rangpur dialect in the northern part of the right bank and Pabna-Bogra dialect in the southern part of the right bank;
- presence of small Himalayan horses on one reach of the right bank utilized for drawing carts;
- differences in terms of cropping patterns and traditional secondary crops (like Millet, Barley etc.) from one bank to the other in equivalent agro-ecological conditions, and
- so many other details which anthropological research at grass root level could bring out from the apparent homogeneity of the Bangladeshi country people when they are only described through quantitative variables.

The elementary administrative units of the mauzas (village revenue made up of one or a few traditional villages) are still based on the administrative demarcation of the village maps from 1905-1906. But from the beginning of the 20th Century many changes have occurred in terms of land erosion/accretion in the widening bed of the Jamuna, which generally seems to have been shifting towards the right bank since the twenties. The tentative estimate of population affected by riverbank erosion as given in Section 2.2 is a rough illustration of the effects this has had on the population over the last twenty years. The consequences of these local administrative boundaries set against the past and present changes of the Jamuna will be studied later (Chapter 6) from a legal and administrative point of view.

3.2 OVERVIEW OF ANTHROPOLOGICAL STRUCTURE AT GRASSROOT LEVEL

Anthropological approaches at grass root level of a *para*, an elementary territory or a social group at any level are still limited in Bangladesh in general and for the JAFP in particular. When case or local studies, like village studies, have been performed they have too often focussed on quantitative criteria and surveys. The purpose of this section is not to provide a comprehensive analysis of the anthropological diversity of the JAFP of course (years of basic studies and research would be needed for that), but simply to try to identify some major characteristics of the rural lifestyle of country-side people and farmers in the JAFP, which are either prevalent in other agrarian systems in Bangladesh or specific to the JAFP. When referred to, the two main specific sources of information will be given under the following acronyms :

- CS.3.1: Char Study Report/FAP 3.1 (August 1992), and
- REIS: "Riverbank Erosion, Flood and Population Displacement in Bangladesh" by K.M. Elahi et al., (1991).

For the record it has to be kept in mind that the general reference of traditional rural society in Bangladesh is the patriarchal (*pitri pradhan*), patrilineal (*pitri sutria*) and patrilocal (*pitri sthania*) elementary or large family, with social differentiation according to sex and age, on which were built the lineage/clan (*bangsa/gusthi*) higher administrative units with transition from the elementary cultural level to the political one. While the patriarchal system is still pre-eminent, the evolution of the household as the elementary socio-economic solidarity unit, is from the joint or large family to the nuclear one. At what evolution step is the JAFP's population, according to these basic sociological criteria? This is an important question. We have seen before that, according to the Char Study of FAP 3.1, the average household (HH) size is higher in the charland (6.1 per/HH) than in the set-back land (5.1 per/HH). This would indicate that households are generally more extended in the first case. However, the weight of destructured displace households on the embankment may also influence this ratio in the second case. A case Char Study in a charland reported in River Bank Erosion Impact Study (REIS) book shows that the extended or multiple type of household still represents around 37% of the total households. Such isolated data cannot lead to any sound conclusion and one must consider that the family - household structure is in fact in correlation with other basic criteria like land ownership and land tenure and type of main occupation (as main indicators of social status). The following figures from REIS illustrate this obvious statement.

Thus if the JAFP has a specific characteristic in terms of grass root anthropological structure, it has more to be understood for the time being through the economic determining conditions of social status (see Section 3.3 below) rather than following the rule of a traditional cultural pattern.

Another very important question concerns the marriage system as an indicator of the social system. But no original information could be found in the framework of this assessment to identify any specific feature of the people living on the charlands related to this theme. The only feature to be mentioned in terms of family household characteristics is that of the displaced population on the embankments, who are new or former landless and for whom there is often a destructuring of the family household and in particular a relatively high percentage of female-headed households compared to the charland situation (REIS). The socio-economic characteristics of the displaced population are also considered below in Section 3.3 and 3.4.

	Percentage of Nuclear-type Households per Social Category
Primary Occupation	
. Farmer	54
. Agricultural wage labor	75
. Commerce	70
. Hand sawyer	100
. Clerical	33
Size of Farm (ownership or not)	
. Land-less	63
. 0-3 acres	63
. 3-6 acres	25
. over 6 acres	0

Table 3.2-1: Distribution of nuclear-type households according to some social status indicators

(Source: REIS, Char Tekani case study, 1985)

Concerning the elementary social organization, i.e. the hamlet/traditional village (para), it is interesting to note that according to FAP 3.1 Char Study there is a noticeable difference of village size between charlands and set-back lands (67% of villages with less than 600 inhabitants, average 77 households per village in the first case; and 86% of villages with over 600 inhabitants, average 153 households per village, in the second case). Other general criteria of social differentiation in rural areas are religion (5 to 10% Hindus on average per village with the remains of the caste system), and local notability: village elder, *mulla*, *sardar* or *matbar*, small landlord (*Jotedar* and *talukdar*), local political leader in the framework of the modern political parties system, well-born people according to famous *bangsa/gusthi*, membereshing of such and such a society (*samaj*) etc.

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3.3 ECONOMIC ACTIVITIES AND SOCIAL CATEGORIES

3.3.1 Occupation

Considering the occupational structure of the population linked with the JAFP, charland dwellers are to be distinguished from set-back land settlers, of whom displacees, newly or formerly landless, represent a high proportion of the demand for available economic employment.

While farming is the main occupation of the household heads in charlands, on the other hand daily labour becomes the first in set-back lands which also have higher percentages of non agricultural occupation like commerce, services and fishing, as is shown in Table 3.3-1.

	Charland (islands)	Set-back Land (attached char included)
. Farming	54	27
. Daily labour	34	42
. Commerce	2	10
. Service	2	6
. Fishing	2	4
. Other	6	11
Total	100	100

(Percentages of Households)

Table 3.3-1: Comparison of main occupations of household heads between charland and set-back land

(Source: FAP 3.1, Char Study, 1992)

Table 3.3-2 below gives more detailed information for comparing the primary occupations of the male population over 10 years of age according to sex category and different locations of housing, from a Kazipur case study.

	Interior (mainland)	Bankline (set-back land)	Embankment	Char (islands and attch.chars)
Farmer	43	34	5	43
Agric. wage labour	5	13	43	23
Unpaid HH Occupations	7	11	16	8
Trade/Commerce and craft	18	16	17	7
Transport	11	1	2	6
Clerical	3	5	9	5
Other (including unemployed)	13	20	8	8
Total	100	100	100	100

Table 3.3-2: Primary occupation per location of housing (male over 10 years)

(Source: REIS, 1992)

3.3.2 <u>Income</u>

Economically speaking, a large majority of households are of the infra-poverty level. Average income per household, all social categories included, appears just a little lower in the charland than in the set-back land, according to the FAP 3.1 Char Study (see Table 3.3-3).

Household Income (Tk)	Charland (islands)	Set-back Land (attached chars included)
Below 5000	11.7	11.3
5000 - 10000	47.0	46.3
10000 - 20000	28.1	29.0
20000 - 40000	10.2	10.2
40000 and more	3.0	3.2
Total	100	100
Mean per Household	12240	13250

(Percentage of households)

Table 3.3-3: Distribution of households by income class in charland and in set-back land

(Source: FAP 3.1, Char Study, 1992)

On the other hand there is a more significant difference, of course, between the displaced and non-displaced population, and in this case, while overall average income is decreasing, low and middle income households are becoming poorer but upper income households are maintaining or even improving their living standard. Finally, displacement of population due to riverbank erosion implies both pauperization of the population and the increase in social disparity (see Table 3.3-4).

An estimate of the value of total assets of charland and set-back land owned by an "average" household was made in the framework of the FAP 3.1 Char Study. It underlines the very low economic level and rustic lifestyle of this population with a total assets value per household of around Tk 14,500 (charland) and Tk 12,600 (set-back land with more resourceless displacees), which represent in both cases an order of magnitude of an annual income only. Out of these overall assets, the value of houses and other buildings represents 73% of the total, furniture 8-10%, agricultural tools 8% and transportation facilities 8%.

Income Class (Tk)	Displaced	Non-displaced
Below 6000	28.3	17.8
6000 - 12000	36.3	39.6
12000 - 24000	27.6	27.1
24000 - 28000	5.6	13.3
48000 and more	2.2	2.2
Total	100	100
Mean per Household	11660	14540

(Percentage of households)

Table 3.3-4: Distribution of household by income class for displaced and non displaced population Kazipur case study

(Source: REIS, 1985)

3.3.3 Land Tenure and Related Social Relationship

Obviously the concentration of landownership and land holding is also much greater in the set-back lands (attached chars included) than in the char islands, as is shown in Table 3.3-5 below.

In the set-back land there is a high rate of landless displacees produced by riverbank erosion. A comparison between land ownership distribution and size distribution of land holdings leads to the following conclusions:

(i) there are more medium and large land owners in the charlands, and

(ii) there is greater scope also for share-cropping in the charlands as a consequence of the presence of relatively large farmers.

In general it seems that in the charlands (both islands and attached chars) the power and land control of the traditional small "landlords" (*badhraloks*), also called *Jotedars* and *Talukdars*, is still deeply rooted in the social system. This power is exerted through the traditional relationship of the patron-client type, noticeably with the share croppers (*bargaits*) and their other types of debtors, and through the agricultural wage labour they can structurally supply to landless.

Class of Land Area	Land Ownership		Land Holding	
	Charland (isles)	Set-back Land (att.chars incl.)	Charland (isles)	Set-back Land (att.chars incl.)
Landless Less than 1 acre 1 - 6 acres 6 acres and more	37 24 34 5	69 20 9 2	29 26 40 5	61 23 13 3
Total	100	100	100	100
Mean for household	1.68	0.80	1.81	0.74
Gini coefficient	0.72	0.88	0.68	0.85
Mean per household (acres)	2.67	2.58	2.55	1.90
Cropping land per household (acre)			2.54	1.90

2.47 acre = 1 ha.
(Percentage of households)

Table 3.3-5: Land ownership and land holding distributions

(Source: FAP 3.1, Char Study, 1992)

3.4 SOCIO-ECONOMIC LIFESTYLE CONDITIONS

Besides the specific internal social structure which is highly determined by the land tenure and the tenancy system, lifestyle in the char islands is characterized by physical isolation from the socio-economic services available on the mainland. Two main problems are, difficulties of transportation and a new phenomenon of insecurity, with the present increase of robberies on the river and in the isolated islands.

On the other hand, while the lifestyle on the set-back lands (i.e. bank line including attached chars, pieces of mainland riverside of the embankments and the embankments themselves) is more secure in terms of housing and can benefit from available socio-economic services, the conditions of survival for the landless are even harder due to the high pressure of the number of landless displacees and the disrupting framework of their new social relationship. In parallel, the middle and especially the higher social classes are maintaining or even improving their privileged conditions (see Section 3.3), taking advantage of the steady supply of displacee man-power.

2ll

Last, but not least, life in the JAFP remains precarious because of the riverbank erosion hazards here and there, and this is true for both charlands and set-back lands (a tentative rough estimate of the phenomenon in terms of population affected has been given above, in Chapter 2). However, it may be that the specific char islands life system, despite its limitation and conservative/ retrograde characteristics, was a better social and cultural response to unpredictable river bank erosion than displacement to the bank line. Displacements to the bank line represent either the only solution for the former set-back land dwellers (taking refuge in an island is unlikely in this case both for physical and social reasons) or the last-hope solution for the char islanders. For char islanders, having to move permanently or temporarily from one char to another is part of their way of life and of managing their farming system (see below: Social response to riverbank erosion in (Section 3.5 and Chapter 4).

This global characterization of the lifestyle in the JAFP is illustrated more in details and according to some particular aspects in the following figures and comments.

3.4.1 Housing

Apart from the precarity of displacee housing on the embankments, housing types appear to be still more traditional in the charlands (islands and attached chars) than in the mainland, as is shown below.

Housing Materials	Char Study FAP 3.1		Kazipur Case Study (REIS 1985)		
	Charland (islands)	Set-back land (att.chars incl.)	Interior land	Set-back land (att.chars incl.)	Charland (islands)
Traditional (bamboo, leaves,straw)	52	56	25	37	52
Corrugated iron roof	48	44	75	63	48

Table 3.4-1: Distribution of households by type of housing (percentages)

3.4.2 Water Supply

According to the FAP 3.1 Char Study, there appear to be no significant difference in terms of availability of tubewells between charlands and set-back lands. No additional information is available concerning either the working order of these water supply tubewells or the comparative frequency of flooding of the shallow water tables in different situations.

3.4.3 Health and Family Planning

The present health situation of the population of the JAFP is not well known. The FAP 3.1 Char Study reveals only a difference related to the frequency of cholera/dysentery declared by people: 32% versus 23% respectively for the set-back lands and the charlands, which might be explained by the particularly bad welfare conditions of the displacees on the embankments. Concerning the availability of health care services and the most common types of treatments applied, the following figures underline the severe lack of modern medical services and the major role of quack doctors in both charlands and set-back lands, with a slight isolation effect for the char islanders.

According to the Kazipur case study reported in REIS, family planning seems to be quite well known in the charlands but less common and thus less applied than in the mainland, which is of course to be put in correlation with the more traditional way of life and related cultural references of the char islanders.

	Charland (islands)	Set-back Land (attached chars included)
Quack doctor	66	67
Trained/MBBS or hospital/clinic	18	20
Ritual (*tabiz*) or indigenous (*hakim*)	6	6
No treatment	10	7
Total	100	100

Table 3.4-2: Frequency of different types of treatments (percentages)
(Source: FAP 3.1, Char Study, 1992)

3.4.4 Education

The FAP 3.1 Char Study does not in fact reveal any substantial difference in education level between char islanders and set-back land settlers. Both appear to comprise slightly more illiterates than the mainland population, as is shown below:

	Charland	Set-back Land	Jamalpur District
No education	83	82	77
Primary level	10	11	11
Up to class x	4	4	8
SSC and above	3	3	4
Total	100	100	100

(% of household heads)

Table 3.4-3: Education level of population
(Source: FAP 3.1, Char Study, 1992)

3.4.5 Social Responses to River Bank Erosion

It would be wrong to believe that charlanders are accustomed to accepting river bank erosion without any response strategies aside from the very limited help from the public administration and services they now get. So long as they are not forced to accept losses passively and to abandon (provisionally) their land, people try to reduce damage through various progressive strategies according to the extent and rapidity of damage, like: dismantling housing structures, selling livestock, cutting trees, moving family and belongings etc. When they become displacees, the main assistance, if any, is provided through the social relationship system ("family and relatives" of the *bangsa/gusti*, friendship connections of *samaj*, of patrons, etc.).

The diversity of cropping systems in the different types of lands and soils in the JAFP and the fragmentation of farm holdings among these different locations basically constitute also a response strategy to the hazardous conditions of farming and living in charlands. Even indigenous technologies are often applied individually or collectively by people to protect land and houses from surface and subaqueous erosion, such as building bamboo fences (*chegar*) on the water front, bamboo crates filled with bricks, rustic earth embankments etc.

3.5 PSYCHO-SOCIOLOGICAL ASPECTS RELATED TO RIVER BANK EROSION

From a few field trips and discussions and the two main sources of information utilized in the present assessment (CS.3.1 and REIS) the following psycho-sociological aspects related to river bank erosion (and not flood aspects in general) are to be considered.

Perception of the Risk of River Bank Erosion

On the whole most people perceive the risk of river bank erosion whatever their lifestyle: bank line, attached chars or char islands. While the risk of homestead loss is naturally perceived more intensely by the char islanders, in contrast the risk of loss of cultivable land is more intensely perceived by people inland, which undoubtedly indicates a better adaptation of char dwellers to this risk. This interesting difference is indicated in the following figures, taken from a Kazipur case survey.

Loss of	Interior Land	Bir Land	Charland
Homestead	84%	99%	98%
Cultivable land	74%	70%	67%

(Percentage of "yes" answers)

Table 3.5-1: Perception of loss risk due to possible river encroachment

(Source: REIS, 1985)

The majority of people living on char islands perceive risks of river bank erosion more in the very short term, i.e. in fact as part of the normal conditions of living, than those of the set-back lands who, on the other hand, consider this risk more in the medium term, as is illustrated below, again through the results of the REIS Kazipur case study.

Possible Losses of Cultivable Land	Interior Land	Bir Land	Charland
Within 1 year	0	61	72
2 - 4 years	21	32	12
5 years or more	79	7	16
Total	100	100	100

(Percentage of households)

Table 3.5-2: Perception of risk of land losses due to river encroachment
(Source: REIS, 1985)

Expected Sources of Assistance in the Event of Displacement
In the light of case studies carried out in Kazipur, Chilmari and Bhola (1985-1986, REIS) the sources of assistance expected by riverside dwellers are in the following order of importance:

		% of answers
1.	National Government	51
2.	Relatives	27
3.	Friends	21
4.	Allah	17
5.	Relief agencies	12
6.	Samaj (society)	11
7.	Regional and local administration (District and thana officials)	6
8.	Local leaders	6

It is interesting to note that, faced with of a risk they are used to living with and for which they had experienced different types of social strategies in the past, people are now making appeals to national government, but they continue also to rely on social relationship assistance. Regional and local administrations and local leaders are not considered, on the other hand, as reliable sources of assistance.

Preference for Relocation if Land and Assistance Available

With regard to this question, charland people can be grouped together into three main categories (from REIS, case studies of Kazipur, Chilmari and Bhola):

- those who would prefer to be relocated in another charland, and as a priority in the neighbourhood;
- those who are appealing to be resettled in Khas land (State owned) and as a priority in the same thana, and
- those thinking of migrating (permanently) to a distant urban area or the Chittagong hill districts.

The first two categories would be more or less equivalent and predominant compared to the third one. In fact, such attitudes may change from one place to another according to the stage of social destructuring reached and the proportion of newly landless people.

Landlessness and Population Displaced

The burden of landless displacees in the bankline areas (bankline and/or embankments) is unfortunately a well known phenomenon. The figures given above (Tables 3.3-1, 3.3-2 and 3.3-5 in particular) illustrate this. But one must keep in mind that already on charlands (as in the mainland everywhere in Bangladesh) the percentage of landless is high. That means that while riverbank erosion is aggravating landlessness it is not the sole determining factor to be taken into account. (See compared percentages of landless between charlands and set-back lands, Table 3.5-5). During field trips, it was confirmed through farmer interviews that displacees who become new landless will keep the hope of regaining their land one day and for that reason they continue to pay land rent (see Chapter 5). In fact they do not have the same social status as the previous structural landless; "they have been farmers and they could be it again.....". Having the know-how they can more easily find a sharecropping activity when displaced than the lower class of the original landless.

4 AGRICULTURE AND RURAL ACTIVITIES

4.1 ECOLOGICAL CONDITIONS OF PRODUCTION FACTORS AND THEIR DISTRIBUTION

There is a large physiographic variety within the Jamuna Active Flood Plain despite the low relief of the charlands. Each variety lends itself to a particular land use and in-so-far as the farmers perceive these qualities, a positive relationship between physiographic sites (or landscapes) and different eroding patterns develops.

Thus the different land uses, for the most part, may conveniently be related to physical factors i.e. physiography, effect of flood water, soil association and types of rainfall.

Each level of land differs in terms of physical characteristics, (see Fig. A.7-2, A.7-3 and uses; land levels identified generally correspond to what can be called:

- homestead on high land sometimes flooded by the "*bonna*" (the abnormal flood);
- medium high land with predominant silty to loamy soils, frequently flooded;
- medium low land with sandy to loamy soils, poorly drained and deeply flooded each year, and
- low land with clayey to loamy soils, deeply flooded each year, and new sandy accretions.

The cropping pattern on each of these landscapes is determined by the magnitude, duration and frequency of flooding, effectiveness of drainage and amount of silt deposited by flooding.

Beside these physical factors other ecological determining factors must be taken into account for understanding environmental conditions that affect agricultural practices and consequently land use inside the charland system. In this way agricultural pests and diseases including insects, are seen by the farmers as an important problem beside the risks concerning abnormal rainfall or drought, lack of irrigation sources, river bank erosion, sand deposition, lack of dense vegetation.

The soils of the charlands are generally coarse textured, ranging from sand to silt. They are subject to inundation, hydromorphic conditions and sedimentation with fresh alluvium. Their retention of water is low and they are very subject to dryness during the Rabi season and sometimes at the end of the second Kharif season, when they are located on the highlands and medium highlands or sandy bare lands along the riverside. Lowlands are particularly exposed to deep and rapid flooding during the first Kharif season and to late floods and unseasonal heavy rainfall during the second Kharif season. On the riverside, the nature of the land itself is also unstable and liable to erosion. This erosion process is accelerated by the lack of dense vegetation on the bank and the proximity of a fast current in the river.

All these features are taken into account by farmers in the choice of the most suitable use, for each landscape type.

Consequently, productivity and stability vary a lot according to the landscape type characteristics.

4.2 SOCIO-ECONOMIC DETERMINING FACTORS OF THE DIFFERENT TYPES OF LAND USE

Landscapes used in this paragraph must not strictly be considered as physical mapping units, rather they represent a landscape exhibiting the interplay of land form process and socio-economic determining factors.

A basic feature of charland agriculture is that access to markets seems more difficult in the island chars than in the other part of the JAFP. The isolated location of island chars and their difficult conditions of communication, inside charlands and with the mainland, imply a price of material inputs that is relatively dearer for island char farmers.

Due to this particular environment each island char farmer trying to minimize the cost of producing any given quantity of foodgrains and other crops adopts appropriate agricultural practices with a low level of technology. Inhabitants generally follow traditional methods of cultivation. In the framework of the char study from FAP 3.1, investigations show that modern irrigation facilities are more or less inexistent in the charlands and widespread use of chemical fertilizers was not observed in the study area. These practices, which tend to be insufficiently capital-intensive, imply very low yields and labour productivity and do not allow any reduction in physical constraints. Consequently every hydroclimatic change in the charland involves very serious risk. Farmers who produce essentially for household consumption and who do not purchase material inputs incur only one risk, viz., that the harvest will fail as a result of an abnormal rainfall or drought. A charland farmer introducing new technology such as irrigation or drainage equipment, would lose not only his harvest but also the working capital he has expanded. Thus he could lose more than the traditional farmer on the mainland. This explains why he may be reluctant to introduce an improved technology. Without significant change of traditional practices there is no possibility to increase employment opportunities and reduce seasonal unemployment. Besides other than traditional sectors of employment, such as, agriculture, day labour, livestock and fisheries, no significant employment is available in the island chars.

Available labour and natural pasture are useful factors for developing livestock in the charlands. Despite the risk of crop failure and the consequence of flood/drought, livestock serves as a source of income for the people. But there are also useful livestock-crop interactions such as cattle dung contributions, use of agricultural by-products, Sesbania hedges used as fodder and the improvement of soil fertility, milk and meat for people, draft power etc. Draft power availability also influences the choice of crop.

Most of the households in the charlands and in the set-back lands use fish catches for their own consumption. For the farmers, fishing is a complementary activity. The charland area has immense open water resources providing scope for quality fish protein but these resources are affected both by man-made and natural factors such as:

- large-scale siltation and shoal enlargement;
- discharge of untreated effluents;
- increased use of plant protection chemicals on the mainland, and
- over-exploitation of certain major fish species.

Beside agriculture, the non-agricultural sector including livestock and fishery, trade, commerce, services etc. is usually conceived in the JAFP as the provider of supplementary incomes. In this sense, peasants engaged in such supplementary activities are mostly selfemployed and produce for the local market. But referring to Section 4.6 we will see that, in the charland, opportunities of off-farm activities provide less employment than in the Jamuna flood plain main lands. So there is a potential inequality in respect of employment between the char island people and the related char and set-back land inhabitants. This situation leads the peasants in the char islands to develop livestock and fishery activities within the limits of the environmental potentialities. Consequently where environmental and socio-economic constraints are very great, population density is lower.

4.3 LAND USE AND CROPPING PATTERNS

Fig. 4.3-1 shows how land use and agricultural practices are determined and so summarizes the contents of Sections 4.1 and 4.2 above. This basic knowledge is obviously necessary to foresee the possible agricultural consequences related to each river training and AFPM alternative.

4.3.1 Crops and Cropping Pattern

The estimated net cropped acreage in the charland system is around 86,000 ha. The majority of the people in this area are dependent directly on agricultural, livestock and fishery activities for their livelihood. As many as 9 crop types are grown in the charland area: paddy and some other grain productions, pulses, cash crops such as jute, sugarcane, tuber crops, spices, fruits and vegetables.

According to the FAP 3.1 Char Study paddy is grown more in the set-back lands as compared to island chars, while the next crop is *koan* for the island chars and jute for the set-back land; wheat seems more cultivated in the set-back land as compared to the island chars.

Broadcast Aus and jute are grown on moderately flooded highlands and medium highlands (February/March to June) sometimes followed by a rained crop. Aman paddy is also sown broadcast in March either as a sole crop or as a mixed crop with B.Aus on medium low lands.

Jute, an important cash crop, is sown in March and harvested in June/July. Koan is a rabi-crop sown in November/December and harvested in May. Where there are sufficiently humid silty soils various kind of rabi-crops are grown such as wheat, pulses, tuber crops, spices, and vegetables. In addition, in the same area, there is sugarcane for household consumption.

The fruit and vegetable garden around the farm house (homestead) is often planted with beans and other vegetables including snake gourd, cucumber, sweet gourd, pumpkin, spinach, etc. Among fruit plantations there are banana, papaya and pineapple. Cropping patterns followed by the farmers in medium low land include Aus (local), B.Aman local and locally rabi crops. This area is seriously affected by abnormal drainage conditions.

On the low land silty soils it is possible to see groundnuts during the rabi and kharif II season and exceptionally T.Aman locally between August and December. Soils emerging later from the river during the dry season are not cultivated and stay with natural vegetation or even without.

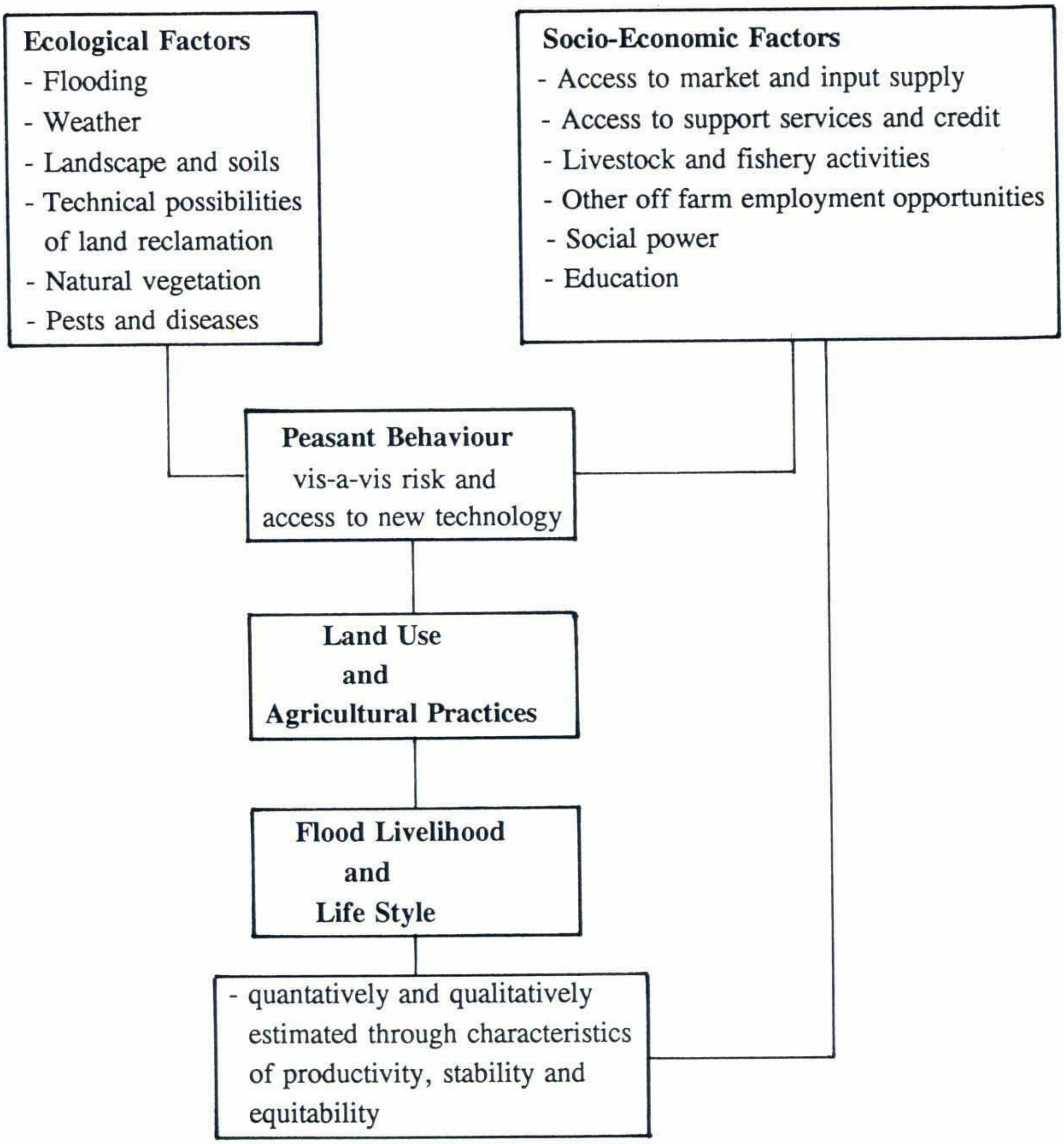

Table 4.3-1: Determining factors of the agricultural production

Table 4.3-1 gives an approximate breakdown of crops according to each landscape type both in island chars and attached chars mixed with set-back lands. The percentages of cultivated area in relation to each landscape type during a normal flooding year are a tentative approach taking into account FAP 3.1 and FAP 12 investigations, after a field visit for adjustment purposes.

Landscape	Island Char		Attached Char and Set-back Land	
	Cropping Pattern	Area %	Cropping Pattern	Area %
High Land	- Homestead garden - Vegetables/sugarcane	0.5 96.5	- Homestead garden - Vegetable/sugarcane	0.5 94.5
Medium highland	- B.Aus-Rabi crops/ wheat - B.Aus L.-Fallow	88 9	- B.Aus-Rabi crops - B.Aus L.-Fallow	86 9
Medium lowland	- B.Aus/Jute-Fallow - B.Aus-Rabi crops with koan - Mixed Aus-B.Aman L. Fallow/or locally Boro	80 8 9	- B.Aus/Jute Fallow - B.Aus/Rabi crops - Mixed Aus-T.Aman L.-Fallow	80 7 8
Low land and new accretions	- Groundnut-Fallow - B.Aus L.-Fallow - Locally diversified Rabi crops with koan	2 6 6	- Groundnut-Fallow - B.Aus L.-Fallow - B.Aus L.-Rabi crops	2 4 4

N.C.A.: Net Cultivated Area = Gross area x 0.95 in attached char and set-back land
Net Cultivated Area = Gross area x 0.97 in island char.

Table 4.3-1: Landscapes and cropping patterns

4.4 HYDRO-AGRICULTURAL INFRASTRUCTURE AND AGRICULTURAL PRACTICES

4.4.1 Hydro-Agricultural Infrastructure

Drainage problems are often aggravated due to siltation of the internal drainage channels. Besides, groundwater irrigation is rarely practised on any significant scale. Only surface water irrigation is practised.

The salient feature that can be extracted from the studies of FAP 3.1 and FAP 12 is the uncertainty of charland agricultural productivity due to lack of drainage or irrigation systems to face abnormal weather conditions.

4.4.2 Agricultural Practices

- Cultivation of Aman varieties: the rice varieties used in the main season are essentially local broadcast Aman varieties. Locally, however, on the medium low land of set-back land area transplanted Aman varieties are used;

- Aus season activities: it is particularly during the pre-monsoon season that rice is grown, depending on rainfall and soil texture, on several type of landscape (medium highland but especially medium low land);
- Cultivation of boro varieties: very locally used on medium low land for the sake of experimentation;
- Ploughing: done with draught animals, and this influences soil structure and thus the percolation of water; manure is also applied but there is no other input such as chemical fertilizers. No ploughing is required on the low land, where seeds are generally directly sown;
- Laddering: mud is created after 1 to 3 ploughings by going over the field with a ladder. However, this is only necessary for transplanting Aman varieties. This requires a certain amount of water on the field;
- Levelling: this activity influences water depths and thus yields. Surface runoff patterns are also affected. Levelling is done by laddering or ploughing or by cutting the soil and moving it;
- Transplanting: for this labour-intensive work the soil has to be in a certain condition; a certain water layer has to be present on the field. It is only possible to find the best conditions for transplanting on the medium low land. Elsewhere rice is generally broadcasted, in which case neither seed beds nor transplanting are required, and
- Cultivation process: there is a progressive process by which land accretes, is colonised by vegetation (principally catkin grass) and is then brought under human use after a minimum of two years. Natural vegetation can be used as grazing. Organic matter may thus be added to the soil, although under pressure of the human population this may be collected as household fuel. There is also widespread cutting and collection of catkin grass for use as stall feed, fodder, domestic fuel and home-building material. This is often on a commercial basis and sometimes sold to the mainland.

After clearance of natural vegetation it is possible to begin cultivation.

The point at which cultivation starts seems dependent upon many variables:

- population pressure (depending on the degree of land loss experienced by local people due to main bank erosion), and
- seasonality of land availability (depending on the height of the land, flood risks and the nature of the soil).

The largest area available for cultivation is during the dry season, when river levels are low and there is sufficient rain water and soil moisture retention for dry land farming.

On the whole, agricultural development possibilities are very restricted on account of physical constraints (risks of flooding, abnormal climatic conditions, soil characteristics, etc.), lack of protection infrastructure and land reclamation measures, hard access to the main land, high risk area for any investment.

Nevertheless peasants exploit their natural resources of the charland system remarkably well.

4.5 TENTATIVE SUMMARY IN TERMS OF FARMING SYSTEMS

According to the Table 4.3-2 above, chars and particularly the island chars are cultivated with early Aus and Jute followed sometimes by B.Aman, which is often mixed with Aus. Wheat cultivation has increased recently. Other Rabi Crops are mustard, kaon, sweet potatoes and cheena. The cropping pattern also includes khesari, masuri, chillies, mung, onions and sugarcane on highlands. Banana is grown thickly around the homesteads especially in the newer accretions. As shown in Table 4.5-1, yields are generally lower than those obtained on the main lands but very comparable with national results when low levels of input are used (Source: CS 1992 based on estimates by B.A.R.I. and B.R.R.I.).

The most important limiting factor in the flooded charland areas is the lack of control over water. Uncertain flood forecasts and both deficiencies and excesses of moisture contribute to instability in agricultural production.

Crops	Yields		
	(1) for attached char and setback lands (T/ha)	FAP 3.1	(2) National yields with low input loss
B. Aus L	1.1	2	1
B. Aman L	1.24	1.2	1.2
B. Aus-Aman mixed	1.65	3.5	-
T Aman L	3.80	1.2	3.3
Jute	1.5	2	1.2
Wheat	0.92	0.65	-
Pulses	0.60	-	1
Oilseeds	0.73	4.0	0.8
Spices (onion)	(2.4)	2.5	-
S. Potato	(2.5)	50	-
Sugarcane	41.17	5	-
Boro	(3.5)	1.3	4.3
Groundnut	(0.77)		-

1. From FAP 12, 2. Cited in FAP 3 study, (). Hypothesis adopted

Table 4.5-1: Production of crops

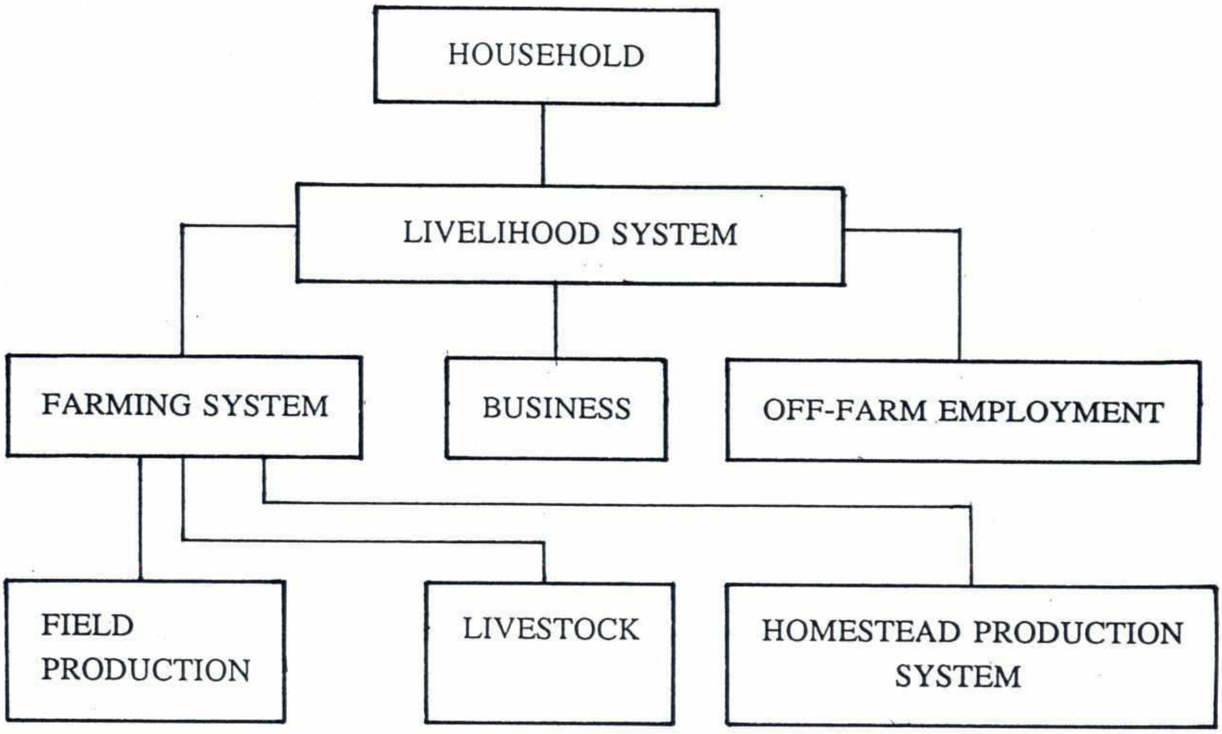

Fig. 4.5-1: Hierarchy of production system in agriculture

The main risks facing crops in the charland system are:

- heavy pre-monsoon rains which affect Aus/Jute yields by damaging the young plants, particularly in the low lands;
- early quick floods, which damage not only Aus but also Aman and Jute;
- total submersion of rice for more than seven days in flood-prone areas, which completely destroys the rice crop, and
- failure of early rains, delaying sowing of Aus and Jute, which in turn delays the transplanting of the Aman crop, particularly on sandy loamy soils.

Uncertainty linked with the risks of flooding limits cropping intensity.

On the mainlands of the JAFP, cropping intensity can vary from 150% to 200% according to sub-region. On the charlands it can vary between 100% and 200% according to landscapes but is generally around 160% in normal flooding years.

The farming system (see Fig. 4.5-1) is generally described as a complex interwoven mesh of soils, plants, animals, implements, workers (farmers), other inputs and environmental influences with the strands held and manipulated by a person called a farmer, who, given his possibilities and needs, attempts to produce output from the inputs and technology available to him. The domain of agricultural production (understood in general terms) comprises three broad sectors: field production, homestead and livestock. The former is traditionally looked after by men while the second particularly by women. Homestead operations include food processing, food preservation, seed selection, preservation, storage and germination, seed bed preparation, all post-harvest operations such as threshing, winnowing, parboiling, drying of both paddy and straw to be used as livestock feed, husking/milling until ready for family consumption or market sale, production of horticultural crops, vegetable gardening, livestock caring, poultry raising. In addition women are engaged in child care, fuel gathering, household maintenance as well as handicraft production or cottage industries. In total these activities take at least 10-14 hours a day (Hye. 1984).

Tables 4.5-2 and 4.5-3 below represent a tentative assessment of the field and homestead production systems. The figures must be considered as orders of magnitude in order to give an approximate image of the JAFP in the present situation. Homestead production represents 15% of the highland and medium highland production.

The value added per ha of cultivated land is around Tk. 9000. It is a relatively low average due to low yields. There are 42% of cultivated lands. The rest consists of bare sandy lands with or without herbaceous vegetation.

Attached chars and set-back lands on the right bank represent only 7% of the total emerged land area while attached chars and set-back lands on the left bank represent around 50% and Island chars around 43%.

The total area of the stretch of water covered approximately 22% of the JAFP area during March 92 (from remote detection by Landsat).

Like most other places in rural Bangladesh Cattle, Buffaloes, Goats, Sheep, Poultry are found in the charland system.

According to the FAP 3.1 study the ratio of draught animals in the inland chars is estimated at around 35% of total livestock and less than 30% in the set-back land and attached chars; while milk cows represent 12% total livestock in both the inland chars and attached chars mixed with set-back lands.

The estimated ratio related to the value of the livestock is Tk 8760 per household for the island chars and Tk 4090 for the setback lands and attached chars (that is to say, very roughly, in terms of value added, Tk 1000 for the island chars and Tk 500 for the set-back lands).

Taking into account the cultivated area per household in the island chars, representing 0.80 ha on average and 0.47 ha in the setback lands and attached chars, it is possible to estimate the number of households at around 50,000 on the island chars and approximately 99,000 on the attached chars and set-back lands.

From this basis it is possible to assess the volume of the livestock roughly at around Tk 438 million in the island chars and Tk 405 million in the attached chars and set-back lands, bearing in mind that for cattle in the island and attached chars the feed is obtained from three main sources: crop residues and weeds from agricultural lands, grasses and weeds grown on the homesteads and grasses and weeds from natural pastures on the new sandy accretions.

In the context of charlands cattle are not only important for draught power and family consumption but also for getting an indispensable complementary income and a means of saving as well in the case of adversity or exceptional social needs.

Item	Market Price/T* Tk	Gross Production/ha Tk	Production Costs/ha Tk	Net Value Added NVA/ha Tk
B. Aus L	6,074	6,681	1,837	4,844
B. Aman L	6,438	(7.971)	2,535	5,436
B.Aus, B.Aman mixed	6,256	10,322	2,089	8,233
T. Aman L	6,438	24,785	14,427	10,358
Jute	8,012	12,073	2,040	10,033
Wheat	6,312	5,807	3,015	2,792
Pulses	14,919	8,952	2,750	6,202
Oilseeds	13,466	9,830	2,750	7,080
Spices (Onion)	9,047	21,720	5,400	16,320
S.Potatoes	400	13,000	2,000	11,000
Sugarcane	1,012	41,664	8,770	32,894
Boro	6,212	21,500	3,975	17,605
Groundnut	10,000	13,000	4,200	8,800

* Market prices from special study on economics: estimates of economic prices of selected commodities for use in FAP Planning studies, Dhaka 1992.

( ) Figures including average production losses by flooding related to a return period of 20 years.

NVA = Net value added = Gross product - total direct production costs (not including labour).

Table 4.5-2: Prices* for the production value assessment

Landscape	Area		Value Added		Man/Day		Area (%)			
	Ha	%	Tk 1000	%	1000 M/D	%	Right Bank At.Char	Left Bank At. Char	In land Chars	Total
Highland and Medium High land cultivated	27,138	13.2	330,334	42.2	6,481	39.5	0.6	44.9	54.5	100
Medium Lowland cultivated	43,145	21.0	357,513	45.7	7,469	49.0	3.6	49.2	47.2	100
Low land cultivated	16,101	7.8	94,436	12.1	1,760	11.5	17.4	52.2	30.4	100
Bare land with more or less herbaceous vegetation	119,458	58.0	-	-	-	-	8.2	50.8	41	100
* Total area of emerged land	205,842	100	782,283	100	15,710	100	14,373 7.0	102,480 49.8	88,987 43.2	205,842 100
* Total area of the Jamuna River	58,058									
Total area of the J.A.F.P	263,900									

* During the dry season
M/D = Man/Day

Table 4.5-3: Total area, landscape unit and production assessment in the JAFP

4.6 OFF-FARM ACTIVITIES AND RURAL DEVELOPMENT POLICY

Farming is the main occupation of the majority of household heads in the charland system but more in the island chars than in the attached chars and setback lands.

This shows that the pressure on the lands and employment opportunities lead to more off-farm activities in the attached chars and setback lands while farming occupations are found higher in the island chars.

As far as fisheries are concerned it can be seen from Table 4.6-1 taken from the FAP 3.1 study that the households in both the island chars and the set-back lands are occasional fishermen. But fishing is more often a complementary source of income in the island chars.

Fish Sold & Consumed	Island Chars % Fishing HH	Attached Chars Mixed with Set-back Lands, % Fishing HH
Own consumption only	71.4	77.8
Sales and consumption	28.6	22.2
Total fishing HH	100	100

Table 4.6.1: Households and fisheries

Based on a ratio adopted by the FAP 3 study, the total fish catch from 1 ha of the Jamuna river would be around 126 kg/year. This figure must be considered as overvalued, however, that is to say roughly Tk 6930 ha/gr or around 20 g per inhabitant per day in the JAFP. This corresponds to half the average daily consumption of animal products in Bangladesh (taken from "Nutrition Survey of Rural Bangladesh, 1981-82). However, as said in Section 4.2 above, a decline in the per capita consumption of fish can be observed in this area.

Thus the rural area of the JAFP can be considered as a sort of semi-nomadic agrarian system characterized by a permanent adaptation to frequent physical and socio-economic changes. This implies low level technology, subsistence farming, underemployment and a low level of investment in agriculture.

An estimation of physical assets shows that more than 70% of total value concerns houses as against the value of agricultural equipment, furniture and transport (around 7.5% each)

Thus in terms of productivity this area has little possibility of development. Land is a scarce and uncertain resource due to erosion risks and overflooding, while river channels and low lands are filling up with sediments. In such a situation, investments in land reclamation and preservation run very important risks.

5 LEGAL AND ADMINISTRATIVE ASPECTS

5.1 LEGAL ASPECTS RELATED TO RIVER BANK EROSION

The State Acquisition and Tenancy (SA&T) Act of 1950 now guides all matters related to land and its administration in Bangladesh. [1]

Chapters XII and XIII of Part V of the Act deal with rights and liabilities of tenants and the effects of holding, transfer, purchase and acquisition of land.

Sections 81, 82, 83, 84 and 85 define rights and liabilities. The issues related to dilution are dealt with in Section 86 and accession from river or sea recess in Section 87. In short the provisions are:

(i) When any land of a holding or a portion of it is lost by dilution, the rent of the holding is abated proportionately. However, this is not the most important point. The important thing is that the right, title and interest of the tenant is extinguished thereby. All lands so lost by dilution, when they reappear, vest absolutely in the government free from all encumbrances and are at its disposal for resettlement or otherwise, becoming thus *Khas* land (state-owned).

    There is, however, provision that if such land or a portion thereof reappears within twenty years from the date of such loss, preference shall be given for resettlement to the person or his successor-in-interest who, immediately before loss by dilution, was owner of such land, provided, however, that the quantity of land to be so settled is such that, when added to the quantity of land already held by such person or his family, does not exceed sixty standard bighas[(1)].

    This provision of preference will, however, not apply to cases of re-appearance of land caused or accelerated by any artificial or mechanical process as a result of development works undertaken by Government or any authority empowered or authorised by or under any law to undertake such development works.

(ii) In case of new accretion of land (Section 87), all such land vests automatically to government if the accretion took place after 28th June, 1972.

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1 In 1972 another land reform fixed the ceiling for family landholding at 100 bighas and redistribution of acquired land and new char land to the landless. The 1983 Land Reform Act tried to provide some security to the sharecropper tenants by fixing a maximum duration of contract at 5 years and distribution of crops in the proportion of 1/3 each to the landowner and the tenant and 1/3 to whoever bears the cost of inputs. The landholding ceiling was reduced afterwards to 60 standard bighas in place of 100 bighas.

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Though these provisions indicate that any land that may reappear from the bed of the river as chars or an accession to the bank should vest in the government for re-settlement as per the rules, in reality however, no such land remains vacant. They are immediately taken possession of either by those who lost their lands or mostly by powerful land-grabbers. The Government, however, can take appropriate measures to oust these unauthorised persons and bring the lands under *diara* settlement operations for proper resettlement or may declare the entire land or part of it as Khas land to be used for other purposes.

Most of the charlands, as per law, therefore should be Government khas land. But the fact of the matter is that whenever one wants to use the same as khas land, claimants do come forward with old ownership claims in one form or another.

Be that as it may, it is possible to use these lands for experimental purposes. It is only when permanent or semi-permanent constructions are to be made or prolonged use has to be ensured, that the land or lands may have to be acquired. This is usually done through the Collector (D.C.) of the District concerned. The Collector has to decide whether such land is already khas land and so no acquisition would be necessary or he may go through the usual land acquisition process by assessing compensation and disbursement of the same.

As has been mentioned before and was again corroborated during the recent field visits, the owners of such land do not tend to have any objection to the acquisition of the land provided appropriate compensation is assessed and the payment of the same is promptly made.

Although charlands are characterized by their uncertainty and charlanders have learnt by sad experience that the lands could be taken away by the Jamuna any time, the fact remains that part of char soils are fertile and can grow valuable agricultural production (see Chapter 4 above) and so these are rather expensive. For example rates of Tk 4000 per bigha of cultivable char Island and of Tk 6000 - Tk 9000 per bigha on attached chars are commonly mentioned by the population (provided an announced project does not inflate the land price market due to, for example, manipulation by local leaders and landers; see the case of the Jamuna Bridge area).

Some charlands may, however, be washed away because of the removal of protection embankments or experimental constructions. In such specific cases, instead of going through the regular land acquisition process of determining compensation and payment of the same, a resettlement plan may be executed by the Collector wherever necessary. If Government *khas* land is available in the adjoining mauza or mauzas on the bank of the river, this can be used for resettlement or relocation of these displaced persons.

Alternatively, new areas may be accreted near the bank because of protection or river training measures. The Collector can declare such new areas as per law (Section 86 of the SA&T Act, 1950) as *khas* lands and use the same for resettlement of the displaced persons from the washed away chars.

In this regard the instructions for allotment of government *khas* land to landless or near landless persons issued under Memo No.8-46/84/24(64) dated 6.1.1986 of the Ministry of Land Administration and Land Reforms may be followed by the Collector

Implementation of large development and equipment programmes such as construction of dams for hydro-electric power, construction of canals, embankments, bridges, etc. results in dislocation and displacement of large numbers of people. They are forced to relinquish their rights to various important assets. These include housing, land, access to economic activities and public services, as well as non-economic assets. The laws and regulations governing compensation very often do not prevent series hardships and suffering. In particular, compensation procedures typically relate to fair market values, whereas in practice the value of assets to their owners may well exceed such valuation. Then again in some instances, the entire compensation has been used for immediate consumption purposes, leaving the displaced with nothing to replace their lost income-generating assets and opportunities.

These are all true in the case of the large projects mentioned above, but fortunately this will not be the position with regard to the requirements for FAP 22.

The land, the area and population concerned by the projects under pilot component FAP 22 would not be extensive. Then again, people who live in the chars and on the banks of the river Jamuna are accustomed to displacements by the periodic natural behaviour of the river. They know how to live with floods and recession.

When only a few people are involved, cash compensation may be adequate. But even then, consideration should be given to the ability of the displaced persons to find alternative homes and alternative employment opportunities. For this purpose the local administration at the union level and the district administration will have to be persuaded to be involved in all issues connected with the determination of adequate compensation, disbursement of the same quickly, relocating the displaced people and their resettlement.

5.2 MAIN INSTITUTIONS CONCERNED WITH RIVERBANK EROSION AND RIVER TRAINING AT CENTRAL AND SECTOR LEVEL

Until now, river bank erosion problems and river training issues and studies have been undertaken in the general institutional framework of a Water Development Project (WDP). FAP 1 and FAP 21/22 in particular are referred to as Flood Action Plan projects, which indicates the lack of a specific institutional approach and framework for river bank erosion and river training studies.

For the record, the following is a summary of the main institutional framework for development projects in Bangladesh. FAP 26 is a specific FAP, the task of which is to prepare a first general Institutional Development Programme in relation with the Action Plan for flood control in Bangladesh. A consultant's report concerning a Needs Assessment Survey was drawn up in June 1992 and taken into consideration in the present assessment.

The Central Ministry under which water development programme and in particular the FAP have to be developed is the Ministry of Irrigation, Water Resources and Flood Control (MIWDFC) and its five supervised agencies:

(i) Bangladesh Water Development Board (BWDB) is the implementing agency of the Ministry and is responsible in particular for the implementation of FAP-generated investment projects.

(ii) The Water Resources Planning Organisation (WARPO) is the agency responsible for preparation of Water Resources Planning. The Surface Water Modelling Centre (SWMC), under WARPO, is involved in the development of mathematical models as water resources planning tools.

(iii) The River Research Institute (RRI), based in Faridpur, is mainly involved in physical models to support technical designs in the framework of water resources development.

(iv) The Joint Rivers Commission (JRC) is engaged with joint water issues related to neighbouring countries.

(v) The Flood Plan Coordination Organization (FPCO) is not really a structural agency but a temporary support organization created after the exceptional 1988 flood in order to "assist the GOB in coordination and implementation of the 5-year Action Plan for flood control..." FPCO was formally created in 1990 and has been operated, like its supervised FAP's, through a substantial multilateral and bilateral joint assistance programme.

Moreover, and for the record, the reader should keep in mind that numerous central and sectional institutions are involved in population displacement and resettlement and in other rural development aspects related to riverbank erosion and flood emergency issues, the main ones being:

- Ministry of Local Government, Rural Development and Cooperation;
- Ministry of Relief and Rehabilitation;
- Ministry of Food;
- Ministry of Agriculture (including Fisheries and Livestock Divisions and Irrigation, Water Development and Flood Control Division);
- Ministry of Land;
- Ministry of Environment and Forest;
- Ministry of Defense;

- Ministry of Information and Broadcasting;
- Ministry of Labour and Man-power;
- Ministry of Social Welfare and Woman's affairs, and
- Ministry of Health and Population Control.

It is not the purpose of the present assessment to carry out a detailed analysis of the macro-institutional set-up to follow for water development programmes. For that purpose the specialized component Institutional Development Program FAP 26 has been included in the Flood Action Plan. Their draft report shall not be commented on at this place, however reference is made to Chapter 9 of the FAP 22 Main Report which summarizes the Project's views on the requirements which have to be met by institutions that are responsible for the implementation of a multi-generation Jamuna river training programme.

5.3 LOCAL INSTITUTIONS IN THE JAFP, RIVER BANK EROSION AND RIVER TRAINING AND DISPLACEES ISSUES

5.3.1 General Considerations

Many reports refer to the lack of people's participation and the weak involvement of local authorities and institutions in the implementation of WDP. The FAP 26 consultancy report, mentioned above, in particular recommends the establishment of Project Implementation Units (PIUs) in order to "encompass people's participation at all stages of the project planning cycle" and to involve more local authorities. In this respect this report proposes joint formal participation in such PIUs of the executing agency, the implementing organization and the local authorities, water user groups or other identified local representative bodies.

If we consider the new River Training Strategy that the foreseen FAP 22 pilot components are participating in, it is even more obvious that, for the moment, people's participation and involvement of local authorities(2) is neither a reality nor even thought of at advisor and decision-maker level. However, such local participation should be considered in the future (on the part of both the population and local authorities and institutions) at least for:

(i) the purpose of pilot technologies/actions such as the one foreseen in FAP 21/22 (and for ancillary measures such as institutional and organization ones), and

(ii) indirect river bank erosion protection measures such as an awareness and information system, land re-allocation and resettlement, social and economic compensatory measures.

On the other hand, however, the stage of actual people's participation and efficient involvement of local authorities cannot be simply achieved through the formal institutional

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(2) See also people's opinions about expected sources of assistance in case of river bank erosion (section 3.5 above).

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membership of any local representative body in any new project organization. This issue is one of the most crucial in the developing countries in general and in Bangladesh in particular. It is determined by deep-rooted structural constraints and bottlenecks such as traditional cultural structures, educational level, local political dimension of the state system, bureaucracy etc. Nevertheless experimental institutional and organizational measures should be foreseen in the framework of a pilot project (see below), which is hardly the case at present.

A review of the main existing institutions that might possibly be concerned at local level in future river training and social protection measures against riverbank erosion, is provided hereafter.

5.3.2 Local Administration and Political Institutions

Under the District (Zila) organization, the Upazila (Thana) system was introduced in 1982 in order to reduce the degree of centralization left by the British Colonial Administration. However, the system did not work as satisfactorily as was claimed and the old system of Union Parishads (UP), Paurashavas and Zila Parishads[3] in being retried.

While the lowest official administrative unit is the mauza (village revenue: one or a few traditional villages), local administration at rural areas is performed through the Union Council (UP), which consists in general of 5 to 15 mauzas and is divided into 3 *wards*. Each *ward* elects 3 members of the UP. In fact the Unions are not the real administrative units of the Central Government but they are theoretically considered as local self-government institutions. The problem is the actual means (human resources, finances, etc.) of such local self-governing institutions.

Above the Union is the Thana (formerly Upazila) with representative offices of almost all central Government Ministries, which are coordinated by the Thana Nirbahi Officer (equivalent to the District Commissioner in the District level). On the other hand Members of the National Assembly are elected at an intermediate electional level (between Thana and Districts).

Thus at the very grassroot level of the village there is no real people's representative institution such as, for instance, the *Gram Parishad* (village Council) of West Bengal (India). Even if the concept of village elders is quite prevalent among country people, it is not officially recognized as such, although the village elders are either also elected members at the UP or have a close social relationship (*bangsa gusthi*, political or economic alliance) with an elected member.

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(3) Union, Municipality and District Council

Thus, in the present situation the Union Parishads should be the most effective local body to handle the problems and issues connected with riverbank erosion and consequent displaced persons' relief and rehabilitation. The UP members and the chairman are the first-order regularly-elected representatives and the UP is at the moment the sole possible body for democratic institutional strengthening at grassroots level.

All development activities, as well as other social services, such as relief operations, food for work programmes, UNICEF activities, vulnerable group feeding and NGO activities are channeled through or undertaken in co-operation with the UPs.

Almost all vital development-oriented organizations may have their line office at the Union level. If some of them are not located there, they may also be brought down to that level if and when required. They can all be made to extend their assistance in the fields of land acquisition, disbursement of corresponding compensation, resettlement/relocation of displaced persons, embankment construction, embankment utilization, drainage, irrigation, horticulture, pisciculture, animal husbandry, poultry farming, health and family planning, primary and adult education and so on.

Finally the main issues are: Who decides the action? For whom and which actual interest? Who and where are the human resources finally responsible, the owners and beneficiaries of the action?

5.3.3 Local Technical Services

Even though BWDB has its field organizations spread over the country, especially where flood activities and river bank erosion are prevalent, it is not sufficient to cope with sudden devastating floods and massive river bank erosion. So there is scope for further strengthening activities at the local level but in close cooperation with the population and local authorities and other concerned institutions at local level. This implies, among other things, new methods of working, new communication systems between the different actors and relevant training at every level. At present it seems that BWDB technicians are not present at the Union level in the flood-prone area - actually in each Union along both banks of the Jamuna. They are to be responsible for keeping watch on the activities of the river as well as for maintenance of physical structures in co-operation with the *Union Parishad* and population.

As has already been mentioned, almost all the central technical departments have their offices at the Thana level. They are supposed to extend technical assistance for rural development in their respective fields, as listed below:

1.(a) Agriculture Extension Officer: agricultural advice, pest control, etc.
  (b) BADC (Bangladesh Agricultural Development Corporation): agricultural input and service supply
2. Fishery officer: pisciculture in closed and open water.

3. Livestock officer: animal husbandry and fodder production
4. BRDB (Bangladesh Rural Development Board): Rural Development Officer
5. LGEB (Local Government Engineering Bureau):
    a. Rural works program - construction works as well as assistance in designing suitable huts.
    b. Public Health Engineer: water supply and sanitation facilities.
6. Health and Family Planning Officer
7. Education Officer: especially for primary education and mass education programmes.
8. Social welfare officer: to initiate new social welfare activities at village level.
9. Co-operative officer: formation of viable co-operative societies in integrated rural activities.
10. Women's Affairs Officer: formation of women's groups, development of income-generation opportunities.
11. NGOs': group mobilization and credit.

All these technical services can assign local representative agents at Union level when particular financing is required for a local project or program.

5.4 OTHER ORGANIZATIONS

At the present moment there are a number of national and international NGO's working in the JAFP in various socio-economic fields (health, family planning, education etc.).

In addition to its own institutional network, BWDB could apply to and support the Village Defense Party (VDP) as well as the *Ansars* at Union level.

6 TENTATIVE OVERALL CONCLUSION

The settlement of the JAFP has met a deep upheaval since the year 1787 when the Brahmaputra began to change its course southward. The social history of the Jamuna Flood Plain is unfortunately little known.

Besides the diversity and the uncertainty due to the agroecological conditions, and the overall low economic level of population, there are various forms of socio-economic inequality in the JAFP. Although one can find here and there indicators of local cultural particularities, it is the economic issues that are now definitely ruling the social relationship. Inequality is prevailing everywhere: in matter of employment opportunities, between attached chars mixed with set-back lands and island chars. There is also inequality in population density and in income distribution, the major cause of which is inequality in land ownership and in the access to share-cropping as well. This is true not only because land is the most important means of production, but also because land ownership is highly correlated with easy access to institutions and to the services and resources they provide (e.g. education, health care, credit and technical assistance etc.).

Given the extent of landlessness which characterizes even more the attached chars mixed with set-back lands, it is not surprising that more diversified occupational structure including transport services, commerce, domestic industry and fishing can be found there. But underemployment is also important because of the distance from urban areas as well as because of the lack of communication facilities. In addition to these various forms of inequality and poverty, populations growth versus the limitation of natural resources and their hazardous conditions of exploitations are unfortunately detoriated by river bank erosion which results in unforeseeable losses of land, houses and assets and goods, additional landlessness and joblessness and population displacements. Moreover if char islanders use to manage their life under such precarious and risky conditions and in the frame built-in relationship system, when they become displacees on the bankline or on the embankments they are socially destructured, which increases then their misfortune feelings. In parallel such population displacements are provoking disrupting effects on local dwellers communities and institutions on the one hand, and new sources of social inequality again, thus repeating the vicious circle.

Hence any national programme that would be able to reduce such displacements by the river erosion would be of an invaluable benefit to the hundreds of thousands of population now either effected or threatened.

PART B: APPROACH FOR A SOCIO-ECONOMIC AND ADMINISTRATIVE ASSESSMENT OF RIVER TRAINING/AFPM ALTERNATIVE STRATEGIES

7 METHODOLOGICAL BASIS OF ASSESSMENT

Fig. 7-1 gives a general idea of the assessment process used in this specific study. It illustrates the relationship of the biophysical and socio-economic environment for river training and water management measures.

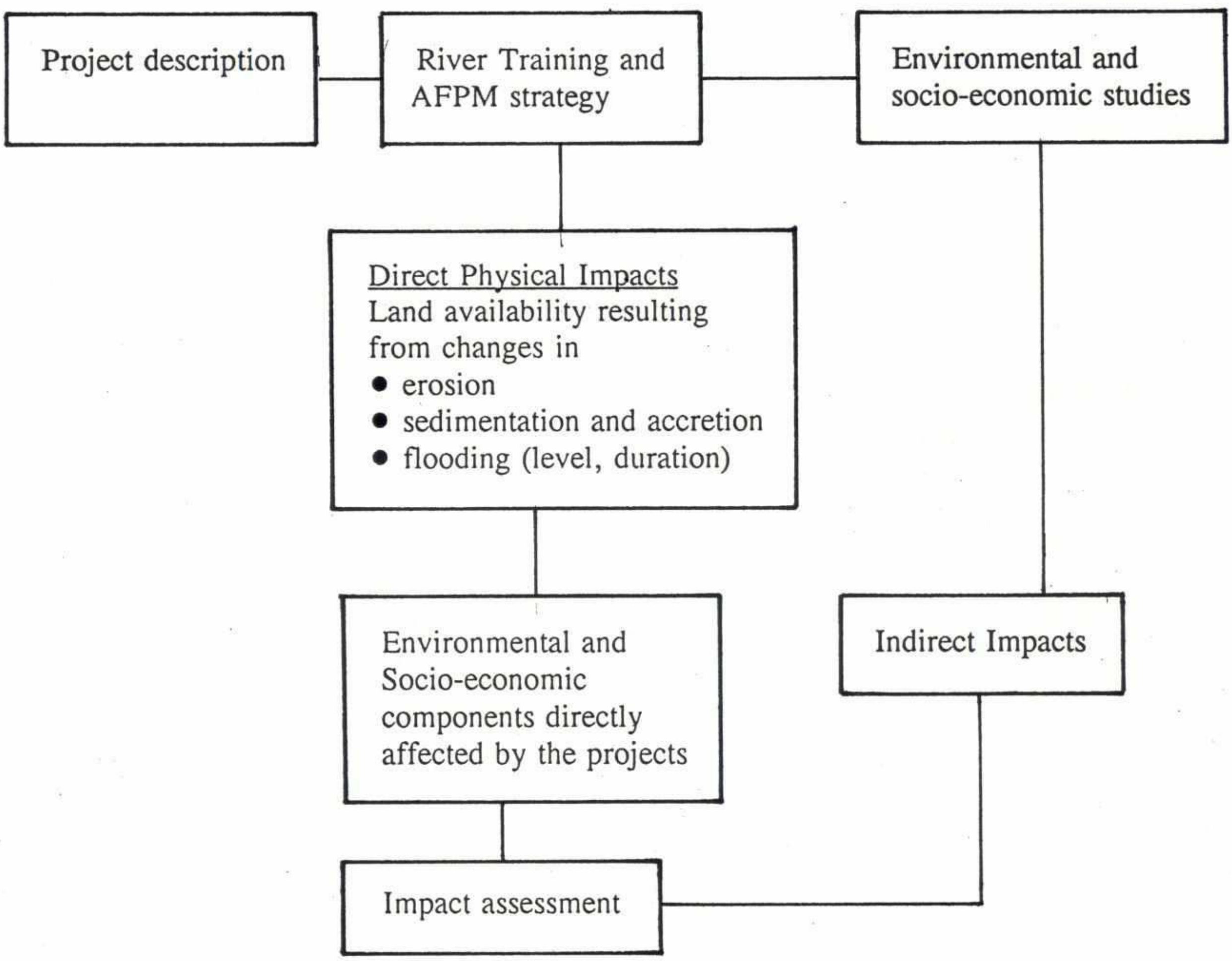

Fig. 7-1: Assessment process

A list of these environmental and socio-economic components is given below, grouped under five headings.

It corresponds to a checklist, which shows what is supposed to be directly affected by the projects

1. Physical components related to living conditions and agricultural activities in JAFP (7 components)

- Land use (erosion/accretion) on:
  - Island chars
  - Right Bank
  - Left Bank
- Flooding
  - Level
  - Duration
  - Agronomic properties of deposits
- Groundwater Resources

2. Social features (7 components)

- Socio-demographic trends;
- Social and cultural changes at household and family level;
- Social equality;
- Social cohesion;
- Lifestyle conditions;
- People's security and population displacement, and
- Conditions of land acquisition and land re-allocation.

3. Agricultural activities and economy (7 components)

- Farming system on charlands
  - Conditions for technological changes;
  - Diversification, and
  - Cropping intensity.
- Livestock on charlands
  - Draught animals;
  - Milk cows and others;
  - Fishery, and
  - Agricultural employment (on-farm and off-farm).

4. Administrative and organisational issues (7 components)

- Need for institutional strengthening at MIWDFC level;
- Need of new Institution for RT/AFPM;
- Conditions for people's participation;
- Conditions for local authorities' involvement
- Conditions for local technical services' involvement;
- Operation conditions for agricultural services, and
- Side needs of public investment at local level for rural development.

5. Embankment protection conditions (4 components: see Section 8.4-5)
Taking into account the essential characteristics of the river, i.e: the process of bank edge erosion and loss of islands, the process of sediment deposition responsible for the emergence of charland presently observed without any river training project; taking also into account the process by which charland is accreted, colonized by vegetation and then used by population in a progressively more intensive manner; considering the river is thought to be at present in dynamic equilibrium (erosion-sedimentation) and is continuing a bodily movement westward, it is possible from the results of existing studies (especially FAP 1, FAP 25, and the Chinese flood control and river training study) to define the principal mechanisms of change which may induce a tentative assessment of erosion control impact on protected land availability.

Table 7-2 gives the principal components of the argument process and the assessment results related to each scenario, namely the Anabranched Flood Channel (scenarios 1 and 2) and the Braided with Reduced Width (scenario 3) in terms of protected land availability in 2050, which represents the future of three new generations (the present one included and considering the national life expectancy of 50 years). The calculation method is summed up in Table 7-3.

Identification of the "Without Project (WO)" situation is finally the most critical part of the Jamuna River Training/AFPM strategy in terms of the river morphological phenomena and all the related disciplines and subject matters (i.e. scientific knowledge of the present situation, the past 200 years of the Jamuna and its predictable future evolution). Thus the present levels of uncertainty and inaccuracy will inevitably limit the efficiency and reliability of any River Training/AFPM strategy however comprehensive, progressive and pragmatic it appears.

Character of the River without Project	Project Elements					
	Scenarios 1 and 2			Scenario 3		
	Structural measures	Mechanisms of change	Impact due to erosion land area effect	Structural measures	Mechanisms of change	Impact due to erosion: land area effect
River north of Sirajganj is more braided						
5 large megastable islands (around 30% of emerged charland against 43.2% for total island chars 49.8% left bank attached chars and set-back land 7% for right bank	Protection of mega island chars. Design-flood level: -20.88m at Bahadurabad -15.52m at Sirajganj -11.48m at Aricha	Stabilization of housing in the mega island chars		Mega island chars not protected	-Moving of island population intensified -Change of landscape due to erosion and new accretions	
Continuing westward bodily movement of the river						
Average rate of retreat of the bankline around 100 m associated with the formation of island sand bars	Protection of bank hard points	Charlands stabilized on the whole		Attached charlands stabilized	Stabilization of existing attached charland and broadening of new accretions	
The river is thought to be at present in dynamic equilibrium (erosion-sedimentation)		No significant change in terms of total area and level of emerged land	Total area of emerged land around 205.000 ha (erosion + accretion taken into account)			Total area of emerged land around 205000 ha (erosion + accretion taken into account)

Table 7-1: Basic matrix for project impacts analysis

Character of the River without Project	Project Elements					
	Scenarios 1 and 2			Scenario 3		
	Structural measures	Mechanisms of change	Impact due to erosion: land area effect	Structural measures	Mechanisms of change	Impact due to erosion: land area effect
Containing and stabilising the river will have little effect on the peak flood level within banks - but more effect on duration of flood		Possible change in terms of land use on low land			Changes of land use due to duration of flooding and level of new accretions	
The shifting of the centre of an inter island cross over (node) partly as a cyclic movement and partly as producing attachment of islands (mainly to the left bank).		Shifting limited			Shifting more pronounced	
Erosion rate higher on the right bank (R.B.) (up to 70m/y) LAND AREA affected by erosion RB = 16.5 sq.km/Y LB = 7.1 sq.km/Y IC = 17.8 sq.km/Y		Erosion mainly on low land	Land area affected by erosion and accretion reduced Land area affected: RB = 15.1 sq.km LB = 4.8 sq. km IC = 12.9 sq.km		Land area affected by erosion and accretion reduced on the right and left banks only	Land area affected: RB = 11.8 sq.km LB = 4.2 sq.km IC = 17.8 sq.km

Table 7-1: Continuation

Line	Line Situation	Landscape Concerned	Environmental Process	Ratio	Data Origin	Calculation Formula for Assessing Impact per Year
1	Without any river training project	*Attached chars (A.C) RB + LB	Annual erosion	100m wide	FAP 1	0.1 x 236 km = 23.6 sq.km
2		Island Char (IC)	,,	0.02	23.6 sq.km ------------- R.B.+L.B. area	0.02 x 1.6 area = 17.8 sq.km
3		AC on RB*	,,	0.70	FAP 1	0.7 x 23.6 sq.km = 16.5 sq.km
4		AC on LB*	,,	-	FAP 1	23.6 - 16.5 = 7.1 sq.km
5	Scenarios 1 and 2	AC on RB	,,	0.12	16.5 sq.km ---------- RB area (see line 3)	0.12 x L.L./R.S.* = 15.1 sq.km
6		AC on LB	,,	0.007	7.1 sq.km --------- LB area (see line 4)	0.007 x L.L./L.B. = 4.8 sq.km
7		*IC	,,	0.02	15.1 + 4.8 ---------- LL/RB+LB (see lines 5 & 6)	0.02 x L.L./I.C. = 12.9 sq.km.
	Scenario 3	AC on RB	,,	0.12	Scenarios 1 and 2 (line 5)	0.12 x LBL/R.B. = 11.8 sq.km
		AC on LB	,,	0.007	Scenarios 1 and 2 (line 6)	0.007 x LBL/LB = 4.2 sq.km
		IC	,,	0.02	Scenarios 1 and 2 (line 7)	0.02 x IC = 17.8 sq. km

* RB = Right Bank; LB = Left Bank; LL = Low Land; AC = Attached Char; IC = Island Char; LBL = Low Bare Land

Table 7-2: Calculation process

On the other hand, part A of this annex has shown the limits of knowledge of the socio-economic and administrative features of the JAFP and the AFPM aspects in terms of their current and specific features. What to say then of the identification of the "WO" situation from the socio-economic and administrative viewpoints except that it is a perilous exercise. This is even more true of the assessment of alternative strategies, even provided they are clearly identified and interconnected with socio-economic and administrative dimensions. As a matter of fact so many other major issues and determining factors have been, are and will continue to be involved ("internally and externally"), such as:

- the overall demographic growth of the population with its cultural, economic and policy dimensions;
- the overall changes in development at regional and national level and in economic and social policy;
- the changes in the national education system and overall cultural changes;
- the changes in the state and political system at both national and central levels and in particular the progress of democracy and decentralization, and
- the rural development policy and in particular the side and back effects of future projects.

Nevertheless a first attempt at assessment has been made considering the maximum acceptable term of 60 years/3 generations, already mentioned above, and by comparing each scenario to a hypothetical "WO" situation.

Concerning the sizing/ranking system applied for the impact assessment, the -5/+5 scale system recommended in the FPCO guidelines for qualitative evaluation has been utilized.

Criteria and phenomena were marked either directly on a qualitative basis appreciation or through a quantitative approach, which anyhow, in the context of this study, remains of very relative precision and appears more as a qualitative marking tool whatever the criteria considered, and their approximate knowledge at this stage. A detailed explanation of the assessment and marking is given hereafter per item and component (Chapter 8).

Table 7-3 presents the overall qualitative scale utilized in terms of positive/negative impacts of a given effect and in terms of order of magnitude of the evolution of a given phenomenon.

Qualitative Scale	Assessment of an Impact/Effect Vis-a-Vis a Given Aspect	Order of Magnitude of a Changing Phenomenon or of a Former Evolution Trend
+5	Very positive	Very high increase
+4	Positive	Increase
+3	Mainly positive (balance of combined opposed effects)	Mainly increased (balance of combined opposed effects)
+2	Partly positive (balance of combined opposed effects)	Partly increased (balance of combined opposed effects)
+1	Slightly positive (minor positive effect identified)	Slightly increased (minor increase identified)
0	Neutral - no significant effect	Equivalent - unchanged
-1	Slightly negative (minor negative effect identified)	Slightly decreased (minor decrease identified)
-2	Partly negative (balance of combined opposed effects)	Partly decreased (balance of combined opposed effects)
-3	Mainly negative (balance of combined opposed effects)	Mainly decreased (balance of combined opposed effects)
-4	Negative	Decrease
-5	Very negative	Strong decrease

Table 7-3: Explanation table of the qualitative scale utilized for the assessment of social impacts and administrative issues (Comparison with "without project" situation)

8 PHYSICAL IMPACT ASSESSMENT

8.1 LAND USE

Assuming that the river is in dynamic equilibrium (between erosion and sedimentation) but with the same eroding capacity, the expected river training and water management strategies ought to change only the proportion between the landscape unit areas of the island chars and attached charland mixed with set-back lands inside the JAFP.

The new breakdown of the landscape units related to each river training scenario is shown in Table 8.1-1. The areas suitable for cultivation are calculated from the figures for land areas affected by erosion (Table 7-2). This calculation takes into account the resulting change of protected land availability (land area affected by erosion in the framework of scenarios 1 and 2, for example, minus land affected in the situation without project) in proportion to the present breakdown of the landscape units.

This tentative interpretation of the JAFP characteristics analysed in the FAP 1, FAP 25, FAP 3.1 studies, in terms of protected land availability, is used to illustrate approximately the planforms related to the anabranched and reduced width strategies supposing overall hydraulic conditions will not change. This assessment shows :

In the Case of Scenarios 1 and 2 (Anabranched Flood Channel)

1. an insignificant increase of areas suitable for cultivation on both island chars and attached chars and set-back lands (around 0.5%);
2. a stable situation on protected highlands and medium highlands (27,252 ha versus 27,138 ha);
3. a relative equilibrium between erosion and sedimentation on cultivated medium low lands and low lands. (59,546 ha, versus 59,246 ha), and
4. A little less emerging sand banks due to river training in the anabranched river.

In the Case of Scenario 3 (Braided River with Reduced Width)

1. progressive disappearance of mega-island chars (during the flood seasons);
2. greater accretion on the right and left banks (relatively more for middle low lands and low lands (62,092 ha) than for high land and middle high land (24,194 ha);
3. A stable situation on highlands;
4. a relative equilibrium between erosion and sedimentation on cultivated medium low lands and low lands;
5. a small increase of areas suitable for cultivation (around 6%), and
6. a little less emerging sand banks due to river training in the braided river with reduced width.

Location	Present Situation		Scenarios 1 and 2		Scenario 3	
	Total Area	Suitable for Cultivation	Total Area	Suitable for Cultivation	Total Area	Suitable for Cultivation
Island Chars	88,987	40,049	88,987	40,254	0(1)	
H.L/M.H.L		14,790		14,855		
M.L.L		20,364		20,466		
L. (Cultivated)		4,895		4,733		
L. (Non cultivable)	48,938	----	48,733			
Attached Chars and Set-back lands						
On Right Bank	14373	4517	14,373	4,646	41,069	23,185
H.L./M.H.L		163		182		3,749
M.L.L.		1,553		1,582		7,258
L (cultivated)		2,801		2,882		12,178
L (non cultivated)	9,856	---	9,727	---	17,884	
On Left Bank	102,482	41,818	102,482	41,898	164,773	68,101
HL/MHL		12,185		12,215		20,445
M.L.L		21,228		21,276		34,370
L (Cultivated)		8,405		8,407		13,286
L (non cultivated)	60,664	---	60,584		96,872	
Total emerged land	205,842		205842		205,842	

(1) This contrasted forecast linked to the Jamuna's eroding capacity does not mean there is no non cultivated low island in the main channel; but these bare lands emerge during the dry seasons and will move every year. So their area has been included in the figures concerning low land area (non cultivated) on the right or left bank.

Table 8.1-1: Protected land availability (ha)

8.2 FLOODING CONDITIONS

The features of the river that are of permanent interest in terms of agricultural productivity in the JAFP are :

- spatial and temporal varieties of sediment transport (already taken into consideration above in relation to land use change);
- a very moderate increase in the peak flooding levels but a more significant change in terms of flooding durations, which can affect cropping patterns and hence cropping intensity, and
- a modification concerning sedimentation forces, this feature being closely interrelated with variations in sediment transport related to each scenario, flooding duration

changes, and decision-making about short, medium and long-term management objectives. Knowledge of sedimentation process would allow predictions of future loamy and silty soil areas, which are more suitable to increase agricultural productivity.

Finally it is noted that the first two river training scenarios differ fundamentally from the third scenario.

An anabranched flood channel is a classic and rigorous stabilization process based on the complementation and consolidation of protection structures and its river's natural bends.

A braided river with reduced width seems to be a more artificial process producing a important modification in the river layout and an expected river response in deepening its bed. These modifications imply important changes in terms of sedimentation processes, which are for the moment difficult to forecast, but a decrease in the cropping intensity must probably be expected in the short and maybe medium terms before any improvement on the periodically flooded areas.

The results of the physical impact assessment underline, as shown by Table 8.2-1, better conditions in terms of agricultural land use possibilities in the case of scenarios 1 and 2.

Criteria (variable, qualitative characteristics, present trend)	Scenarios 1 and 2	Scenario 3
LAND USE		
Emerged Land Availability on:		
Island chars	+1	-4
Right bank	+1	+2
Left bank	+1	+3
FLOODING AND JAFP WATER RESOURCES		
Duration of flooding	-2	-3
level of flooding	-1	-2
Agronomic properties of deposits	+2	-2
Ground water resources	+1	+1

Table 8.2-1: Matrix of physical impacts

8.3 SOCIAL IMPACTS

The foreseeable social impacts are assessed in general terms on the basis of following guidelines:

- consideration of the present situation analysed in Part A as a starting point for a foreseeable/predictable "without project" situation by year 2050, taking into account both present structural factors in their static and dynamic dimensions and present changing phenomena and trends (this refers to the classic double diachronic/synchronic way of analysis in human sciences);
- consideration of present contrasted situations and evolution inside the JAFP, noticeably between char islands and set-back lands, and different social categories. Scenario projection of a consequent series of comparison pairs, and
- assessment of the social dimensions and consequences of physical impacts assessed above (Sections 8.1 and 8.2).

On the whole, the assessment and tentative projection of a given phenomenon or criterion was done considering as far as possible each scenario itself, mainly inside the JAFP or better, say, in the riverine areas and social groups, without considering any other external factor involved. For each criterion representing each component of each item, a specific approach had to be adopted upon the methodological basis defined above (Chapter 7), applying the most efficient guideline(s), and considering sometimes both "inside and outside" effects (for setback land particular), and direct and indirect impacts as well. In addition for each criterion a specific identification of what the "WO" project situation could be had to be reiterated.

The results of the Social Assessment based on the main components mentioned above (Chapter 7) are shown in Table 8.3-1 below and more detailed explanations of the assessment per component are given after wards. In totalling simply the marks of the seven components without any relative weighting, scenarios 1 and 2 would appear positive (+3) and Scenario 3 negative (-5) in terms of the social components considered and composing criterion (a criterion may be a quantitative variable, a qualitative characteristic, a trend etc.).

	Scenarios 1 and 2	Scenario 3
Social Components		
- Socio-demographic trend	0	-2
- Social and cultural changes at household and family level	+1	-2
- Social equality	+1	-2
- Social cohesion	0	-3
- Lifestyle conditions	+1	+2
- People's security and population displacement	+2	+2
- Conditions of land acquisition and land re-allocation	-2	+0
Total (-35/+35)	+3	-5
The Component "Socio-demographic Trends" was assessed according to the following criterion. Their marking and main explanations if needed are in brackets		
o Population density (total JAFP)	+1	-2
- sub-criterion density set-back land + neighbouring land	-1	+1
- sub-criterion density char island	+2	-5
o Conditions of limitation of natural population growth in the JAFP (Access to family planning services)	0	+1
o Population sex structure (more female-headed households & male migration with displacements from char islands to set back lands)	0	-1
Out-migration(compared to increase trend from present situation)	-2	-4
Total (-5/+5)	0	-2
Component "Social and Cultural Change at Household and Family Level		
o Household/family destructuring	0	-2
- sub-criterion char islands (compared evolution of present trend)	-1	-5
- Sub-criterion set-back land dwellers (Better control of char island migration conditions)	+1	+1
o Women's Situation	+1	-2
- Sub-criterion char islands (homestead and lifestyle conditions)	+1	-3
- Set-back lands (under-employment and economic responsibilities of women)	0	-1
o Evolution of other traditional anthropological structures: *bansha, gusthi,* Kinship system (destruction is considered negative in terms of loss of solidarity, social cohesion and without any efficient alternative cultural mode, at least economically speaking)	+1	-2
- Sub-criterion : Char Island	+2	-2
- Sub-criterion : Set-back lands	0	-1
Total -5/+5	+2	-2

Table 8.3-1: Matrix of social impacts

	Scenarios 1 and 2	Scenario 3
Component "Social Equality" (income distribution, social mobility, economic equilibrium and stability between social categories, social "compartmentalization" etc.)		
o Income distribution (in relation to population displacement and increase in population density, see part A)	0	-3
- Char Islands	0	-4
- Set-back lands	0	-2
o Landlessness and Joblessness increase	+2	-1
- Char Islands	+2	-5
- Set-back lands	+1	+3
o Employment availability	+1	-3
- Char Islands	+1	-4
- Set-back lands	+1	-1
o Conditions of other social categories (improvement is considered negative for ruling categories and on the contrary positive for ruled categories)	0	-2
- Small farmers (Landownership and land holding considerations)	0	-2
- Local landlords	-2	-4
- Share croppers	0	-3
- Agricultural wage labourers	+1	-2
- Traders/merchants (large)	+1	-2
- Craftsmen and minor service workers and shop tenants	0	+2
- local leaders and notables (village elders, UC members, politicians, religious leaders, etc.)		
* Char Islands	+2	-4
* Set-back lands	+4	-3
Total -5/+5	+1	-2
Component "Social Cohesion"		
o Disrupting effects of population changes and displacement (Meta-social destructuring between solidarity groups and categories, conflicts, loss of social consensus, social tension and competition between rulers and notables, youth protest, etc.)	-1	-3
o Ideological risks v.a.v democracy and people's participation and responsibilities (related to social presence versus natural resources and employment availability and poverty and inequality)	0	-3
o Improvement education (access to education facilities and mass motivation)	-2	+2
o Loss of cultural identity and heritage (social minorities of char islands and village communities on set-back lands)	+3	-5
o Traditional adaptation and self-sufficiency vis a vis river bank erosion control, and potential for people's participation in AFPM measures	-1	-4
Total -5/+5	0	-3

Table 8.3-1: Continuation

	Scenarios 1 and 2	Scenario 3
Component "Lifestyle Conditions"		
o Housing conditions (safety, stability, quality)	+2	-1
- Char Islands	+4	-4
- Set-back lands	0	+3
o Needs and conditions for flood proofing measures	0	+2
- Char Islands	+2	n. a.
- Set-back lands	-2	+2
o Water Supply conditions (flood control in the inhabited areas)	+2	+2
- Char Islands	+2	n. a.
- Set-back lands	0	+2
o Disease prevention (ecological conditions and natural vectors : flooding conditions, (landscapes)	+1	+2
- Char islands	+2	h.a.
- Set-back lands	0	+2
o Access to health-care services	+1	+3
- Char Islands	+1	+4
- Set-back lands	0	+1
o Access to social and relief services in case of need	+1	+3
- Char Islands	+1	n.a.
- Set-back lands	0	+3
o Consumer prices and food supply and goods availability	+1	+2
- Char Islands	+1	+2
- Set-back lands	0	+1
Total -5/+5	+1	+2
Component "People's Safety and Population Displacement"		
o Risk conditions vis a vis living on char Islands	+4	-5
o Risk conditions vis a vis living on set-back lands (attached chars included)	-3	+4
o Implementation of an awareness system (riverbank erosion and floods in the JAFP)	+2	+4
o Planning possibilities for population displacements	+3	+5
Total -5/+5	+2	+2
Component " Conditions of land acquisition and land re-allocation		
o Land acquisition (works, structural and recurrent measures)	-1	+3
- Char Islands	-2	n.a
- Set-back lands	0	+3
o Disturbance in the land price system	-2	-2
- Char islands	-3	n.a
- Set-back lands	-0	-2
o Conditions of land re-allocation (land availability, new accessions of *khas* lands etc.	-3	-1
- Char islands	-3	-5
- Set-back lands	0	+3
Total -5/+5	-2	+0

Table 8.3-1: Continuation

8.4 AGRICULTURAL ACTIVITIES AND ECONOMY

Factors that describe agricultural activities and the agricultural economy are a composite of numerous interrelated and non-related items. On the one hand, these factors represent a catch-all group, since they include factors not directly associated with the physical environment (such as conditions for technological change, off-farm employment opportunities, and draught animal and milk cow numbers. On the other hand, these factors form the most descriptive group of human and physical relationships and interactions (such as diversifications and cropping intensity).

8.4.1 Evolution of Farming Systems

Table 8-4 provides a general list of agro-economic factors allowing a comparison of scenarios 1 and 2 with scenario 3 and an assessment of agricultural production value, including both field and homestead productions. Sources of assessment for agro-economic factors are the physical data analysed in Sections 8.1 and 8.2 above and aggregate data and information given in Tables 7-2, 7-3 and 8.1-1.

Table 8-4 shows changes than may occur in agricultural activities.

In order to draw up Table 8.4-1, a prior quantification was made to give a relative rating of the changes resulting from each scenario under consideration with respect to agricultural productions (i.e. cultivated areas, cropping intensity, value added, on-farm employment).

This quantification is given in terms of areas suitable for cultivation in each landscape unit on the island chars on the one hand, and the attached chars and set-back land, on the other hand. By cross-checking this quantitative information (see Table 8.4-2) with cropping intensity and flooding conditions it is possible to obtain a qualitative assessment of cropping diversifications.

As far as conditions for technological change are concerned, the following factors were taken into consideration:

- changes concerning agricultural productivity (gross value added);
- risks for agricultural investment (enlargement of protected agricultural areas), and
- conditions in terms of communication and access to support services.

Agricultural Activities		
	Scenarios 1 and 2	Scenario 3
- Farming System	+1	-5
• Agricultural production on Island chars	+2	-5
. Conditions for technological change	+1	-5
. Diversification	+1	-5
. Cropping intensity		
• Livestock on island chars	+1	-5
. Draught animals	+1	-5
. Milk cows	+1	-5
. Others	+1	-5
• Agricultural production on attached charlands and set-back lands	+1	0
. Conditions for technological change	+3	+2
. Diversification	+2	-1
. Cropping intensity	+2	-1
• Livestock on attached charlands and set-back lands	+1	+2
. Draught animals	+1	+2
. Milk cows	+2	+3
. Others	+1	+1
• Fishery	0	-3
- Agricultural HH Employment		
• On island chars	+1	-5
. On-farm employment	+1	-5
. Off-farm employment	+1	-5
• On attached chars and set-back land	+2	0
. Farm employment	+2	+2
. Off-farm employment needed	+1	-2
Total -35/+35	+7	-16

Table 8.4-1: Agro-economic impact matrix

In terms of quantitative information, Table 8.4-2 below gives a rough assessment of the production value and employment related to each scenario in the island and attached chars mixed with the set-back lands.

Situation	Cultivated Areas (1000 ha)	Cropping Intensity (percent)	Gross Value Added (Tk 1000,000)	On Farm Employment (1000.000 man x days)
- Present situation				
Island chars	40.0	160	346.1	7.3
attached chars[(1)]	46.4	175	436.4	8.4
- Scenarios 1 and 2				
Island chars	42.1	170	386	7.7
attached chars	47.3	185	471	8.6
- Scenario 3				
Island chars	0	0	0	0
attached chars	98.8	160	849.5	17.9

(1) Attached chars mixed with set-back lands

Table 8.4-2: Production value and employment

8.4.2 Changes in the Livestock System

The links between farming and livestock systems are well known. Important aspects include:

- the production of organic matter;
- between 50% and 100% of all nutrients are supplied by cow *dung* in the Charlands;
- livestock is an essential source of milk, leather etc. and a converter of weeds, grasses, crop residues, tree leaves etc. into more readily available forms of energy;
- the ownership of milk cows declines with the increase of distance from markets for milk, and
- a strong relationship exists between the specific ecological conditions of the charlands (soil, climate, etc.), and the mix of livestock and crop species in landscape conditions (percentage of non-cultivated area with herbaceous fallow and cultivated areas).

By aggregating all these quantitative and qualitative factors for each category of livestock in the framework of the island chars on the one hand and the attached chars and set-back lands on the other hand, the relative rating shown in Table 8.4-1 is obtained.

As far as quantitative factors are concerned, the figures concerning value added and non-cultivated areas are given Table 8.4-3.

Situation	Non-cultivated Areas (1000 ha)	Gross Value Added (Tk 1000,000)
- Present Situation		
• Island chars	49	
• Attached chars	70.5	50
		49.5
- Scenarios 1 and 2		
• Island chars	46.9	50.5
• Attached chars	69.6	49.7
- Scenario 3		
• Island chars	0	0
• Attached chars	107.1	94.4

Table 8.4-3: Value added and non-cultivated areas

8.4.3 Fishery

Fish production is probably over-evaluated in the framework of the assessment of the present situation. It shows that fish is scarce for local consumption. The project aiming at a braided river with reduced width (scenario 3) will particularly affect fish production in the Jamuna river.

Hence, reference is made to ANNEX 8 for more thorough considerations to assess the impact on fishery.

Provisionally some qualitative factors are taken into account in the rating shown in Table 8-4.

8.4.4 Agricultural Household Employment

Table 8.4-2 gives a theoretical assessment of charland on-farm employment related to the cropping pattern used both in the present situation and in scenarios 1, 2 and 3.

It is from these figures that the rating shown in Table 8.4-1 has been obtained. As far as off-farm employment is concerned, the following factors were taken into account:

- displacement of population from eroded highland areas;
- access to the mainland, and
- decrease in the average per capita income.

Aggregating these qualitative components we obtain a rating in favour of scenarios 1 and 2 because in these cases there will be less population displaced, no important change in terms of access to the main land but an average increase of per capita income versus a large displaced population; in the case of scenario 3, there will be better access to the main land but a decrease of the average per capita income.

On the whole it appears that, from the sole agro-economic point of view, the scenarios 1 and 2 project seems to be better as regards expected effects inside the JAFP, though differences with the present situation are not very important in the case of some factors.

8.4.5 Protection of the Embankment

Table 8.4-4 below gives a qualitative assessment of the relative conditions expected in the case of scenarios 1, 2 and 3. This information must be compared with the relative cost assessment of each strategy.

	Scenarios 1 and 2	Scenario 3
Protection Conditions of the Embankments	+3	+5
• Protection of the existing right bank embankment (present threatened points and bends)	+5	+5
• Additional protection in possible future threatened points, and distance constraint from the bankline for necessary new sections (right bank)	+3	+5
• Protection of the existing left bank embankment (sections to be rehabilitated, threatened points)	+5	+5
• Distance constraint for future new left bank embankment	+3	+5
• Additional new protected lands on main land side of future new embankments (Both sides of the river)	-2	+3

Table 8.4-4: Assessment on embankment conditions

8.5 ADMINISTRATIVE AND ORGANIZATIONAL ISSUES

The assessment of the administrative and organization aspects of each scenario has been conducted in respect with the same principles as explained before for the social assessment. The results of the administrative and organization assessment based on the seven main components already mentioned before (Chapter 7) are shown in Table 8.5-1 below including the needed explanations per component. After sum-up of components marks again without any over or under-weighing to one on another Scenarios 1 and 2 would appear with less constraints and needs than Scenario 3 vis a vis administrative and organization issues with respectively a total of -4 and -14.

Components/Criteria	Scenarios 1 and 2	Scenario 3
- Needs of institutional strengthening at MIWDFC's level : BWDB, WARPO, RRI and JRC for leading River training/AfPM strategy and pilot projects (additional strengthening needs and constrains are marked negatively)	-3	-4
o Central Level	-3	-3
o Regional and local level	-3	-5
- Need of new specific institutions (IRMI etc...) and organization system for River Training/ AFPM	-2	-4
- Conditions of people participation to R.T. projects and AFPM	+2	-2
o Char islanders (see social impacts)	+3	-5
o Set-back land dwellers (see social impacts)	0	+2
- Conditions of local authorities and institutions involvement (see social impacts)	+2	+1
o Char Islands	+3	n.a
o Set-back lands	0	+1
- Condition of local technical services involvement (GEB, IWTA, other technical services....) in engineering works supervision and monitoring...	-2	-4
o Engineering and works supervising (need of strengthening)	-2	-4
o Information system and permanent follow-up and O&M vis a vis new technologies	n.a	-4
o O&M vis a vis classical technologies	-2	n.a
- Operating conditions for agricultural services (access to land, and people motivation and technical possibilities)	+1	+2
- Side needs of public investment at local level for rural employment (additional need = negative marking)	-2	-3
Total -35/+35	-4	-14

Table 8.5-1: Matrix of administrative and organization issues

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9 OVERALL SYNTHESIS

From the detailed analysis carried-out above and putting in parallel the four main impact items partly determined by the physical impact components (see Chapter 7) it comes the following synthesis matrix.

Main Item	Scenarios 1 and 2	Scenario 3
- Social features (-35/+35)	+3	-5
- Agricultural activities and economy (-35/+35)	+7	-16
- Administrative and organizational issues (-35/+35)	-4	-14
- Protection conditions of the embankments (-25/+25)	+3	+5
Total (-165/+165) (-10/+10)	+20 +1.2	-12 -0.7

Table 9-1: Synthesis matrix of the socio-economic and administrative assessment

However a warning of paramount importance has to be given concerning the above socio-economic and organisational/administrative assessments. Besides the uncertainty and imprecision of knowledge at many levels it must be recalled that such multicriterion qualitative analysis is of course subjective and partly empirical. The a-priori number of different items/components/criteria considered and their marking system imply arbitrary decisions and implicit ideological and policy options. A-posteriori summing-up and over/under-weighting of items/components/criteria are even more of an a-priori decision-making system. The results of the assessment given above are to be considered as "expert advice" without any a-posteriori over or under-weighting of the assessment components. This has to be incorporated into the overall assessment approach in parallel with other technical, environmental and economic aspects, the general aim being to assist in decision-making

The contrasted scenario method was a practical means of analysis for the socio-economic and administrative assessment. From that, intermediate scenarios could be built combining alternative options and measures, geographically and socio-politically, based on appropriate items/components criteria and a marking system.

10 RECOMMENDATIONS FOR FURTHER STUDIES AND INVESTIGATIONS

After the socio-economic and administrative assessment, and provided RT/AFPM pilot actions and measures are decided in the form of a consolidated strategy (i.e. identified for the long term), the following recommendations are made for possible further stages of feasibility/design studies and implementation of a FAP 22 pilot project.

(i) **Before selection of sites and sizing for pilot and test measures:** (low cost recurrent measures and pilot channel cut-off): it is recommended to take into account specific socio-economic and administrative features, potential and constraints at local and grassroots level (Specific detailed studies based on field work, including land use, cropping patterns and agricultural engineering aspects). Interviews will be needed for this.

(ii) **After selection of pilot project sites:** it will be necessary to carry out detailed and localized impact studies, using a multidisciplinary approach for each site, including a comprehensive analysis of the present situation and of the "WO" project situation as well, impact assessment and identification of compensatory measures. These will need, among other things, substantial field work and interviews. (References for TOR: FPCO guidelines and present assessment report for the socio-economic and administrative aspects). The following matters will have to be considered in particular:

- Identification of critical factors (such as high density of population, social and cultural changes etc.);
- Prediction of changes in socio-economic factors (for example cropping intensity, fishery production etc.), and
- Analysis of implication of changes, the final step in prediction and assessment of impacts on the socio-economic environment being an analysis of the implications of the changes for each of the socio-economic factors, considering both "without" and "with" project conditions. This may involve adjusting the project.

(iii) **During pilot project implementation:**

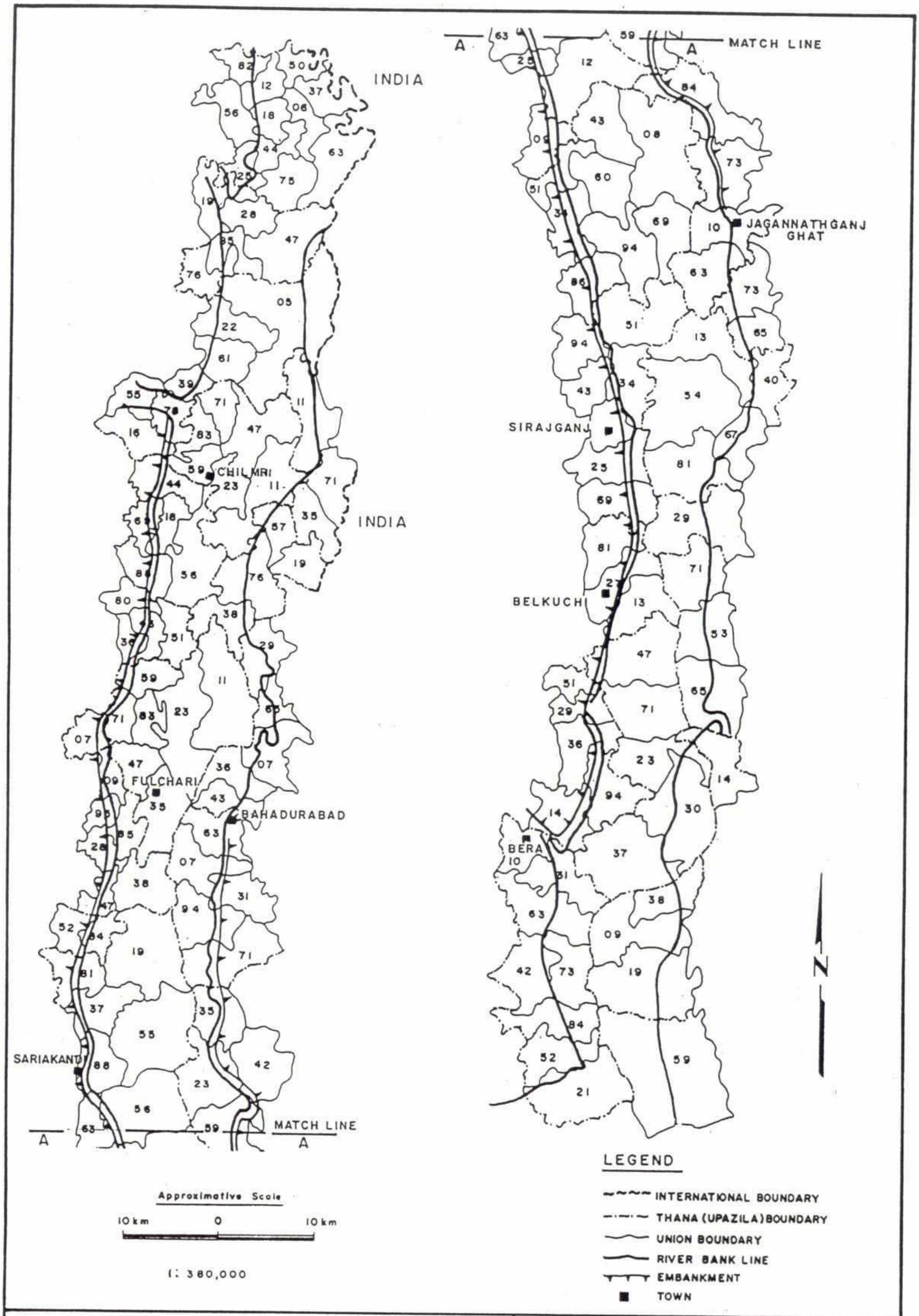
- Action-studies at grassroots level concerning different items/subjects such as, for instance;
  * people's participation and test-organization for new fields of social solidarity,
  * physico-chemical analysis of the new accretion soils, and
  * daily labour employment related to pilot project implementation.

- Experimentation with local institutions in real conditions (size and time) related to people's participation, local authorities and technical service involvement;
- Consequent organized training programmes at the level of every social actor concerned/involved, and

- Organization of a permanent follow-up system including management, technical, socio-institutional and economic aspects, with monitoring and evaluation, external auditing and subject matter "observatories" of technological, social and economic changes.

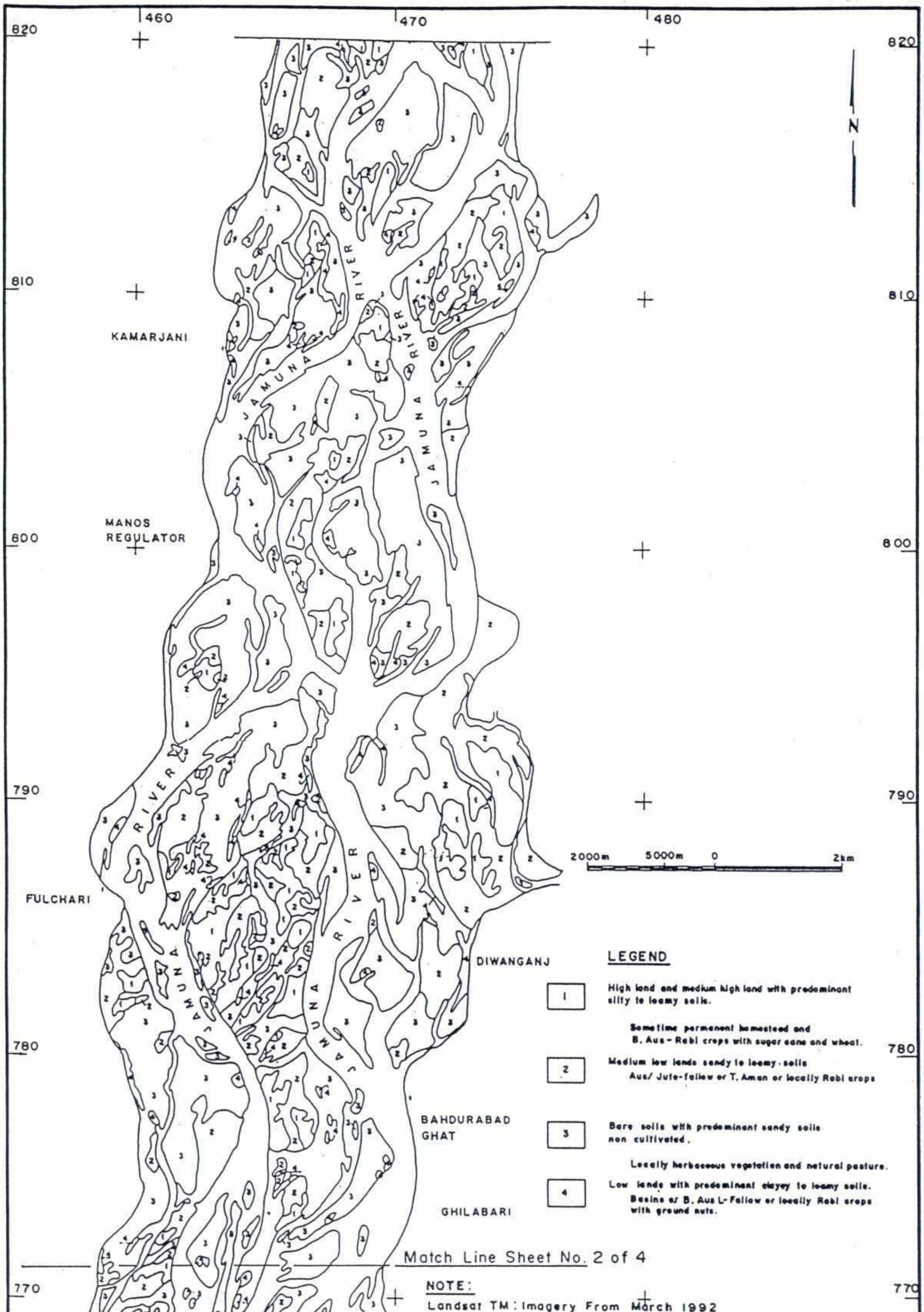
(iv) **Further general recommendations include:**

- Historical research programme focussed on the social history of the Jamuna River through the involvement of national and foreign universities and specialized research institutes, and
- Farming system research covering all the agro-ecological conditions of charlands, in order to undertake an adapted programme related to more integrated farm systems, including livestock, fishery, homestead production, employment of female labour, water management through a National Coordinated Cropping Systems Research Programme (NCCSRP).

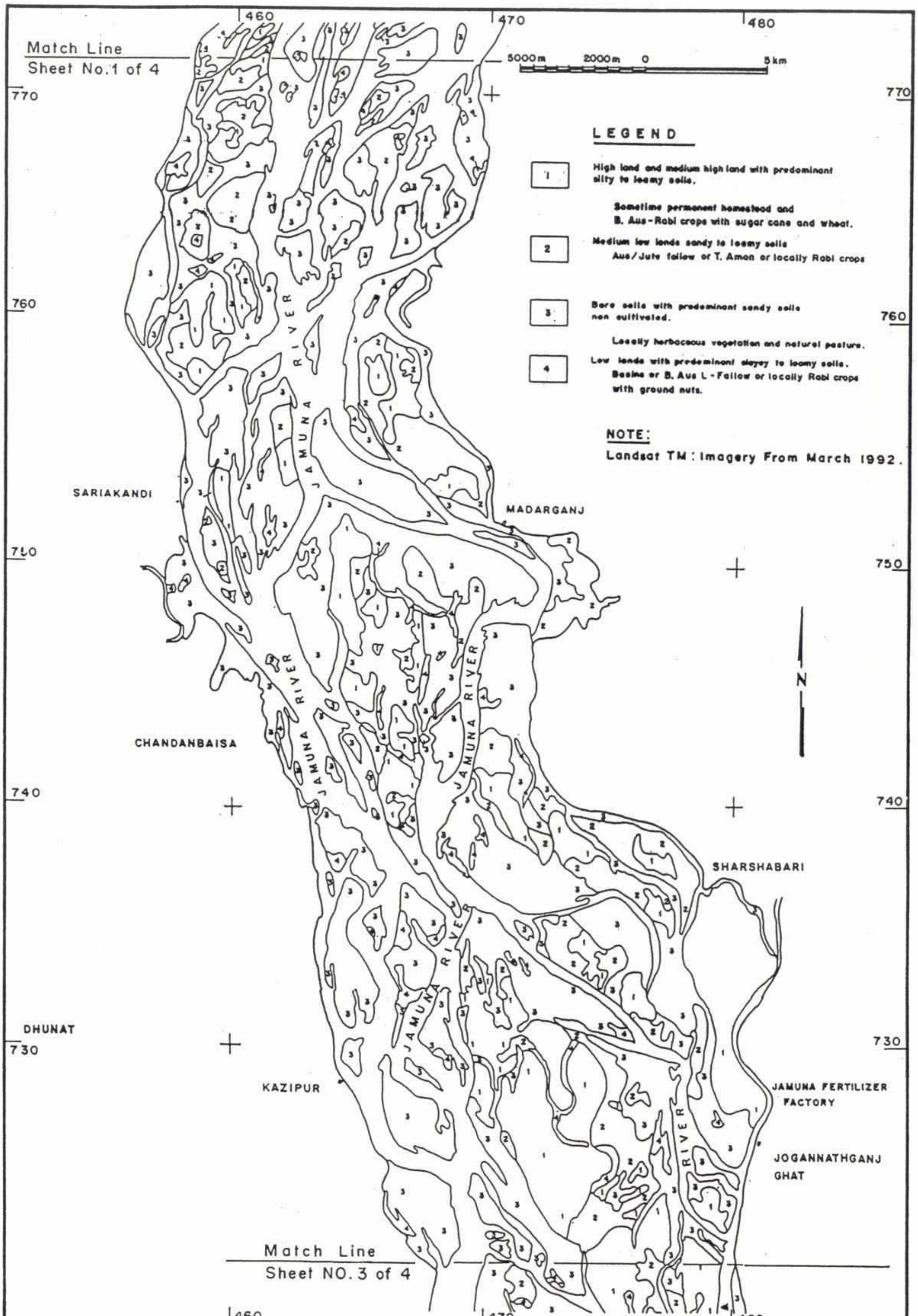


THE JAMUNA ACTIVE FLOOD PLAIN (JAFP) AND THE ADMINISTRATIVE SET-UP

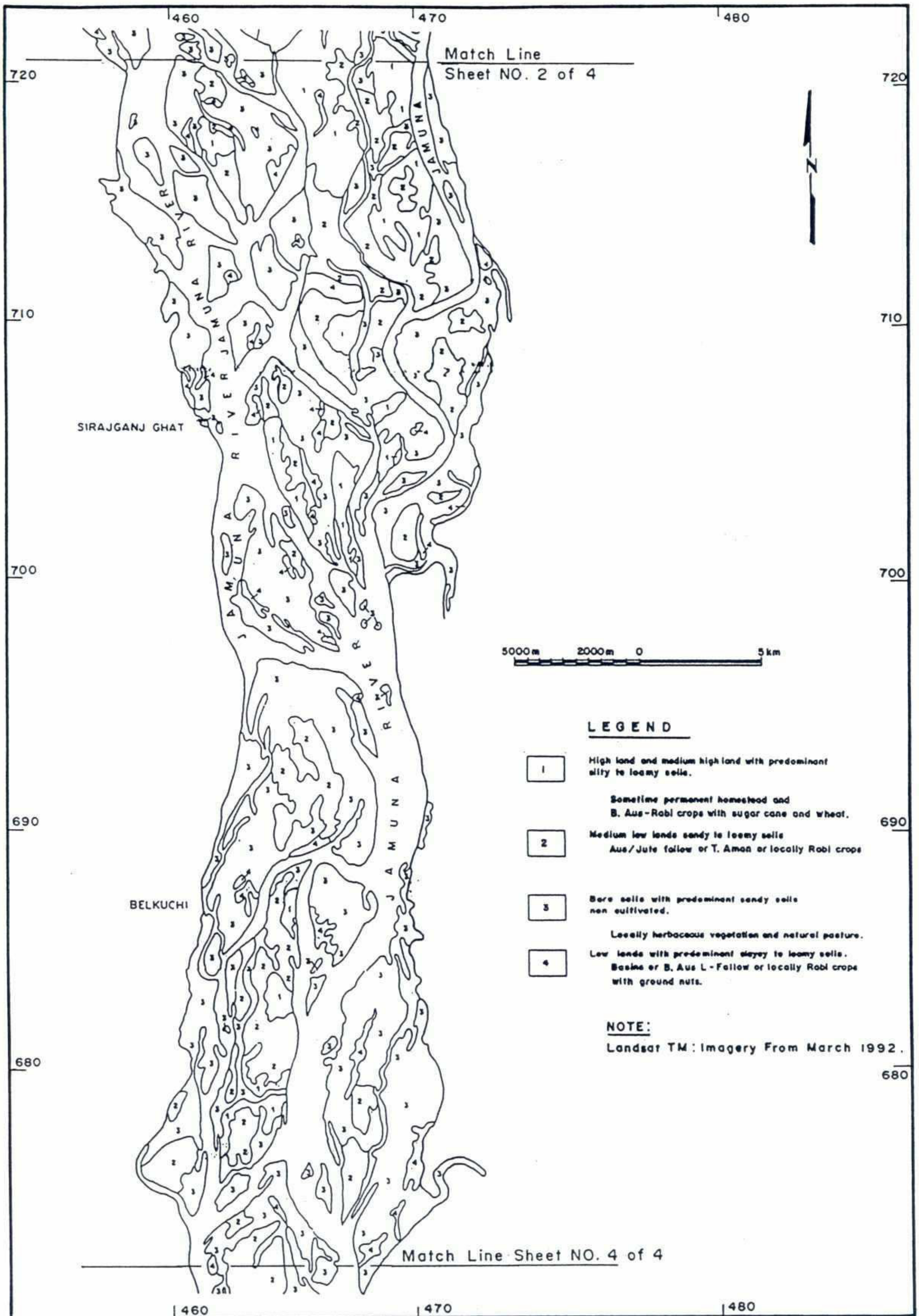
FAP - 21/22	
BANK PROTECTION AND RIVER TRAINING / (AFPM) PILOT PROJECT	
FINAL REPORT	FIG. A.7 -1



LAND SCAPE UNITS AND LAND USE SHEET NO. 1 of 4	FAP – 21/22 BANK PROTECTION AND RIVER TRAINING/ (AFPM) PILOT PROJECT	
	FINAL REPORT	FIG. A.7 – 2



LAND SCAPE UNITS AND LAND USE SHEET NO. 2 of 4	FAP – 21/22 BANK PROTECTION AND RIVER TRAINING / (AFPM) PILOT PROJECT
	FINAL REPORT — FIG. A.7 – 2



LAND SCAPE UNITS AND LAND USE SHEET NO. 3 of 4	FAP – 21/22 BANK PROTECTION AND RIVER TRAINING/ (AFPM) PILOT PROJECT
	FINAL REPORT — FIG. A.7 – 2

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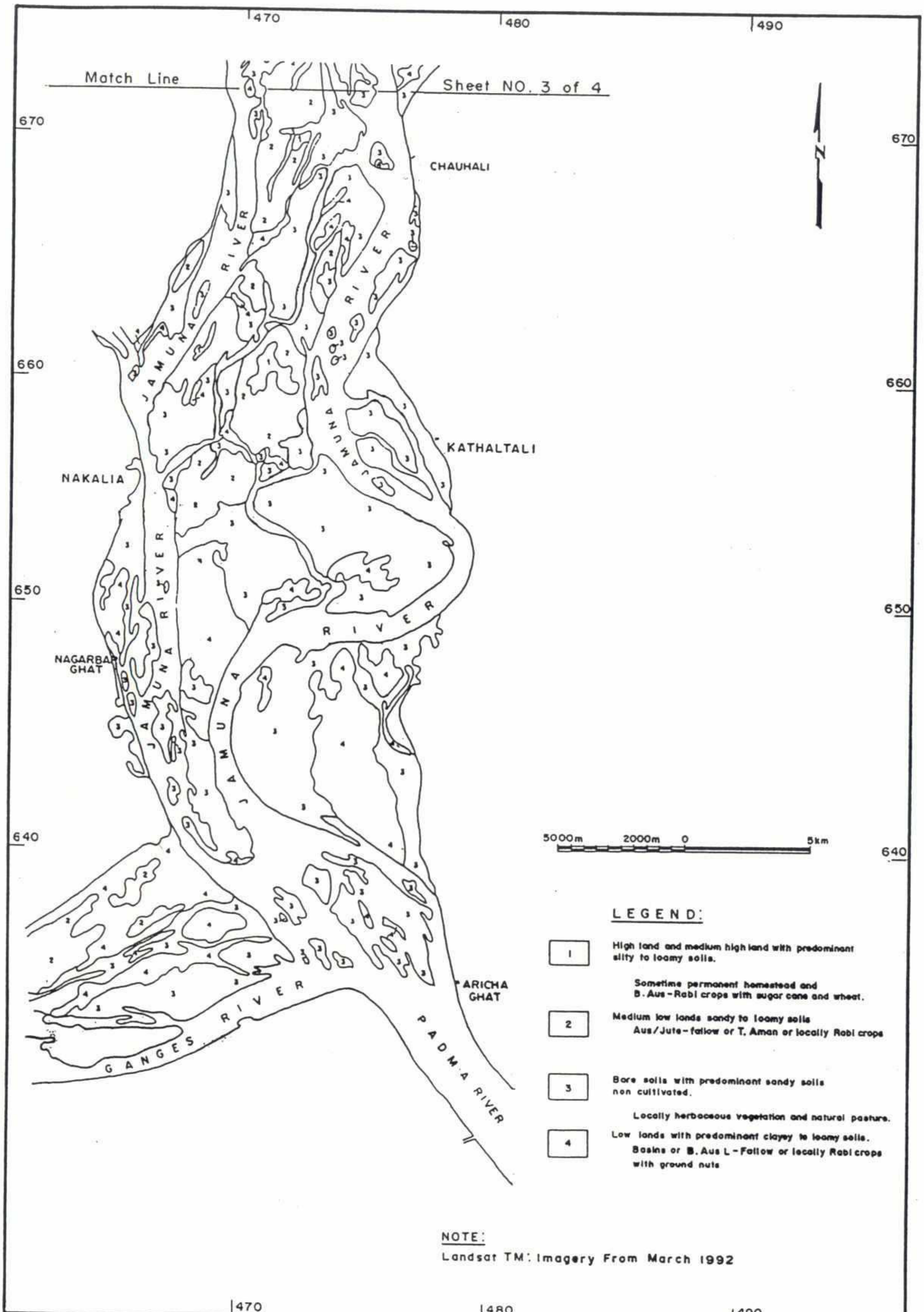
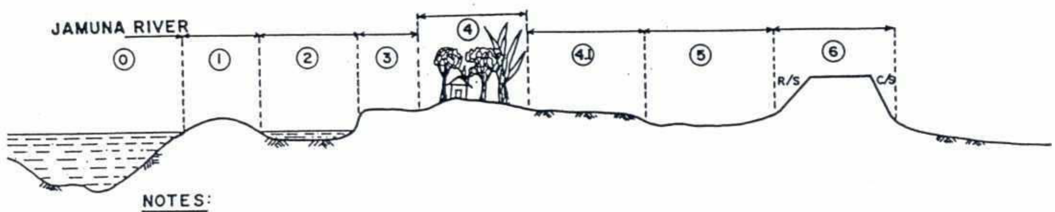


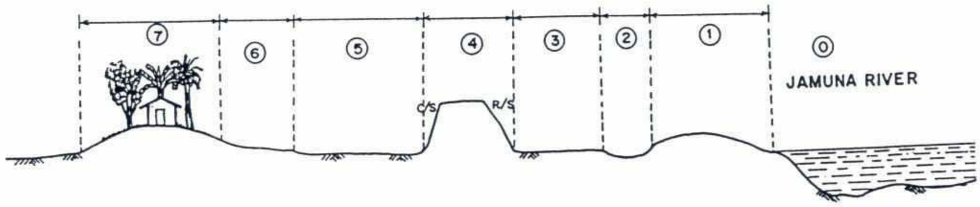
LAND SCAPE UNITS AND LAND USE SHEET NO. 4 of 4	FAP - 21/22 BANK PROTECTION AND RIVER TRAINING/ (AFPM) PILOT PROJECT	
	FINAL REPORT	FIG. A.7 - 2



NOTES:

- 0 JAMUNA RIVER
- 1 ATTACHED CHAR
- 2 ATTACHED LOW LANDS WITH SILTATION PHENOMENA
- 3 INTERMEDIARY RIDGE LANDS WITH EROSION PHENOMENA
- 4 RIDGE LANDS WITH HOUSE LOTS AND FRUITS TREES
- 4.1 INTERMEDIARY RIDGE LANDS
- 5 LOW LANDS WITH PADDY CROPS
- 6 EMBANKMENT

LEFT BANK ATTACHED CHAR AND
SET-BACK LAND (BAHADURABAD SITE)

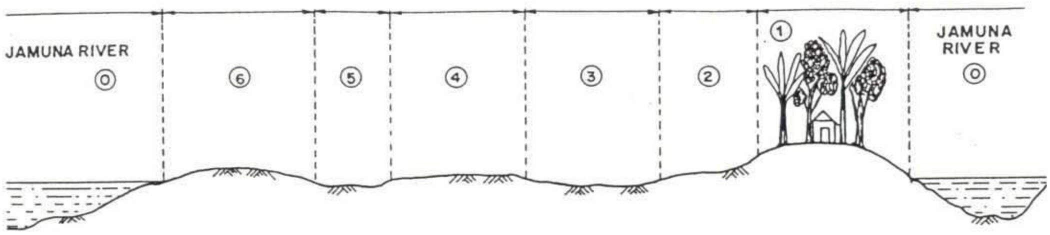


NOTES:

- 0 JAMUNA RIVER.
- 1 ATTACHED CHAR.
- 2 ATTACHED LOW LANDS WITH SILTATION PHENOMENA.
- 3 NOT PROTECTED ACTIVE FLOOD PLAIN.
- 4 EMBANKMENT.
- 5 PROTECTED LOW LANDS WITH PADDY CROPS.
- 6 INTERMEDIARY RIDGE LANDS.
- 7 RIDGE LANDS WITH HOUSE LOTS AND FRUIT TREES.

RIGHT BANK ATTACHED CHAR AND
SET-BACK LAND (KAMARJANI SITE)

AGRO ECOLOGICAL UNITS SHEET NO. 1 of 2	FAP – 21/22 BANK PROTECTION AND RIVER TRAINING/ (AFPM) PILOT PROJECT
	FINAL REPORT | FIG. A.7 – 3



NOTES:

⓪ JAMUNA RIVER

① HOUSE LOTS AND FRUIT TREES (HIGH LAND)

② INTERMEDIARY MEDIUM HIGH LAND

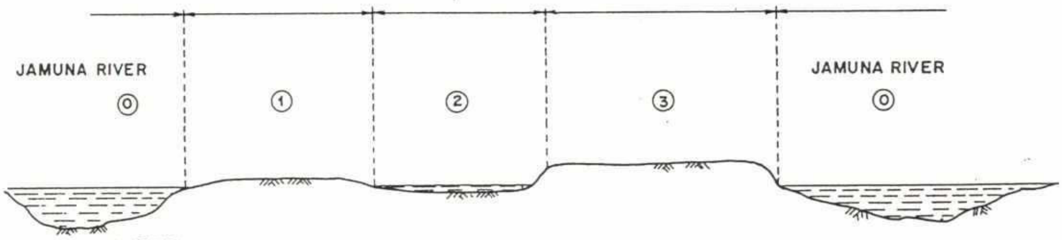
③ MEDIUM LOW LANDS WITH SILTATION PHENOMENA

④ RIDGE LANDS WITH EROSION AND SANDY DEPOSITS PHENOMENA

⑤ LOW LANDS WITH PADDY CROPS

⑥ SANDY LEVEE

MEGA ISLAND CHAR
(TYPICAL EXAMPLE)



NOTES:

⓪ JAMUNA RIVER

① PREDOMINANTLY SANDY SOIL LEVEE

② LOW LANDS WITH SILTATION PHENOMENA

③ MIDDLE LOW LANDS

LOW ISLAND CHAR
(TYPICAL EXAMPLE)

AGRO ECOLOGICAL UNITS SHEET NO. 2 of 2	FAP – 21/22 BANK PROTECTION AND RIVER TRAINING/ (AFPM) PILOT PROJECT	
	FINAL REPORT	FIG. A.7-3

Dist. Kurigram Thana Nageswari Unions:	Acres	Household (1981)	Population (1981)	No. of Mouzas	Density of Population (1981) (per km²)	District Wise Annual Grouth Rate (AGR)	Projected Population (1991)
Narayanpur (63)	13575	2073	11392	11	207		
Noonkhawa (75)	8807	1714	9157	6	257		
Kaliganj (44)	5291	2227	12123	3	566		
Bhitarband (25)	4537	2470	13763	8	749		
Nageshwari (56)	8697	4970	30531	8	867		
Kachakata (37)	6526	2612	13988	3	529		
Kedor (50)	6236	2708	16423	5	650		
Raiganj (82)	5560	2681	15303	4	680		
Ballaverkhas (06)	8226	2623	16420	6	493		
Bamandanga (12)	5208	1850	10791	6	512		
Sub-total	72663	25928	149891	60	509	1.77	178638
Thana Ulipur (94) Unions:							
Begumganj (05)	36301	3997	24850	20	169		
Burabari (22)	9833	3680	20067	14	504		
Hatia (61)	7571	3930	19808	10	642		
Dhameswari (39)	4363	3487	18029	10	1021		
Tabakpur (78)	6146	4595	24792	11	996		
Bazra (16)	8768	4276	24212	10	682		
Gunaigacha (55)	7178	4248	24758	19	852		
Sub-total	80160	28213	156516	94	482	1.77	186533
Thana Raumari Unions:							
Bandaber (11)	14680	4997	31777	10	535		
Raumari (71)	8992	4331	25602	4	703		
Jadurchar (35)	8671	3246	19131	19	545		
Sub-total	32343	12574	76510	19	584	1.77	91183
Dist. Kurigram Thana Kurigram Unions:							
Jatrapur (47)	17008	2105	12465	9	181		
Ghogadaha (28)	6705	3051	16000	7	589		
Panchgachhi (85)	5963	2663	16689	5	691		
Mogal Bachha (76)	7961	2004	10813	8	335		
Bhogdanga (19)	9236	4519	25990	7	695		
Sub-total	46873	14342	81957	36	432	1.77	97675

Table A.7-1: Identification of the envelope administrative area of the JAFP

Dist. Kurigram Thana Chilmari Unions:	Acres	Household (1981)	Population (1981)	No. of Mouzas	Density of Population (1981) (per km²)	District Wise Annual Grouth Rate (AGR)	Projected Population (1991)
Nayarhat (47)	12845	1212	6900	10	133		
Chilmari (23)	6654	791	4128	10	153		
Ashtamarchar (11)	18528	2433	14752	22	197		
Ramna (59)	5161	4416	22716	4	1087		
Thanahat (83)	6020	4477	23916	7	981		
Raniganj (71)	6381	3168	16690	5	646		
Sub-total	55589	16497	89102	58	396	1.77	106190
Thana Char Rajibpur Unions:							
Kodail kati (57)	6199	2035	12576	4	501		
Char Rajibpur (19)	7739	3690	22584	5	721		
Mahanganj (76)	13499	3117	19002	17	348		
Kamarjani (38)	7734	1435	9237	8	295		
Sub-total	35171	10277	63399	34	445	1.77	75557
Dist. Rangpur Thana Sundarganj Unions:							
Kapasia (56)	14792	2211	12999	7	217		
Chandipur (18)	5338	4226	22145	3	1025		
Haripur (44)	8937	3548	17352	11	480		
Shantiram (69)	5075	3242	19972	4	972		
Sripur (88)	7442	4569	25004	6	830		
Sub-total	41584	17796	97472	31	579	2.13	120341
Dist. Gaibandha Thana Gaibandha Unions:							
Kamarjani (51)	7935	2140	10307	12	321		
Gidari (43)	5880	4151	23022	7	967		
Malibari (80)	5118	3308	17932	5	865		
Ghagoa (36)	3950	2454	12652	3	791		
Badiakhali (07)	5748	3442	17983	10	773		
Sub-total	28631	15495	81896	37	706	1.65	96458
Thana Phulchari Unions:							
Erendabari (11)	21952	3697	22646	16	254		
Fazlupur (23)	17021	2364	15565	18	226		
Phulchari (35)	12244	1966	11803	15	238		
Gazaria (47)	7111	3042	17201	8	597		
Kanchipara (59)	6610	3919	21030	13	786		
Uria (83)	5835	2334	13086	4	554		
Udakhali (71)	4973	2726	14851	6	738		
Sub-total	75746	20048	116182	80	379	1.65	136839

Table A.7-1: Continuation

Dist. Gaibandha Thana Sughatta Unions:	Acres	Household (1981)	Population (1981)	No. of Mouzas	Density of Population (1981) (per km^2)	District Wise Annual Grouth Rate (AGR)	Projected Population (1991)
Haldia (38)	11566	2725	17159	13	366		
Sughatta (85)	6019	3380	17084	12	701		
Bharatkhali (09)	3521	2736	14146	8	992		
Saguna (95)	3646	2650	13655	10	925		
Ghuridaha (28)	5148	2863	16182	10	776		
Jummerbari (47)	4476	3350	17685	16	976		
Sub-total	34376	17704	95911	69	689	1.65	112965
Dist. Bogra Thana Sonatola Unions:							
Tekani	3916	2136	11345	11	716		
Chukainagar(84)	3796	2251	12843	11	836		
Madhupur (52)							
Sub-total	7712	4387	24188	22	775	1.98	29427
Thana Sariakandi Unions:							
Chaluabari (19)	14454	1563	8424	30	144		
Pakulla (81)	5953	3379	17683	12	734		
Hatsherpur (37)	6813	2750	11601	12	44		
Kazla (55)	16509	2048	10963	8	164		
Sariakandi (88)	6328	3722	19809	18	773		
Kutubpur (63)	4836	3385	18150	3	927		
Karnibari (56)	12920	3349	16802	11	321		
Chandanbaisa (25)	3180	2741	14510	5	1127		
Bohali (12)	17155	2910	15034	14	216		
Sub-total	88148	25847	132976	113	373	1.65	161779
Thana Dhunat Unions:							
Bandarbari (09)	5671	3792	20576	5	896		
Sub-total	5671	3792	20576	5	896		25032
Dist. Sirajganj Thana Kazipur Unions:							
Char Girish (08)	16872	2753	16763	20	245		
Kazipur (34)	6786	4886	27735	-	1009		
Khasrajbari (43)	9042	1428	7999	15	219		
Maizbari (51)	4873	4207	22324	8	1132		
Natuarpara (60)	6740	2532	15433	8	566		
Nishchintapur (69)	8983	1435	8580	8	236		
Subhagacha (86)	7085	4099	24320	9	848		
Tekani (94)	8162	2215	12986	7	393		
Sub-total	68547	23555	136140	75	491	1.79	162569

Table A.7-1: Continuation

Dist. Sirajganj Thana Sirajganj Unions:	Acres	Household (1981)	Population (1981)	No. of Mouzas	Density of Population (1981) (per km^2)	District Wise Annual Grouth Rate (AGR)	Projected Population (199)1
Kalia Haripur (25)	6736	4603	26406	15	968		
Kadakola (34)	8409	1789	11585	30	340		
Khoksabari (43)	4838	3411	19833	17	1013		
Mechhra (51)	11109	4096	20508	22	456		
Saidabad (69)	6902	4089	25243	20	903		
Chhangacha (94)	6693	4526	27150	18	1002		
Sirajganj Town	4833	17313	101587	(32)	5192		
Sub-total	99520	39827	232312	122	577	1.79	277410
Thana Belkuchi Unions:							
Baradhul (13)	7730	1985	10086	22	322		
Belkuchi (27)	6554	6412	37105	10	1398		
Rajapur (81)	6947	5507	32837	26	1167		
Sub-total	21231	13904	80028	58	931	1.79	95563
Thana Chauhali Unions:							
Gharjan (23)	7398	1798	10038	19	335		
Mirkutia (30)	12033	5725	33711	29	692		
Umarpur (37)	14763	4263	24317	38	407		
Sadiachandpur (47)	12790	4162	25750	32	497		
Sthal (71)	10341	2047	12230	33	292		
Sub-total	57325	17995	106046	151	457	1.79	126632
Thana Shahjadpur Unions:							
Gala (14)	7521	4657	28632	21	940		
Jalalpur (29)	4010	3076	18094	15	1115		
Kaijuri (36)	7115	5262	32559	17	1130		
Khukni (51)	3561	5355	34462	7	2390		
Sonatani (94)	7676	4118	22844	19	735		
Sub-total	29883	22468	136591	79	1129	1.79	163107
Dist. Pabna Thana Bera Unions:							
Bera (10)	4516	4678	29699	17	1624		
Dhalar char (21)	9575	1674	9987	26	258		
Haturia Nakalia (31)	7543	4123	25003	17	819		
Jotshakhni (42)	8575	4832	29400	19	847		
Masundia (52)	6965	2274	12196	23	432		
Nutan Bharenga (63)	10371	4804	29663	20	706		
Puran Bharenga (73)	6431	1843	11641	23	440		
Ruppur (84)	7355	2755	15647	19	525		
Sub-total	61431	26983	163236	164	656	1.89	196848

Table A.7-1: Continuation

Dist. Manikganj Thana Shibalaya Unions:	Acres	Household (1981)	Population (1981)	No. of Mouzas	Density of Population (1981) (per km²)	District Wise Annual Grouth Rate (AGR)	Projected Population (1991)
Toeta (59)	2470	4358	24646	35	2465		
Sub-total	2470	4358	24646	35	2465	1.00	27225
Thana Daulatpur Unions:							
Bachamara (09) Baghutia (19) Charkatari (38)	9733 11124 4697	3197 4125 2530	17564 22368 15050	24 25 2	446 497 791		
Sub-total	25554	9852	54982	51	531	1.00	60734
Dist. Tangail Thana Nagarpur Unions:							
Bharra (14)	7604	3467	21510	16	699		
Sub-total	7604	3467	21510	16	699	1.88	25913
Thana Gopalpur Unions:							
Hemnagar (65) Jhasil (73)	6141 6863	4206 4121	24182 24452	11 16	973 880		
Sub-total	13004	8327	48634	27	924	1.88	58591
Thana Tangail Unions:							
Hugra (53) Katuli (65) Kakua (71)	8529 12214 9380	3247 4843 4072	19826 29648 25257	22 44 19	574 600 665		
Sub-total	30123	12162	74731	85	613	1.88	90031
Thana Kalihati Unions:							
Durgapur (29)	12781	4684	29570	30	571		
Sub-total	12781	4684	29570	30	571	1.88	35624
Thana Bhuapur Unions:							
Arjuna (13) Phulda (40) Gabsara (54) Gobindasi (67) Nikrail (81)	9822 5929 17056 5692 10968	3837 3857 3650 4568 2885	23547 22300 20703 26421 18070	18 10 15 16 21	592 929 300 1147 407		
Sub-total	49467	18797	111041	80	554	1.88	133774

Table A.7-1: Continuation

Dist. Jamalpur Thana Sarishabari Unions:	Acres	Household (1981)	Population (1981)	No. of Mouzas	Density of Population (1981) (per km²)	District Wise Annual Grouth Rate (AGR)	Projected Population (1991)
Aona (10)	7553	4245	23214	15	759		
Pingna (63)	7203	3706	20371	13	699		
Pogal Digha (73)	9883	6027	34047	8	851		
Satpoa (84)	11561	5928	34719	23	742		
Sub-total	36200	19906	112351	59	767	2.03	137359
Thana Madarganj Unions:							
Balijuri (23)	9826	5871	31555	12	793		
Char Pakerdaha(35)	8316	3882	20875	12	620		
Gunaritala (47)	7905	5603	30529	8	953		
Jorekhali (59)	10519	3613	21311	17	500		
Sub-total	36566	18969	104270	49	704	2.03	127479
Thana Islampur Unions:							
Belgacha (07)	8746	2801	15037	9	425		
Chinaduli (31)	5933	4044	21732	7	905		
Kulkandi (63)	7024	2133	11674	6	411		
Noapara (71)	9564	3804	21058	10	544		
Sapdhari (94)	7580	2633	15375	8	501		
Sub-total	38847	15415	84876	40	540	2.03	103768
Thana Dewanganj Unions:							
Bahadurabad (07)	10713	3817	20432	3	471		
Char Amkhaoa (29)	9170	3518	22793	7	614		
Chikajani (36)	8576	3043	14604	8	421		
Hatibhanga (65)	4619	2042	11395	3	603		
Chukaibari (43)	6867	2788	13962	7	502		
Sub-total	39945	15208	83186	28	514	2.03	101702
Grand total	1185163	488777	2790726	1807	683		

Between 1981 (census) and 1991 (projected population) the population of the envelope increased by 5,52,220, e.i. by 19.78 percent.
Average family size per household 5.71

Table A.7-1: Continuation

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BANK PROTECTION AND RIVER TRAINING (AFPM) PILOT PROJECT FAP 21/22

DRAFT FINAL REPORT

ANNEX 8

ENVIRONMENTAL ASSESSMENT

DECEMBER 1992

(Will be Presented along with the Draft Final Report FAP 21)

D00

BANK PROTECTION AND RIVER TRAINING
(AFPM) PILOT PROJECT
FAP 21/22

DRAFT FINAL REPORT

ANNEX 9

ECONOMIC ASSESSMENT

DECEMBER 1992

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ANNEX 9

ECONOMIC ASSESSMENT

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1 INTRODUCTION

The FAP 21/22 Project aims at evolving appropriate standards for bank protection and strategies for river training/active flood plain management on the Jamuna River.

The development of new standards for bank protection under the FAP 21 component requires the implementation, monitoring and adaptation of test structures and would finally yield manuals and guidelines for both the design and construction of cost effective bank protection works. The economic feasibility of bank protection works each can only be examined within overall (regional) development projects. Test structures are not suited for full fledged economic analysis. The cost efficiency of the designs to be investigated by test structures will be determined by a comparison of alternative investment and maintenance cost as estimated in the present phase of the Project. That analysis will be given in the Final Report FAP 21.

The implementation of river training/AFPM strategies on the Jamuna river (FAP 22 component) in the medium and long term requires a period which will unquestionably exceed 50 years. In that context, and at the present very beginning of such a study, it is necessary to take into consideration a certain unpredictability of costs and of benefits which is inherent to such a programme.

A detailed economic analysis of costs and benefits is thus excluded. Economic aspects mainly cover the following subjects:

i. The present situation in the concerned area,
ii. past expenditures for bank protection,
iii. estimate of river training/AFPM costs in the medium and long terms for different possible alternatives and
iv. assessment of potential benefits for river training/AFPM.

2 PRESENT SITUATION

2.1 ACTIVITIES IN THE JAMUNA ACTIVE FLOOD PLAIN

In the conditions of Bangladesh, where river floods cover very extensive areas and river banks are highly unstable, the boundaries of the Active Flood Plain are neither obvious nor constant. As a result of past events, the Active Flood Plain includes all the islands and new land deposits that are between the present river banks; for planning purposes it has to also include the areas that are at risk of being eroded within the next 30 years; furthermore, areas presently protected by embankments on the right bank become affected by river bank erosion when these embankments are eroded although such areas are not a part of the Active Flood Plain.

Agriculture is presently the most important activity in the Active Flood Plain and in the area protected by embankments exposed to erosion. It is described in ANNEX 7. The annual value added by the crop subsector is estimated at about Tk 9,000 per hectare of agricultural land with an average farm size of 0.80 ha on island char and less than 0.5 ha in areas between embankments and river banks attached char and set-back land. Livestock subsector is reported to provide an annual added value of around Tk 1,000 per household in char lands and Tk 500 in set back land areas. Fishery income is poorly known but seems to be relatively important.

Cottage industry, especially weaving, is present on the main land but provides only a small part of local income. The only large industrial establishment is Jamuna Fertilizer Factory recently installed on the left bank at about 3 km from the River with a production capacity of 1,078 tons of ammonia and 1,700 tons of urea per day. Once threatened by River bank erosion, it now meets navigability problems due to the silting of access channels.

Trade, transport and other services are important subsectors in Bahadurabad and Bhuapur on the left bank and Sariakandi, Fulchari, Kazipur, Sirajganj, Betil and Nagarbari on the right bank.

2.2 EXISTING INFRASTRUCTURE AND PRIVATE ASSETS

Public infrastructure mainly include right bank embankments which have already been subject to local retirements following river erosion. It also includes some left bank embankments. Roads, ferry terminals, administrative buildings and social amenities are mostly present in small towns mentioned above. Public infrastructure is practically absent from island chars.

Jamuna Fertilizer Factory was constructed and equipped at a cost of Tk 12,380 million on a site which was expected to enjoy inland navigation facilities.

Private assets in rural areas are estimated in ANNEX 7 on the average at Tk 14,500 per household in char lands and Tk 12,600 in set back rural areas of the mainland. Their total value may be estimated from ANNEX 7 data at about Tk 700 million in the char lands and about Tk 1,260 million in the set back area of the mainland.This does not include the value of properties in the small towns and villages along the Jamuna river.

2.3 PAST EXPENDITURES FOR BANK PROTECTION

2.3.1 Available Information and Source of Data

The past experience of BWDB in bank protection and river training works is reported in different papers recently published by BWDB. The magnitude of the river bank erosion problem in Bangladesh was summarized by BWDB as follows:

River	N° of Locations	Length of Erosion (km)
Teesta	11	34.9
Brahmaputra-Jamuna	41	162.6
Ganges-Padma	26	94.5
Meghna	8	72.0
Minor rivers	112	92.3
Flashy rivers	75	23.0
Tidal rivers	32	85.8
Overall	305	565.1
Cities & villages	85	

Table 2.3-1: River bank erosion in Bangladesh

(Source: BWDB)

22 bank protection or river training schemes were reported in 1988 while others were under execution or at planning stage. Technical details have been given together with the history of the schemes for Sirajganj, Chandpur and Rajshahi town protection schemes respectively on Jamuna, Meghna, and Ganges rivers.

Construction and O & M budgets have not yet been published except for World Bank funded works executed under the Flood Damage Restoration Project. Data on previous cost estimates and actual expenditures since the beginning of works were consequently directly collected from the Executive Engineers, O&M Division, BWDB at Sirajganj, Bogra, Gaibandha, Chandpur and Rajshahi. Government expenditures for bank protection in selected areas were also reported in FAP 8A and 9B reports. Some discrepancies may be found between the three sources of data due to differences in the definition of funding. Figures presented further are generally those provided by Executive Engineers of BWDB.

Past expenditures in current Taka were reported as local cost only; they have been converted into 1991 constant Taka by using the deflator index published by BBS for the Construction Sub-Sector in the years 1972-73 to 1990-1991. The deflator index was roughly estimated by the Consultant for the years 1969-70 to year 1971-72 using the cost of living index published by BBS as an indicator. The forecast for year 1991-92 has been estimated by extrapolation of the observed trend since 1984-85. The correction factors derived from these data and estimates are shown in Table A9-1.

2.3.2 Sirajganj Town Protection and Kazipur

Since 1940 bank protection measures were taken, consisting mostly of brick mattressing which revealed effective till 1968 when erosion became very active. After emergency measures taken in 1969, new construction works started, consisting of brick mattressing and of the dumping of loose stones and brick filled wire cages. Later on, steel jacks were

dumped and concrete blocks of 1 cubic foot were placed without filter due to difficulty in placing khoa; it was thus accepted to spend more for maintenance by dumping additional concrete blocks when required. One groyne was constructed at Sailabari some 12 km upstream of Sirajganj in 1978. Another groyne was constructed at Ranigram immediately upstream of the town in 1985-86.
A summary record of expenditures is shown in Table A9-2.

Town protection appears to have been partly effective during 23 years at a total estimated cost of about 1991 constant Taka 1,180,000,000 including initial construction cost, repairs, improvements, the construction of Sailabari and Ranigram groynes and maintenance. For town protection itself the repair and maintenance budget has amounted to about 8% of the initial investment. It has been 2 % for Sailabari groyne.

Kazipur groyne was washed away with the first flood, immediately after construction in June 1989 after a total expenditure of 1991 constant Taka 63,772,000.

2.3.3 Embankment Protection Near Sariakandi

Protection against river bank erosion has been provided since 1987 to prevent the destruction of trading center and agricultural land. Another major concern is the risk of capture of the Jamuna by the Bengali River. Protective works included a groyne, cross bars and bank revetments with brick mattressing and the dumping of concrete blocks over khoa filter. They are presently complemented by revetment with concrete blocks on the left bank of Bangali river.
Past expenditures are shown in Table A9-3.

Repairs were required to revetments and apron. Erosion severely increased downstream after the completion of Kalitola groyne.

2.3.4 Embankment Protection Near Fulcharighat

The area has an important rail ferry ghat for goods and passengers and suffered from bank erosion. The Brahmaputra Right Embankment is at risk of being breached in the next years. Protective measures taken included the construction of cross bars and the placing of bamboo porcupines which revealed not effective.
Past expenditures are shown in Table A9-4.

2.3.5 Bank Protection Works on Right Bank of Teesta River

Bank protection of the right bank of the Teesta river has been provided by groynes and cross bars. One groyne and one cross bar were recently washed away while the other structures were considered effective.
Construction and maintenance costs are reported in Table A9-5.

2.3.6 Chandpur Town Protection Works

Chandpur town is located on the left bank of the Lower Meghna and has been subject to severe erosion during the last 35 years. Emergency protective works started in 1972 by boulder revetment and the construction of a groyne. Lateron, the boulder revetment was extended to a total length of about 2,000 m and a regular dumping of boulders is required to maintain the river banks. The groyne was washed away in the last years and the town remains threatened by gradual destruction.

Expenditures reported by BWDB since 1972 are shown in Table A9-6. They amount to a total of about Tk 430 million in 1991 constant Taka with an O & M budget of about 0.5% of the initial investment.

2.3.7 Rajshahi Town Protection Works

The erosion of the Ganges river banks in the vicinity of Rajshahi is reported to have occurred as far back as one century ago or even more. After a shifting of the main channel which stopped erosion for 10 years between 1960 and 1970, erosion started again and required protection measures. Emergency works included the construction or reconstruction of spurs and groynes. They were followed by a comprehensive programme of works which extended till 1981. Since then, regular maintenance and repairs are provided and make bank protection fairly effective.

Expenditures reported by BWDB since 1971 are shown in Table A9-7. Only total expenditure for years 1971 to 1981 is presently available. This budget has been supposed equally distributed in current Taka over the 10 years. Data are lacking for the six years between 1981 and 1987. The provisional estimate of expenditures amounts to a total of almost Tk 600 million in 1991 constant Taka with an O & M budget during the last 5 years of about 3% of the initial investment.

2.3.8 BWDB Expenditures for Bank Protection of Jamuna River

Past budgets recorded in the office of BWDB executive engineers on the right bank of Jamuna since 1969-1970 are summarized in Table A9-8 and show an average annual expenditure of about 1991 constant Tk 64 million with high fluctuations from one year to another.

3 ECONOMICS OF ALTERNATIVE STRATEGIES FOR RIVER TRAINING

3.1 POSSIBLE SCENARIOS

Three possible scenarios have been identified as a result of technical studies. They can be summarized as follows:

i. Jamuna stabilized as an anabranched flood channel through "hard" measures;
ii. Jamuna stabilized as an anabranched flood channel through both "hard" and recurrent measures;
iii. Jamuna stabilized as a braided River with a reduced width.

The first scenario corresponds to the solution proposed by the Chinese/Bangladesh team. It aims at stabilizing the Jamuna river in its present land form by creating hard points, so called "nodal points", by means of revetments and groynes or similar structures at regular intervals on both sides of the river and at the head of main islands. Provision is made for additional protection works on the banks which would remain erosion prone between the nodal points. Monitoring is required till no more erosion is observed; protection works are then completed and would only require simple maintenance with minor monitoring only.

The second scenario is similar to the first one but additional protection works between nodal points are mostly replaced by recurrent measures such as the use of surface screens, bottom vanes, bend cut-off, intended to deviate the stream from threatened banks. With this scenario, permanent monitoring and recurrent measures are required till the river is considered stabilized and "hard" protection works can be constructed at a minimum cost to arrive at a permanent solution. Recurrent measures may also be used continuously as a substitute for "hard" works.

The third scenario starts with the prevention of the westward drift of the Jamuna River. Hard points are thus constructed on the right bank and recurrent measures are used as in scenario 2 to protect the right bank between the hard points. Recurrent measures are used to protect the left bank against erosion and gradually reduce the width of the main channel. Existing islands may partly disappear and the accretion of new land along the left bank will approximately replace the eroded land areas.

The implementation of the three scenarios is envisaged within 3 main phases:

i. In the first phase (years 1993 to 1998) FAP 21 Pilot-Projects and the River Bank Protection I Project which are in the pipe-line are implemented. Parallely the efficiency of recurrent measures are tested;
ii. In the second phase which may last about 10 years, hard protection works are implemented on the right bank in vulnerable areas and possibly complemented by recurrent measures;

iii. In the third phase which will probably require a longer time, possibly at least till year 2050, river training works assisted by permanent monitoring are completed.

After the third phase the river training will be maintained by repair of hard works and recurrent measures.

3.2 COST ESTIMATES

3.2.1 Available Cost Data

Detailed cost analysis based on bill of quantities would not be justified at the present stage of study which only requires preliminary estimates for the comparison of different strategy options. For the present purpose it is deemed suitable to make use of overall estimates already prepared by other consultants for similar works in Bangladesh concurrently with estimates prepared by the Consultant for the FAP 21/22 test structures and recurrent measures.

The following sources of information are available:

i. Study Report on Flood Control and River Training Project on the Brahmaputra River in Bangladesh issued in March 1991 by the China-Bangladesh Joint Expert Team; construction quantities and cost estimate for bend control and node control scheme are given for the whole scheme in Table A9-9; Table A9-10 shows quantity and cost estimation for the first phase of the recommended scheme;

ii. River Training Studies of the Brahmaputra River (FAP 1), Second Interim Report issued in December 1991; detailed cost estimates in 1991 constant Taka are given for priority works in 5 locations (see Table A9-11); maintenance cost is estimated as 0.5% of investment cost per year plus 5% each 5 years;

iii. Jamuna Bridge Project Reports;

iv. Estimates prepared by the Consultant for recurrent measures (see ANNEX 3).

3.2.2 Estimation Method and Assumptions

Total cost estimate of the first scenario is taken from the China-Bangladesh Joint Expert Team Study. Cost estimates in 1990 current US$ are updated and converted into 1991 constant Taka by using G-5 Manufacturing Unit Values (MUV) index and an exchange rate of US$ 1 = Tk 38 as per the Guidelines for Project Assessment (see Table A9-10).

Priority works for different locations have been costed in the above-mentioned report and in the FAP 1 report (see Tables A9-10 and A9-11). Estimates broadly differ between these two studies as shown in the following table:

Site	China-Bangladesh Team	FAP 1
Fulcharighat	3,199	1,178
Sariakandi/Mathurapara	3,076	1,212
Kazipur	2,774	1,216
Sirajganj	2,673	1,542

Table 3.2-1: Comparison between China-Bangladesh and FAP 1 cost estimates
(1991 constant million Tk)

The difference is partly explained by the more detailed approach of the FAP 1 study and partly by the larger sizes (lengths) of the works in the China-Bangladesh study approach, due to the difference in objectives.

The first phase of scenario 1 is supposed to include the river training works associated with the Jamuna Bridge, the FAP 21 pilot-projects at Kamarjani and Bahadurabad, the FAP 22 testing of recurrent measures, and protection works at Sariakandi and Sirajganj as proposed in the FAP 1 study. The river training costs associated with the Jamuna Bridge may be considered as sunk costs and are not included in the Project costs. The second phase is assumed to include the same investment costs as in phase I of the China-Bangladesh Team report (see Table A9-9) plus the cost of 2 hard points downstream from Jamuna bridge each one estimated as in FAP 1 study for Betil and minus the costs already accounted for the 1st phase. Total cost at the end of the third phase are assumed to be as forecasted in the China-Bangladesh Team report.

The second scenario is costed by assuming the same content for the 1st phase as in the first scenario. Hard points constructed during the second phase with the additional use of 2 moving screens (i.e. 1 screen is a row of separate screen units/barges) and one bend cut-off are roughly estimated at an average price comparable to the FAP 1 estimates and a little lower than the China-Bangladesh Team estimates. In the third phase of scenario 2 which could last at least some 40 years the construction of 9 new hard points is assumed. Their cost is estimated as an approximate average of cost estimates by FAP 1 per protected location i.e. around Tk 1,200 million per site. The permanent use of 2 moving screens is anticipated and one cut-off every 2 years is assumed on the average.

The same content is assumed for the first and second phases of the third scenario. The third phase of the third scenario is not supposed to include the construction of any additional hard points but to require the permanent use of 5 moving screens and one cut-off every 2 years as in scenario 2.

Maintenance costs of hard points are assumed to amount to 1.5% of investment costs as suggested in the FAP 1 study. Monitoring of River training, engineering, displacement and installation of moving screens and other costs are estimated by the Consultant as described in ANNEX 3.

Summarized, the relevant costs presented in that annex are: (Tk million)

- annual cost for monitoring and engineering for river training — 20
- manufacturing of one 1500 m screen with a life time of 10 years — 150
- displacement, installation and maintenance of one screen — 50
- cost for the construction of one cut-off — 287

For the economic analysis the costs for the displacement, installation and maintenance of the screens are considered as investment costs for recurrent measures. For the bend cut-offs no maintenance costs are considered in the economic analysis.

3.2.3 Preliminary Cost Estimates

The cost of the different components of river training in 1991 constant Tk at financial price is tentatively estimated in Tables A9-12 to A9-13. A summary of costs for the three scenarios is presented in Table 3.2-2 below:

	Financial costs in 1991 constant million Tk		
Phases (estimated)	Scenario 1 Investment	Scenario 2 Investment	Scenario 3 Investment
(1) 1993 to 1998 (2) 1998 to 2010 (3) 2010 to 2050	3,854 15,279 41,566	3,854 15,356 18,540	3,854 15,356 10,740
Subtotals	60,699	37,750	29,950
Total annual eng. and maintenance costs	28,015	17,926	13,937
Totals	88,714	55,676	43,887

Table 3.2-2: Total investment and maintenance costs

With scenario 1 (see Table A9-12) total investment amounts to about 1991 constant Tk 60,700 million with about 6% in the first phase, 25 % in the second phase and the remaining 69 % in the third phase. In the mean time annual maintenance costs increase gradually up to about Tk 910 million after completion of the works. The total of investment and annual costs during the three phases is Tk 88,714 million.

With scenario 2 (see Table A9-13) total investment is reduced to about Tk 37,750 million with a decrease appearing mainly in the third phase. Annual maintenance costs increase gradually up to about Tk 414 million after completion of the third phase. The total of investment and annual costs during the three phases would be Tk 55,676 million.

With scenario 3 (see Table A9-14) total investment amounts to a little less than Tk 30,000 million. The Project costs are the same as in scenario 2 during the two first phases and become lower during the third phase. Annual maintenance costs increase gradually up to Tk 252 million after the end of the second phase and remain constant during and after the third phase. The total of investment and annual costs during the three phases is Tk 43,887 million.

Detailed price analysis in the FAP 1 report showed that the average conversion factor to convert overall bank protection project costs at financial price into project cost at economic price is close to 0.80 for each site. It is considered suitable for the economic assessment of FAP 22 as well.

Annual expenditures at economic prices including those for construction, recurrent measures, monitoring and engineering, and maintenance are detailed in Table A9-15 assuming that investments are equally spread over each year within each development phase.

The Present Value of project costs at financial and economic prices and 12% interest rate is then as follows:

	Financial	Economic
Scenario 1	9,756	7,805
Scenario 2	8,993	7,194
Scenario 3	8,623	6,898

Table 3.2-3: Present value of project costs at financial and economic prices
(1991 constant million Tk)

The interest of developing recurrent measures is emphasized by the comparison of total investment and recurrent costs between the different scenarios. Scenario 2 which partly relies on the use of recurrent measures for river training has a total cost which is almost 38% lower than the more classic solution involved in scenario 1. Scenario 3 which makes the highest use of recurrent measures has a total cost 51% lower than that of scenario 1. The comparison of the present values of total project costs is less striking due to the fact that most of the difference in river training methods occurs during the third phase. It however confirms the expectation of a decreased overall project cost and the need for testing the proposed methods.

3.3 POTENTIAL BENEFITS

3.3.1 Source of Data

Technical aspects of bank protection and river training have been covered in BWDB publications but benefit assessment was not deemed necessary till recently and bank protection schemes were generally decided in the past with the conviction that there was an urgent need for such measures and that their justification was obvious.

The most valuable information on potential benefits of protection works has been produced by recent FAP studies:

- o FAP 1 : Brahmaputra Right Embankment Strengthening
- o FAP 9B : Meghna Left Bank Protection Project

An economic assessment of river bank protection is provided by FAP 1 in December 1991 for 6 selected priority locations on Jamuna Right Bank (River Training Studies of the Brahmaputra River, Second Interim Report). The economic analysis of 7 towns, communication infrastructure and irrigation scheme protection projects is included in the report of FAP 9B (Meghna River Bank Protection Short Term Study,Interim Report, October 1991).

The results of benefit assessment for bank protection in FAP 1 are shown in Table A9-16. Average benefit per km of bank protection and per annum in selected areas of Jamuna Right Bank is thus estimated to vary between about Tk 4.5 and 12.6 million. The part of benefits issuing to rural areas appears to be around Tk 4 million.

FAP 9B study (see Table A9-17) concerns areas where the natural conditions and the activities are fairly different from those of the Jamuna. Communication and industrial infrastructures there appear to be key factors in the economic justification of the projects.

The benefit assessments hereabove concern selected locations where river bank erosion threatens existing economic activities, properties and infrastructure. They are based on the present development of activities and eventually on present development trends. This approach is fully justified for projects that are planned in the short or medium term. It may not cover all expectable benefits when planning for the long term.

A good illustration of the possible scale of future river training requirements is provided by the Jamuna Bridge project which is under short term planning. The cost of river training within this project has been estimated on behalf of UNDP/WB at 1987 constant US$ 94 million equivalent to 1991 constant Tk 3,600 million or approximately 25% of total project costs.

3.3.2 Estimation Method and Assumptions

The consequences of river banks erosion and channel shifting are identified as follows:

i. Land losses, at least partly compensated with some delay by the accretion of new lands;
ii. Destruction of public and private property;
iii. Destruction of infrastructure with further consequences, especially in the case of flood protection embankments or communication infrastructure;
iv. Indirect negative impact on the intensity and productivity of farming systems;
v. Disruption of economic activities;
vi. More or less adequate investments following emergency decisions;
vii. Obstacle to the development of communications and consequently to the overall economic development of the country.

While Phase 1 project benefits can be approximately quantified by using FAP 1 data, the rough assessment of potential benefits of Phase 2 has to be based on tentative assumptions. Phase 3 benefits are still more difficult to forecast and will depend on the future development of communication networks which are still to be planned. They will also depend on changes which will occur in the evolution of the river and which cannot be predicted at present.

It has been observed (see ANNEX 7) that the presence of risks restricts investment and productivity of farming in the Active Flood Plain. An improved protection together with the general economic growth can be expected to gradually increase the protection benefits. An annual rate of increase of 3% is deemed reasonably conservative.

Assumptions made are thus as follows:

- Economic growth of 3% per annum inflating expected benefit estimates since 1991;
- Benefits of Phase 1 based on FAP 1 estimates for Sariakandi and Sirajganj and assuming the same benefits for each FAP 21 Pilot Project as for Fulcharighat in FAP 1;
- Benefits including the current expenditures of BWDB for bank protection works at present;
- Benefits of Phase 2 including FAP 1 estimates for Fulcharighat, Kazipur and Betil plus an average 1991 price benefit of Tk 4 million per km over a protected length of about 160 km in addition to Phase 1 benefits;
- No quantification of benefits for Phase 3.

3.3.3 Tentative Benefit Estimates

Project benefits at the end of each Phase before inclusion of the impact of economic growth are estimated as follows:

	Phase 1	Phase 2
Sariakandi	201	201
Sirajganj	68	68
FAP 21 Test Structures	73	73
Savings on BWDB expenditures	56	64
Fulcharighat, Kazipur, Betil		120
Other Phase 2 areas		640
Total benefits	398	1,167

Table 3.3-1: Tentative estimate of annual benefits not including economic growth at the end of each phase (in 1991 constant million Tk per annum)

Benefits are assumed to build up regularly within each phase. On this basis a tentative cost/benefit analysis is presented in Table A9-18 with the following results:

	NPV (12%)	EIRR
Phase 1 (Scenario 1, 2 & 3)	1,090	16.3%
Phase 1 & 2 (Scenario 1)	720	13.2%
Phase 1 & 2 (Scenario 2 & 3)	749	13.3%

Table 3.3-2: Tentative estimate of net present value (NPV) and economic internal rate of return (EIRR) (NPV in 1991 constant million Tk)

Phase 1 appears highly feasible (the EIRR for 5% and 10% annual maintenance cost still amounting to 13.7% and 10.4% respectively) while the economic justification of Phase 2 still requires more details on construction costs and direct or indirect benefits of bank protection. Benefit estimates should be respectively increased by 6% and 5% for Phase 2 of scenario 1 and scenario 2 or 3 to make the project profitable. Alternatively cost estimates should be respectively reduced by less than 7 and 5%. This demonstrates the interest of FAP 21/22 Pilot Projects which are aimed at experimenting cost-effective methods of river training.

The benefits of Phase 3 will depend on unpredictable changes which will occur in the evolution of Jamuna left bank and of char islands following the complete protection of the right bank. They will also strongly depend on possible changes in the socio-economic environment and on the future needs for improved communications throughout the country which cannot be quantified at this stage. It may however be mentioned that scenario 3 appears the least costly and providing the best conditions for the improvement of communications. On the other hand it may generate more social inconvenience than scenario 1 or 2 for the population living in the Active Flood Plain (see ANNEX 7) whereas the erosion of char islands might increase during Phase 2.

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TABLE A9-1
CORRECTION FACTORS FROM CURRENT TAKA TO 1991 CONSTANT TAKA

Sl. No.	Year	Construction deflator	Correction factor (local cost)
1	1969-70	12.00	13.022
2	1970-71	15.00	10.417
3	1971-72	18.00	8.681
4	1972-73	18.18	8.595
5	1973-74	28.25	5.531
6	1974-75	50.33	3.105
7	1975-76	57.58	2.714
8	1976-77	51.30	3.046
9	1977-78	52.49	2.977
10	1978-79	55.09	2.836
11	1979-80	66.77	2.340
12	1980-81	78.35	1.994
13	1981-82	91.67	1.705
14	1982-83	89.93	1.738
15	1983-84	90.15	1.733
16	1984-85	100.00	1.563
17	1985-86	113.75	1.374
18	1986-87	117.86	1.326
19	1987-88	125.94	1.241
20	1988-89	136.25	1.147
21	1989-90	144.91	1.078
22	1990-91	156.26	1.000
23	1991-92	168.00	0.930

SOURCES :

. BBS for Years 1972-73 to 1990-91

. Consultant's estimate for years 1969-70 to 1971-72 and 1991-92

TABLE A9-2
BANK PROTECTION WORKS NEAR SIRAJGANJ

Year	Sirajganj town		Sailabari groyne		Beara cross bar		Kazipur groyne	
	Current Tk,000	1991 Constant Tk,000	Current Tk,000	1991 Constant Tk,000	Current Tk,000	1991 Constant Tk,000	Current Tk,000	1991 Constant Tk,000
1969-70	28791	374905						
1970-71	3963	41284						
1971-72	3712	32226						
1972-73	13158	113091						
1973-74	3718	20567						
1974-75	3029	9403						
1975-76	2998	8136						
1976-77	5054	15395						
1977-78	12948	38546	35000	104193				
1978-79	1902	5394	1429	4053				
1979-80	8230	19260	1429	3344				
1980-81	32759	65335	1429	2850				
1981-82	4445	7577	1429	2436				
1982-83	2535	4406	1429	2483				
1983-84	7166	12421	1429	2477				
1984-85	3020	4719	1429	2233				
1985-86	68175	93653	1429	1963				
1986-87	36880	48896	1429	1895				
1987-88	49565	61497	1429	1773	11900	14765		
1988-89	29697	34058	1429	1639	6637	7612	49817	57133
1989-90	16390	17674	1429	1541	0	0	6157	6639
1990-91	10280	10280	1429	1429	5997	5997		
1991-92	5995	5576	1429	1329	0	0		
Total		1044300		135638		28374		63772

. Maintenance cost of Sailabari groyne reported at about current Tk 20,000,000
since construction without annual detail

TABLE A9-3
BANK PROTECTION WORKS NEAR SARIAKANDI

Year	Kalitola groyne		Antarpur x bar		Hasnapur x bar		Pakulla x bar		Chalkandi x bar	
	Current Tk,000	1991 Constant Tk,000	Current Tk,000	1991 Constant Tk,000	Current Tk,000	1991 Constant Tk,000	Current Tk,000	1991 Constant Tk,000	Current Tk,000	1991 Constant Tk,000
1969-70										
1970-71										
1971-72										
1972-73										
1973-74										
1974-75										
1975-76										
1976-77										
1977-78										
1978-79										
1979-80										
1980-81										
1981-82										
1982-83										
1983-84										
1984-85										
1985-86										
1986-87										
1987-88	38025	47180							10908	13534
1988-89	28945	33196			656	752			0	0
1989-90					93	100	358	386	0	0
1990-91	4989	4989			1537	1537	992	992	0	0
1991-92									0	0
Total		85364				2390		1378		13534

TABLE A9-4
BANK PROTECTION WORKS NEAR FULCHARIGHAT

Porcup. at Fulchari		
Year		1991
	Current	Constant
	Tk,000	Tk,000
1969-70		
1970-71		
1971-72		
1972-73		
1973-74		
1974-75		
1975-76		
1976-77		
1977-78		
1978-79		
1979-80		
1980-81		
1981-82		
1982-83		
1983-84		
1984-85		
1985-86		
1986-87		
1987-88		
1988-89	32785	37600
1989-90	484	522
1990-91	10622	10622
1991-92		
Total		48744

TABLE A9-5
BANK PROTECTION WORKS ON RIGHT BANK OF TEESTA RIVER

Year	Belka x bars		Tarapur x bar I		T. x bar II & III		Tambulpur groyne		Pinaighat groyne	
	Current Tk,000	1991 Constant Tk,000	Current Tk,000	1991 Constant Tk,000	Current Tk,000	1991 Constant Tk,000	Current Tk,000	1991 Constant Tk,000	Current Tk,000	1991 Constant Tk,000
1969-70										
1970-71										
1971-72										
1972-73										
1973-74										
1974-75										
1975-76										
1976-77										
1977-78										
1978-79										
1979-80										
1980-81										
1981-82										
1982-83										
1983-84										
1984-85										
1985-86										
1986-87										
1987-88	21072	26145	6340	7866	12581	15610	3674	4559	15227	18893
1988-89	2579	2958	698	801			12952	14854	2992	3431
1989-90	0	0					12209	13165	13651	14720
1990-91									70	
1991-92										
Total		29103		8667		15610		32578		37045

TABLE A9-6

CHANDPUR TOWN PROTECTION WORKS

Year		Bank revetment and groyne Current Tk,000	1991 Constant Tk,000
1969-70			
1970-71			
1971-72			
1972-73	)	9470	81398
1973-74	)	9470	52383
1974-75	)	9470	29402
1975-76	)	9470	25700
1976-77	)	9470	28846
1977-78	)	9470	28192
1978-79		1481	4201
1979-80	)	783	1833
1980-81	)	783	1562
1981-82	)	783	1335
1982-83		2300	3996
1983-84		1240	2149
1984-85		1661	2595
1985-86		2267	3114
1986-87		7811	10356
1987-88		13600	16874
1988-89		14487	16615
1989-90		103913	112052
1990-91		5666	5666
1991-92		10	9
Total			428280

. Groyne was washed away in the last years

TABLE A9-7
RAJSHAHI TOWN PROTECTION WORKS

Bank revetment and groynes			
Year		Current Tk,000	1991 Constant Tk,000
1969-70			
1970-71			
1971-72	)	12638	109708
1972-73	)	12638	108622
1973-74	)	12638	69903
1974-75	)	12638	39236
1975-76	)	12638	34296
1976-77	)	12638	38494
1977-78	)	12638	37621
1978-79	)	12638	35846
1979-80	)	12638	29575
1980-81	)	12638	25204
1981-82			
1982-83			
1983-84			
1984-85			
1985-86			
1986-87			
1987-88		6382	7919
1988-89		16833	19305
1989-90		347	374
1990-91		21801	21801
1991-92		17156	15957
Total			593863

TABLE A9-8
TOTAL BWDB EXPENDITURES FOR BANK PROTECTION OF JAMUNA RIVER RIGHT BANK

Year	Sirajganj & Sariakandi	Total Jamuna Right bank
1969-70	374905	374905
1970-71	41284	41284
1971-72	32226	32226
1972-73	113091	113091
1973-74	20567	20567
1974-75	9403	9403
1975-76	8136	8136
1976-77	15395	15395
1977-78	142739	142739
1978-79	9448	9448
1979-80	22604	22604
1980-81	68185	68185
1981-82	10013	10013
1982-83	6889	6889
1983-84	14898	14898
1984-85	6952	6952
1985-86	95616	95616
1986-87	50791	50791
1987-88	123984	138749
1988-89	69645	171990
1989-90	19701	26862
1990-91	19227	35846
1991-92	6905	6905
Total	1282604	1423494
Average	55765	61891

TABLE A9-9

QUANTITY AND COST ESTIMATE FOR THE OVERALL SCHEME BY CHINA-BANGLADESH TEAM

	Bend control	Node control
LENGTH OF WORKS (KM)		
Protection and constraint works	192	141
(Length of advance in water)	(58)	(58)
Node works	13	62
Auxiliary works	18	62
Branch closure works	47	25
Total	270	290
QUANTITIES OF MAJOR WORKS ('000 M3)		
Concrete blocks	10761	15750
Earth filled bags	24634	28250
Slope protection	1607	1454
Earth filling	50692	67684
Mattress with reinforced concrete blocks	1275	652
Geotextile ('000 m²)	10823	6180
COST ESTIMATE (1991 CONSTANT Tk MILLION)		
Protection and constraint works	52131	45314
Node works	3418	16639
Auxiliary works	161	931
Branch closure works	8413	10711
Total	64124	73596

SOURCE: Study Report on Flood Control and River Training Project on the Brahmaputra River in Bangladesh - Volume 3, March 1991

TABLE A9-10

QUANTITY AND COST ESTIMATE FOR PHASE I BY CHINA-BANGLADESH TEAM

	Work length (km)	Quantity ('000 m3 or '000 m2) Concrete blocks	Earth filled jute bags	Slope protection	Earth works	Geotextile	Investment (1991 Constant (Tk Million)
RIGHT BANK							
1. Bank protection at outfall of Teesta River	6	481	570.0	57.0	754.9		1629
2. Supplementary works at Node VI and Kamarijani	5	92	766.4	18.5	785.5	221.3	1238
3. Protection works at Fulchari railway station	10	817	1295.8	70.6	3618.4		3199
4. Supplementary works at Sariakandi and Mothurapara	12	491	655.6	52.6	1220.3	780.0	3076
5. Protection works at Kazipur	11	890	829.4	50.2	1182.7		2774
6. Protection works for Sirajganj town	8	689	979.1	24.2	3832.0		2673
SUBTOTAL RIGHT BANK	52	3460	5096.3	273.1	11393.8	1001.3	14590
LEFT BANK							
1. Protection works at offtake of Old Brahmaputra River	9	508	270.6	10.8	295.7		1347
2. Protection works for Aona fertilizer plant	10	543	600.0	57.8	655.0	306.3	2202
SUBTOTAL LEFT BANK	19	1051	870.6	68.6	950.7	306.3	3549
TOTAL	71	4511	5966.9	341.7	12344.5	1307.6	18139

SOURCE: Study Report on Flood Control and River Training Project on the Brahmaputra River in Bangladesh - Volume 3, March 1991

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TABLE A9-11
FINANCIAL AND ECONOMIC CAPITAL COSTS AT FAP 1 PRIORITY LOCATIONS

	Capital cost (1991 Constant Tk Million)		Average conversion factor
	Financial	Economic	
- Fulchari	1178	940	0.80
- Sariakandi-Mathurapara	1212	970	0.80
Kazipur Phase 1	608	490	0.81
Kazipur Phase 2	608	490	0.81
- Total Kazipur	1216	980	0.81
Sirajganj Phase 1	1004	803	0.80
Sirajganj Phase 2	538	430	0.80
- Total Sirajganj	1542	1233	0.80
- Betil	567	450	0.79

SOURCE: River Training Studies of the Brahmaputra River (FAP 1) - Second Interim Report Volume 6, December 1991

TABLE A9-12
COST ESTIMATE AT MARKET PRICE FOR SCENARIO 1 (Tk million)

	PHASE 1 (1993-1997)	PHASE 2 (1998-2009)	PHASE 3 (2010-2050)
Test structures (FAP 21)	1035		
Testing of recurrent measures (FAP 22)	65		
Sariakandi Protection works (FAP 1)	1212		
Sirajganj Protection works (FAP 1)	1542		
Completion of 8 Right Bank hard points (1)		10696	
Construction of 2 Left Bank hard points (2)		3549	
Construction of 2 hard points downstream from Jamuna bridge (3)		1034	
Completion of River training (4)			41566
Annual cost of Monitoring and Engineering (5)	20	20	20
Annual cost of Maintenance after completion (6)	57	286	910
Total investment	3854	15279	41566

(1) China-Bangladesh Team estimate minus FAP 21 Pilot-Projects and FAP 1 estimates for Sariakandi and Sirajganj protection
(2) China-Bangladesh Team estimate
(3) Double of FAP 1 estimate for Betil protection works
(4) China-Bangladesh Team estimate minus previous investments not including the testing of recurrent measures of FAP 22
(5) FAP 21/22 Consultant estimate
(6) 1.5 % of construction costs as estimated in FAP 1 study

TABLE A9-13
COST ESTIMATE AT MARKET PRICE FOR SCENARIO 2 (Tk million)

	PHASE 1 (1993-1997)	PHASE 2 (1998-2009)	PHASE 3 (2010-2050)
Test structures (FAP 21)	1035		
Testing of recurrent measures (FAP 22)	65		
Sariakandi Protection works (FAP 1)	1212		
Sirajganj Protection works (FAP 1)	1542		
Completion of 8 Right Bank hard points (1)		9600	
Construction of 2 Left Bank hard points (1)		2400	
Construction of 2 hard points downstream from Jamuna bridge (2)		1034	
Use of 2 moving screens of 1500 m width (3)		600	
Bend cut-off (3)		1722	
Construction of 9 hard points (1)			10800
Use of 2 moving screens (3)			2000
Bend cut-off (3)			5740
Annual cost of Monitoring and Engineering (3)	20	20	20
Annual cost of Maintenance after completion (4)	57	252	414
Total investment	3854	15356	18540

(1) Average cost per hard point roughly estimated as from FAP 1 study at about Million Tk 1200
(2) Double of FAP 1 estimate for Betil protection works
(3) FAP 21/22 Consultant estimate; one cut-off each 2 years
(4) 1.5 % of construction costs as estimated in FAP 1 study

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TABLE A9-14
COST ESTIMATE AT MARKET PRICE FOR SCENARIO 3 (Tk Million)

	PHASE 1 (1993-1997)	PHASE 2 (1998-2009)	PHASE 3 (2010-2050)
Test structures (FAP 21)	1035		
Testing of recurrent measures (FAP 22)	65		
Sariakandi Protection works (FAP 1)	1212		
Sirajganj Protection works (FAP 1)	1542		
Completion of 8 Right Bank hard points (1)		9600	
Construction of 2 Left Bank hard points (1)		2400	
Construction of 2 hard points downstream from Jamuna bridge (2)		1034	
Use of 2 moving screens of 1500 m width (3)		600	
Bend cut-off (3)		1722	
Use of 5 moving screens (3)			5000
Bend cut-off (3)			5740
Annual cost of Monitoring and Engineering (3)	20	20	20
Annual cost of Maintenance after completion (4)	57	252	252
Total investment	3854	15356	10740

(1) Average cost per hard point roughly estimated as from FAP 1 study at about Million Tk 1200
(2) Double of FAP 1 estimate for Betil protection works
(3) FAP 21/22 Consultant estimate; one cut-off each 2 years
(4) 1.5 % of construction costs as estimated in FAP 1 study

TABLE A9-15

FAP 22 ANNUAL COST AND PRESENT VALUE ESTIMATE AT ECONOMIC PRICE (1991 constant Tk million)

(Sheet 1 of 4)

		1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
SCENARIO 1																
Investment (construct.)		606	606	606	606	606	1019	1019	1019	1019	1019	1019	1019	1019	1019	1019
Recurrent measures		10	10	10	10	10	0	0	0	0	0	0	0	0	0	0
Monitoring & Engineering		20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Maintenance		0	9	18	27	36	45	61	76	91	107	122	137	152	168	183
Total (1)		637	646	655	664	673	1084	1099	1115	1130	1145	1160	1176	1191	1206	1222
(2)	70971															
(3)	7805															
SCENARIO 2																
Investment (construct.)		606	606	606	606	606	869	869	869	869	869	869	869	869	869	869
Recurrent measures		10	10	10	10	10	155	155	155	155	155	155	155	155	155	155
Monitoring & Engineering		20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Maintenance		0	9	18	27	36	45	59	72	85	98	111	124	137	150	163
Total (1)		637	646	655	664	673	1089	1102	1115	1128	1141	1154	1167	1180	1193	1207
(2)	44541															
(3)	7194															
SCENARIO 3																
Investment (construct.)		606	606	606	606	606	869	869	869	869	869	869	869	869	869	869
Recurrent measures		10	10	10	10	10	155	155	155	155	155	155	155	155	155	155
Monitoring & Engineering		20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Maintenance		0	9	18	27	36	45	59	72	85	98	111	124	137	150	163
Total (1)		637	646	655	664	673	1089	1102	1115	1128	1141	1154	1167	1180	1193	1207
(2)	35109															
(3)	6898															

(1) Total per year

(2) Total investment and annual costs

(3) Present value of total costs (12%)

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TABLE A9-15 (Continued)

FAP 22 ANNUAL COST AND PRESENT VALUE ESTIMATE AT ECONOMIC PRICE (1991 constant Tk million)

(Sheet 2 of 4)

		2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
SCENARIO 1																
Investment (construct.)		1019	1019	831	831	831	831	831	831	831	831	831	831	831	831	831
Recurrent measures		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Monitoring & Engineering		20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Maintenance		198	214	229	241	254	266	279	291	304	316	329	341	354	366	378
Total (1)		1237	1252	1080	1093	1105	1118	1130	1142	1155	1167	1180	1192	1205	1217	1230
(2)	70971															
(3)	7805															
SCENARIO 2																
Investment (construct.)		869	869	216	216	216	216	216	216	216	216	216	216	216	216	216
Recurrent measures		155	155	155	155	155	155	155	155	155	155	155	155	155	155	155
Monitoring & Engineering		20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Maintenance		176	189	202	205	208	212	215	218	221	225	228	231	234	238	241
Total (1)		1220	1233	1189	596	599	602	606	609	612	615	619	622	625	628	632
(2)	44541															
(3)	7194															
SCENARIO 3																
Investment (construct.)		869	869	0	0	0	0	0	0	0	0	0	0	0	0	0
Recurrent measures		155	155	215	215	215	215	215	215	215	215	215	215	215	215	215
Monitoring & Engineering		20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Maintenance		176	189	202	202	202	202	202	202	202	202	202	202	202	202	202
Total (1)		1220	1233	437	437	437	437	437	437	437	437	437	437	437	437	437
(2)	35109															
(3)	6896															

(1) Total per year

(2) Total investment and annual costs

(3) Present value of total costs (12%)

TABLE A9-15 (Continued)

FAP 22 ANNUAL COST AND PRESENT VALUE ESTIMATE AT ECONOMIC PRICE (1991 constant Tk million)

(Sheet 3 of 4)

		2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
SCENARIO 1																
Investment (construct.)		831	831	831	831	831	831	831	831	831	831	831	831	831	831	831
Recurrent measures		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Monitoring & Engineering		20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Maintenance		391	403	416	428	441	453	466	478	491	503	516	528	541	553	566
Total (1)		1242	1255	1267	1280	1292	1305	1317	1330	1342	1354	1367	1379	1392	1404	1417
(2)	70971															
(3)	7805															
SCENARIO 2																
Investment (construct.)		216	216	216	216	216	216	216	216	216	216	216	216	216	216	216
Recurrent measures		155	155	155	155	155	155	155	155	155	155	155	155	155	155	155
Monitoring & Engineering		20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Maintenance		244	247	250	254	257	260	263	267	270	273	276	280	283	286	289
Total (1)		635	638	641	645	648	651	654	657	661	664	667	670	674	677	680
(2)	44541															
(3)	7194															
SCENARIO 3																
Investment (construct.)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Recurrent measures		215	215	215	215	215	215	215	215	215	215	215	215	215	215	215
Monitoring & Engineering		20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Maintenance		202	202	202	202	202	202	202	202	202	202	202	202	202	202	202
Total (1)		437	437	437	437	437	437	437	437	437	437	437	437	437	437	437
(2)	35109															
(3)	6898															

(1) Total per year

(2) Total investment and annual costs

(3) Present value of total costs (12%)

TABLE A9-15 (Continued)

(Sheet 4 of 4)

FAP 22 ANNUAL COST AND PRESENT VALUE ESTIMATE AT ECONOMIC PRICE (1991 constant Tk million)

		2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051
SCENARIO 1														
Investment (construct.)		831	831	831	831	831	831	831	831	831	831	831	831	0
Recurrent measures		0	0	0	0	0	0	0	0	0	0	0	0	0
Monitoring & Engineering		20	20	20	20	20	20	20	20	20	20	20	20	20
Maintenance		578	590	603	615	628	640	653	665	678	690	703	715	728
Total (1)		1429	1442	1454	1467	1479	1492	1504	1517	1529	1542	1554	1566	748
(2)	70971													
(3)	7805													
SCENARIO 2														
Investment (construct.)		216	216	216	216	216	216	216	216	216	216	216	216	0
Recurrent measures		155	155	155	155	155	155	155	155	155	155	155	155	155
Monitoring & Engineering		20	20	20	20	20	20	20	20	20	20	20	20	20
Maintenance		293	296	299	302	306	309	312	315	319	322	325	328	331
Total (1)		683	687	690	693	696	700	703	706	709	713	716	719	506
(2)	44541													
(3)	7194													
SCENARIO 3														
Investment (construct.)		0	0	0	0	0	0	0	0	0	0	0	0	0
Recurrent measures		215	215	215	215	215	215	215	215	215	215	215	215	215
Monitoring & Engineering		20	20	20	20	20	20	20	20	20	20	20	20	20
Maintenance		202	202	202	202	202	202	202	202	202	202	202	202	202
Total (1)		437	437	437	437	437	437	437	437	437	437	437	437	437
(2)	35109													
(3)	6898													

(1) Total per year

(2) Total investment and annual costs

(3) Present value of total costs (12%)

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TABLE A9-16
REPORTED DISBENEFITS IN SELECTED AREAS (FAP 1) (annual average in Tk million)

	Fulcharighat	Sariakandi	Kazipur	Sirajganj	Betil
Length of bank erosion (km)	8	16	8	8	8
Erosion rate (m/year)	60	100	60	100	60
Consequence of erosion					
Land losses	7.640	25.225	8.035	14.063	10.500
Property losses	3.813	6.181	2.480	30.422	5.070
Infrastructure losses	1.014	1.682	0.816	2.708	1.419
Subtotal	12.467	33.089	11.331	47.193	16.989
Consequence of embankment breaches					
Crop losses	16.039	5.759	23.332	5.774	6.319
Livestock losses	0.321	0.034	0.314	0.595	0.332
Property losses	1.864	0.731	3.469	8.331	7.626
Infrastructure losses	1.567	0.380	1.942	1.705	2.150
Subtotal	19.791	6.904	29.057	16.405	16.427
Consequence of embankment retirement					
Reduced crop production	0.413	160.208	0.351	0.296	0.306
Reduced fish production	0.000	1.128	0.000	0.000	0.000
Reconstruction and O & M costs	4.060	0.000	4.060	4.060	4.475
Subtotal	4.473	161.336	4.411	4.356	4.781
Total average annual disbenefits	36.731	201.328	44.799	67.954	38.197
EIRR	-2.9%	14.9%	-0.9%	22.9%	7.2%
Average per km	4.591	12.583	5.600	8.494	4.775

Source : 2nd Interim Report

TABLE A9-17
MEGHNA RIVER BANK PROTECTION/SHORT TERM STUDY
AVERAGE EXPECTED ANNUAL BENEFITS (in Tk million)

	Average benefits	EIRR	
Bhairab Bazar	210.2	38.6%	(Inland port and industrial township)
Munshiganj	54.6	27.9%	(Cold storage and industrial center)
Chandpur	238.6	7.1%	(Inland port and industrial-trading center)
Eklashpur	56.2	2.8%	(Irrigation project, but agricultural benefits represent less than 10% of the river training project benefits)
Haimchar	33.0	1.8%	(Irrigation project, but agricultural benefits represent less than 10% of the river training project benefits)
Meghna R&H Bridge	380.4	189.9%	(Communication node)
Maniknagar	14.9	0.2%	(Agricultural project, but agricultural benefits represent only 20% of the river training project benefits)

TABLE A9-18

COST/BENEFIT ANALYSIS FAP 22

(Sheet 1 of 4)

		1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Phase 1 (scenarios 1, 2 & 3)																
Total costs		637	646	655	664	673	65	65	65	65	65	65	65	65	65	65
Total benefits		0	90	185	285	392	505	520	536	552	568	585	603	621	639	659
Net benefit		-637	-556	-470	-378	-281	439	454	470	486	503	520	537	555	574	593
EIRR	0.163															
NPV (12%)	1090															
Phase 2 (scenario 1)																
Total costs		637	646	655	664	673	1084	1099	1115	1130	1145	1160	1176	1191	1206	1222
Total benefits		0	90	185	285	392	505	603	708	817	933	1055	1184	1319	1461	1611
Net benefit		-637	-556	-470	-378	-281	-579	-496	-407	-312	-212	-105	8	128	255	389
EIRR	0.132															
NPV	702															
Phase 2 (scenario 2 & 3)																
Total costs		637	646	655	664	673	1089	1102	1115	1128	1141	1154	1167	1180	1193	1207
Total benefits		0	90	185	285	392	505	603	708	817	933	1055	1184	1319	1461	1611
Net benefit		-637	-556	-470	-378	-281	-584	-499	-408	-311	-208	-99	16	139	268	404
EIRR	0.133															
NPV	749															

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TABLE A9-18 (continued)

COST/BENEFIT ANALYSIS FAP 22

(Sheet 2 of 4)

		2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Phase 1 (scenarios 1, 2 & 3)																
Total costs		65	65	65	65	65	65	65	65	65	65	65	65	65	65	65
Total benefits		678	699	720	741	764	786	810	834	859	885	912	939	967	996	1026
Net benefit		613	633	654	676	698	721	745	769	794	820	846	874	902	931	961
EIRR	0.163															
NPV (12%)	1090															
Phase 2 (scenario 1)																
Total costs		1237	1252	249	249	249	249	249	249	249	249	249	249	249	249	249
Total benefits		1768	1933	2107	2170	2235	2302	2372	2443	2516	2591	2669	2749	2832	2917	3004
Net benefit		531	681	1858	1921	1987	2054	2123	2194	2267	2343	2420	2500	2583	2668	2755
EIRR	0.132															
NPV	702															
Phase 2 (scenario 2 & 3)																
Total costs		1220	1233	222	222	222	222	222	222	222	222	222	222	222	222	222
Total benefits		1768	1933	2107	2170	2235	2302	2372	2443	2516	2591	2669	2749	2832	2917	3004
Net benefit		549	701	1885	1948	2014	2081	2150	2221	2294	2370	2447	2527	2610	2695	2782
EIRR	0.133															
NPV	749															

TABLE A9-18 (continued)

COST/BENEFIT ANALYSIS FAP 22

(Sheet 3 of 4)

		2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
Phase 1 (scenarios 1, 2 & 3)																
Total costs		65	65	65	65	65	65	65	65	65	65	65	65	65	65	65
Total benefits		1057	1089	1121	1155	1190	1225	1262	1300	1339	1379	1420	1463	1507	1552	1599
Net benefit		991	1023	1056	1089	1124	1160	1197	1234	1273	1314	1355	1398	1441	1487	1533
EIRR	0.163															
NPV (12%)	1090															
Phase 2 (scenario 1)																
Total costs		249	249	249	249	249	249	249	249	249	249	249	249	249	249	249
Total benefits		3094	3187	3283	3381	3483	3587	3695	3806	3920	4037	4159	4283	4412	4544	4680
Net benefit		2846	2938	3034	3132	3234	3338	3446	3557	3671	3789	3910	4034	4163	4295	4432
EIRR	0.132															
NPV	702															
Phase 2 (scenario 2 & 3)																
Total costs		222	222	222	222	222	222	222	222	222	222	222	222	222	222	222
Total benefits		3094	3187	3283	3381	3483	3587	3695	3806	3920	4037	4159	4283	4412	4544	4680
Net benefit		2872	2965	3061	3159	3261	3365	3473	3584	3698	3816	3937	4061	4190	4322	4459
EIRR	0.133															
NPV	749															

TABLE A9-18 (continued)

COST/BENEFIT ANALYSIS FAP 22

(Sheet 4 of 4)

		2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051
Phase 1 (scenarios 1, 2 & 3)														
Total costs		65	65	65	65	65	65	65	65	65	65	65	65	65
Total benefits		1647	1696	1747	1799	1853	1909	1966	2025	2086	2149	2213	2279	2348
Net benefit		1581	1631	1682	1734	1788	1844	1901	1960	2021	2083	2148	2214	2282
EIRR	0.163													
NPV (12%)	1090													
Phase 2 (scenario 1)														
Total costs		249	249	249	249	249	249	249	249	249	249	249	249	249
Total benefits		4821	4966	5114	5268	5426	5589	5756	5929	6107	6290	6479	6673	6873
Net benefit		4572	4717	4866	5019	5177	5340	5508	5680	5858	6041	6230	6424	6625
EIRR	0.132													
NPV	702													
Phase 2 (scenario 2 & 3)														
Total costs		222	222	222	222	222	222	222	222	222	222	222	222	222
Total benefits		4821	4966	5114	5268	5426	5589	5756	5929	6107	6290	6479	6673	6873
Net benefit		4599	4744	4893	5046	5204	5367	5535	5707	5885	6068	6257	6451	6652
EIRR	0.133													
NPV	749													

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BANK PROTECTION AND RIVER TRAINING
(AFPM) PILOT PROJECT
FAP 21/22

DRAFT FINAL REPORT

ANNEX 10

IWT ASPECTS OF THE JAMUNA RIVER WITH RESPECT TO RIVER TRAINING

DECEMBER 1992

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ANNEX 10

IWT ASPECTS OF THE JAMUNA RIVER WITH RESPECT TO RIVER TRAINING

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1 INTRODUCTION

The FAP 22 study has the objective to find alternative and/or additional solutions to river training measures as per FAP 21 (and previous studies). The latter contains principally solutions for river stabilisation by means of fixed structures.

Alternative/ additional solutions comprise recurrent measures with a flexible character aimed at diverting the river from the threatened reaches along the banks and in the long term to change the characteristics of the river. This might have an impact on the navigation as being performed on the Jamuna river.

The Inland Water Transport (IWT) study was to assess this impact following an additional ToR, reading:

> **To analyze the influence of navigational aspects on the strategies for bank protection and river training, as well as the AFPM (Active Flood Plain Management) and to indicate possible mutual interests in the performance of an initial pilot project.**

The contents of this annex concern:

- a general review of the interrelated navigation and river characteristics as considered for the Jamuna River
- IWT traffic on the Jamuna River at present
- impact assesment of some river strategies for the Jamuna on the Inland Water Transport.

2 THE JAMUNA RIVER

2.1 GENERAL

To understand the functioning of inland navigation in the region of the giant water course which forms a barrier in the area and dominates by providing means of existence, but also destroying and bringing misery, a summary description of its various aspects is given hereunder.

Many details which have a bearing on the conditions for inland navigation have been compiled from current and previous FAP studies, others from previous IWT focused studies or from field observations and last not least from interviews with those whose daily life is governed by the river itself or by river-related activities.

2.2 TOPOGRAPHY

River Course: Flowing on a westerly course through the Assam valley, with the Himalaya range to the north and the Meghalaya mountains to the south, the Brahmaputra river turns south at the Indian township of Dhuburi and crosses the border in Nunkhawa to enter the flood plains of Bangladesh. The mainstream today flows all the way south till the confluence with the Ganges river some 240 km from where it crossed the border. However after 80 km, at Bahadurabad the river changes name into Jamuna. The distributory at that spot is now called "Old Brahmaputra", but it used to be the main river until a major shift took place and the Jamuna became the main stream.

Riverbank Land Use: All along its course, the land is cultivated by a population principally living in numerous small villages and settlements which are scattered along the banks. Only a few townships are located immediately on the riverbank. Most of the cities are found in a distance of 30 to 50 km from the riverbank like Rangpur and Bogra to the west and Jamalpur to the east. Furthermore it is estimated that 300,000 persons (see ANNEX 7) are living on the more or less permanent islands or chars in the river.

Road Access: Access by road to the riverbanks is rather difficult, if not impossible. The only more or less fixed points are the railheads (ghats) where freight wagons and passengers are ferried across the river (Bahadurabad - Fulchari in the northern sector and Jogannathganj - Sirajganj in the south) and the road heads where trucks and busses are ferried across (Bhuapur - Sirajganj and Aricha - Nagarbari), both in the southern sector). A road bridge just south of Sirajganj is planned to be constructed in the near future. Roads running parallel to the river on the east bank (Dhaka-Jamalpur) are in bad condition. However the condition of road portion from Nagarbari to Baghabari (on the bank of Baral river) on the other bank is reasonable. The condition of road from Baghabari to Bogra and then to Rangpur is excellent. From this road the Jamuna river can be reached at several places.

2.3 RIVER CHARACTERISTICS

River Length: The total length of the run from the Himalaya range to the Bay of Bengal via the rivers Brahmaputra - Jamuna - Padma - Lower Meghna, is 2700 km. The Brahmaputra /Jamuna section in Bangladesh is about 240 km from the Indian border to the confluence with Ganges river. The total area north of latitude $25^0 10'$(Bahadurabad) comprises 580 000 km^2, but less than 5% of this area is Bangladesh territory.

Type & Discharge: The Jamuna is an alluvial and non-tidal river with a slope of 8.0 to 6.0 cm/km and has an annual average discharge of 20 000 m^3/s. A record peak flood discharge of 99 500 m^3/s, was recorded in 1988. The usual average peak discharge is in the order of 60 000 m^3/s, with a minimum of 43 100 m^3/s and peaks of 77 000 m^3/s.

Discharge Sources: The discharge is principally fed from snow melt of the Himalayas. But in the wet season the rainfall in Assam contributes significantly to the discharge. Tributaries are found on the westbank only. A major tributary is the Teesta river which flows in south-east direction over a distance of 250 km from the Himalaya range to its confluence with Jamuna, just south of the border with India. Smaller tributaries are Dudkumar and Dharla river. All these rivers have their source in the Himalayas; yet they contribute also with rainfall from the northwest of Bangladesh. Pure rainfall tributaries on the westbank are Banjani river, Ghagat river (Manos regulator), Hurasagar river, Karatoya and Gohala river (= Baral river).

Some distributaries like Old Brahmaputra and Daleswari rivers are found on the east bank but their share of water diverted to the Meghna basin has become relatively small.

Part of the rainfall in the adjacent areas is drained through smaller rivers which run parallel to the Jamuna to the south to debouch into the Ganges or Padma river.

River Width: The width of the river between the banks ranges between 6 km and 18 km, the wider sections having large islands or chars. They are flooded during the peak of the flood when also a part of the discharge is spilled in the floodplain. In the surrounding land the embankments and dikes which cris-cross the area then remain the only dry tracks.

Hydrograph: The hydrographs in subsequent years vary in peak discharge level but the level changes are more or less identical for the various periods characterised as follows:

November - February	gradually falling levels
January till mid-March	minimum levels, hardly changing
March	some rise of levels
April - June	rapidly rising levels
early July till mid-October	maximum levels, changes up and down

Although the peak levels may vary considerably, the low water levels throughout the years are reasonably constant and vary less than 1.0 m in the various stations along the river. The difference between the highest and the lowest water level in one year may amount to 6 to 8m in Nunkhawa as well as in Aricha.

Channel Pattern: With decreasing discharge, starting around September and reaching its lowest in January, the permanent islands, the chars, will fall dry again and gradually also the surrounding sandbanks and flats.

Deep channels will emerge in a braided pattern, but when closely observed two or three main branches can be distinguished and a number of minor interlinking channels. Of the main branches generally only one of the two or three parallel branches is distinctly the deepest, but this may change after every flood. And even in the deepest branches shallows will form in such a way that they would hamper navigation if 'bandalling' were not applied (usually starting by mid-November).

Bed Morphology: The river bed consists of a movable bed of fine sand. During flood, sand dunes with an average length of 200 m are found on most stretches. The average height of these dunes amounts to 10 to 20% of the water depth. As such 3 to 4 m high dunes may be found in the main branches. Their propagation celerity averages 85 m/day. The dunes are shaped like sand waves in the desert; gently rising in downstream direction and a steep fall from the crest into a through.

Current Velocities: Current velocities during flood are measured with an average of 2 m/s in the northern part and 1.75 m/s in the southern stretch, but maximum velocities up to 4 m/s have been reported in some locations. During low water the current velocities decrease to 1.5 to 1.0 m/s.

Sediment Load: The Jamuna waters are heavily sediment loaded with fine silt particles. The clay content is rather low.

2.4 VAGARIES OF THE RIVER

Flooding: The annual spill into the floodplain, although probably having some benefit for agricultural production, often causes chaos and destruction when coinciding with heavy rainfall in the area.

Erosion: More serious than flooding is bank erosion. During the peak discharges the rate of erosion reaches such a level that whole settlements are swept away and many square kilometres of farmland with roads and embankments disappear. Although bank erosion always has been present in the history of the river it seems that presently the main attack is concentrated on the west bank, thus causing the river gradually to shift westward.

Shifting Channels: A result of increased erosion is that traditionally navigable branches are suddenly closed whereas others have opened up. Or, that landing places and their infrastructure disappear or become inaccessible.

But also when erosion is 'normal' shifting of the navigable route is a constant threat to navigation. The branches of the route selected as being the most appropriate for navigation, may have widths up to 3 or 4 km; however, within these branches a navigable channel with an average width of 200 m may be distinguished, meandering as a river in a river. These channels shift frequently, sometimes within a day, and during that process the least available depth may be reduced considerably.

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2.5 INTRICACIES OF NAVIGATION

Pilotage Services: Bangladesh Inland Water Transport Authority (BIWTA) inherited from the Joint Steamer Company a network of pilot stations, each being in charge of a stretch or 'beat' upstream and downstream of its base station. Pilotage is **not** compulsory, but vessel masters do happily use this service to avoid the hazard of grounding.

The frequency of pilotage trips gives an impression of the amount of pilot services rendered on the stretch Kawlia - Daikhawa (border). The stretch is subdivided into the following pilot 'beats':

beat		length (km)
Kawlia	- Sirajganj	40
Sirajganj	- Kazipur	22
Kazipur	- Bahadurabad	50
Bahadurabad	- Chilmari	52
Chilmari	- Daikhawa	30

On the whole stretch 3512 pilotage trips were made from July 1990 through June 1991, with a monthly average varying between 230 and 369.

Locating and Marking the Channel: The location of the navigable channels and their shifting is closely observed by the BIWTA stretch pilots, but even they may be in for a surprise when returning after a day or so. Marking the channel is only done where it is absolutely required, for instance at the ferry crossings. But it is a time consuming and labour intensive job which is impossible to execute along the whole river; that is, when taking into account the relatively few vessels that pass.

The stretch pilots keep 'an eye on the water', which means that the water movement indicates where the channel is. However it can also indicate that the channel is in the making. During a fieldtrip it was observed that large vortices, which are formed through bottom undulation, were travelling in water not even 0.60 m deep. Perhaps that the next day the depth would be 1 m.

The Railway has its own organization for surveying and marking the routes of the railway ferries. They maintain two teams on the round-the-clock service at Bahadurabad - Fulchari, and one at the daylight only Jogannathganj - Sirajganj service, who daily verify the depth and mark the channel with bamboo poles.

Position Finding: Position finding on the river is difficult. There are very little landmarks over long stretches and when present (villages, radio masts) they are invariably located far off the riverbanks and thus generally too far away to serve as a heading or sighting reference. The shape of the land (headlands, islands) does not help either as their shape and position may have completely changed since the last map was produced. Of course the local pilots, who constantly observe the changes do have their orientation points on the banks and islands and this makes them indispensable for vessels navigating the Jamuna.

Depth in the Navigable Channel: The minimum depth of the navigable channel all along the Jamuna is claimed to be kept such that 1.80 m (still named 6 ft) draught vessels can pass with 0.50 m keel clearance (still referred to as 1.5 ft). However, due to the haphazardly emerging shoals the maximum draught must sometimes temporarily be reduced to 1.50 m (5 ft). This 'actual depth' is announced in a 'River Notice'. In the past, for instance in 1973, the draught had to be restricted to 1.20 m (or 4 ft), but this may have been an excessive situation, also because the Conservancy & Pilotage organisation at that time, still was suffering from the set back of the liberation war. The average depth in the river is much larger but the shoals at several places do hamper the safe passage of a deep draughted vessel.

The minimum depth at the shallowest location is called 'controlling depth' or Least Available Depth (LAD) and is valid for a certain stretch only. But this is of little value to shippers since they are not allowed to sail the Jamuna with more draught than indicated by the Conservancy & Pilotage Department of the BIWTA, even if the controlling depth -in their opinion- would allow so. For instance; in october 1992 between Aricha and Chilmari 3.0 m draught was allowed and 2.30 m between Chilmari and the border. But in general the high water draught is given with 2.40 m (8 ft) only. Apparently the pilots maintain as much safety margin as possible, which is understandable because it is not easy to find an unmarked thalweg channel in a 600 m to 1500 m wide stretch of water, with almost no reference point ashore. A stabilised navigable channel, resulting from training measures would certainly give some relief in the presently maintained draught allowance.

Depth Improvement: By mid October the hydrographic department of BIWTA has a complete overview of locations where the LAD will be less than to guarantee passage of 1.80 m draught vessels.

Usually this list contains some 15 to 20 locations, the majority of which are recurrent within a certain stretch. On these locations 'bandals' will be placed from mid November onward. Most of the locations are selected such that a passage is created along a steep bank so that only one bandal has to be placed on the shallow opposite. But a number of passages have to be created on a shoal mid river, for which bandals on both sides are required.

Once that the bandals are placed the scouring will be monitored and if necessary the bandal will be shifted or additional bandals will be erected. Construction of one bandal of 1000 ft length takes one week for 11 labour. After that 8 men will do the monitoring of the scouring process.

For the 1992/93 season the locations are as follows (in downstream direction):

	Name	Latitude	Position in River
-	Kaliragla shoal	25°46'-49'	R bank to mid river
-	Bangmara shoal	25°33'	R bank (Chilmari access)
-	Teestamuk shoal	25°28'	R bank side
-	Kamarjani shoal	25°22'	R bank
-	Balashi shoal	25°19'	R.bank
-	Changar Char } Bogar Char } shoals Manikdah }	25°03'-00'	L bank
-	Miakholaa shoal	24°44'	R bank
-	Char Boyra shoal	24°35'	R bank
-	Tengla Hata shoal	24°32'	R bank side
-	Sirajganj Ghat shoal	24°28'	R bank
-	Nalchia shoal	24°26'	L bank
-	Isa Pasha shoal	24°18'	L bank
-	Muradpur shoal	24°06'	L bank
-	Pachuria shoals	24°03'	L bank side
-	Alokdia shoals	23°55'-52'	R bank side

Despite the thorough preparations and soundings during the falling stage of the river, additional shoals may emerge at random. Usually some 5 additional bandals have to be erected during the lowest discharge.

Grounding Hazard: Even when guided by a stretch pilot from BIWTA (which is not compulsory), vessels run the risk of grounding due to the rapid shifting of the channel, unexpected sedimentation and lost position during bad visibility.

Apparently the intermediate season between flood and low water is the most embarrassing period, since the sandbanks are only just emerging and the navigable channel still shifting at will. Finding the channel is then most problematic, but once found there is sufficient depth available.

There are reports of vessels becoming grounded at dusk, to find themselves high and dry on a sandbank next morning, after the waterlevel had receded during the night. In such cases the vessels must be dredged out with the help of the propeller wash from other vessels, which may take time to arrive on the scene.

With the water falling further, the depth in the navigable channels is affected in many places as well. By the end of September when the first signs of shoaling appear in the navigable channels, the Conservancy and Pilotage Department of BIWTA is alerted to start their annual depth improvement programme.

Overnight Stops: Night navigation, except on the ferry routes, is hardly possible. The Conservancy and Pilotage Department renders no night pilotage service on unmarked stretches and it seems virtually impossible to do so when considering the day light difficulties of position determination.

Consequently the vessels plying the Jamuna have to stop for the night. This introduces another danger; that of assaults by 'dacoits', which seems to be an increasing problem. As a result the barges prefer to stay overnight in the vicinity of a village or preferably a pilot station. These are also places where anchoring is known to be safe, if the vessel cannot tie up to the bank. But it stands to reason that where such stops are scarcely found along the river, the daylight cannot always be used to its full extent.

Anchoring in Midstream: Another problem of staying 'somewhere' on the river is that midstream anchoring may cause loss of anchor. The shifting sand dunes may bury the anchor to such an extent that retrieval is impossible.

Appraisal of the Jamuna: Amongst the barge men of Bangladesh, the river is known and feared for its vagaries and intricacies of navigation. This may be one reason that the private sector is not very keen on accepting cargo to or from stations along this river, in particular the northernmost locations. Still there are regular transports as far upstream as Chilmari by private vessels, who apparently have developed skill to overcome the problems of Jamuna navigation, like the state-owned IWT companies from Bangladesh and India have done before. It must be stated that BIWTA largely contributes to this by improving the safety of navigation with their efficient conservancy and pilotage operations on this difficult river.

Nevertheless, apart from other hazards, vessels do run aground from time to time and this makes the Jamuna somewhat less than popular amongst the Bangladesh barge owners, since vessels may get stuck for a long time when it happens on the downward journey or, even worse, when during a falling stage. On the other hand, the worst locations are found just downstream of the border with India, where mainly transit vessels from India ply.

3 IWT TRAFFIC ON JAMUNA RIVER

3.1 GENERAL

Although waterborne traffic along the river is relatively underdeveloped when compared with the use of waterways of the rest of the country, the Jamuna river is an important artery for various categories of IWT. They are:

From the 'organized' sector

a) private owned
- steel hull cargo vessels
- steel hull tankers
- steel hull passenger vessels
- wooden cargo launches
- wooden passenger launches

b) public owned
- steel hull road passenger ferries
- steel hull vehicle ferries
- steel hull railway passenger ferries
- steel hull railcar ferries

From the unorganized sector

private owned only
- wooden sailing or rowed country boats
- wooden mechanized country boats

Of the above categories the steel hull passenger vessels, such as plying the southern regions, have not been noticed. As far as long distance passenger line services do still exist, they are performed with wooden launches. The sailing country boat is also almost extinct. The remainder is operating on the Jamuna river as described in the following sections.

3.2 TRAFFIC ALONG THE RIVER

3.2.1 Long Range Traffic

Traffic from vessels sailing all the way from Chittagong (Bay crossing) up to the most northern stations on Jamuna river does not exist. But tankers with POL (petroleoum, oil, lubricant) products (principally diesel oil) from Dhaka oil depots do sail as far as Chilmari where tank barges moored along the riverbank act as a floating storage.

Other traffic from Chittagong as well as from Dhaka / Narayanganj or Mongla / Khulna area exists to Baghabari on the Baral river, a tributary of the Jamuna river with its confluence at Nakalia. This traffic comprises POL products as well as bulk cargo and is being executed with private sector tankers and cargo vessels up to 600 ton as an average.

There are no indications of other important commodity movements to and from stations along the Jamuna river with ample sized vessels. There are however possibilities for such developments, provided that IWT Terminals are created in places where access to the hinterland through the waterway/roadway system is possible.

As such might be considered: Kurigram on the Dharla river, Chilmari near the mouth of Teesta river, perhaps Kamarjani on the confluence of Banjani river, Balashi on the mouth of the Manos/Ghagat river and Sariakandi with Bangali river very near.

A primary condition for the development of such centres, apart from the economical viability, would be the guarantee of a stable location on the river bank, not threatened by erosion. As such, ports should be located near hard points, because the channel may still shift or erode in the intermediate zones.

An improvement of the navigational conditions of the Jamuna river through the proposed means of river training would of course boost such a development as well.

3.2.2 Short Range Traffic

This traffic comprises principally the movements of country boats, which after having been losing to truck traffic, are coming rapidly 'back in business'. This is mainly because the sector has discovered the advantage of mechanized propulsion which not only brings them faster to destination, but also makes them more reliable in terms of transit time for the shipper of goods.

In this way the countryboat is retaking the distribution function from the truck, which can be clearly observed at Baghabari IWT Terminal. Here fertilizer arrives from Chittagong and Dhaka area by private sector freight vessels and is distributed all over the region by trucks and country boats. Because of their low draught (1 to 2 ft) they are able to penetrate deep into the area along the many rivers and creeks and deliver 'at the front door' almost as quick as the truck and thus successfully contend the latter's proclaimed advantage.

Whether this will develop at stations along the Jamuna as suggested above is still a question. A condition is that sufficient feeder traffic as in Baghabari comes to development or that local production is stimulated. As such the recently inaugurated Jamuna fertilizer factory at Jogannathganj might create country boat movements for distribution.

On the Jamuna river the phenomenon of come-back of the country boat can be observed also, be it for other purposes than physical distribution. All along the river flotillas of mechanized country craft can be seen plying with huge loads of jute or other cargo. Here their traditional function as trader and buyer of agricultural products from producers living along the riverbanks and on the chars, is being strengthened by their increased speed to reach the markets and return to their trading area.

3.2.3 Local Traffic

Little is known about local commercial traffic, which if any, concerns country craft only. It may be that this traffic merges with the above mentioned and reverse. There is also a possibility that local traffic serves as feeder for the trading country boats.

3.2.4 Transit Traffic

This traffic is exclusively executed by the Indian State owned barge operator Central Inland Water Transport Company (CIWTC) of Calcutta. They have of course a big interest in the quality of the waterway as it is an important link with Assam. A treaty exists between the two countries in which the free transit passage, pilotage services, as well as the obligation of conservancy of the waterway in the interest of India is settled. As the CIWTC vessels are the biggest and most frequent users of the Jamuna, it will be clear that a substantial part of the conservancy and pilotage activities is directed on this traffic.

3.3 TRAFFIC ACROSS THE RIVER

More than for traffic along the river, the Jamuna is known for its ferry services to cross the river and its related problems of delays and interruption.

3.3.1 Road Ferries

Of the two road ferries, the Aricha - Nagarbari ferry service is the most important. This service operated by Bangladesh Inland Water Transport Corporation (BIWTC) has a round the clock service with modern ro-ro ferries of which 10 vessels are authorized on this run. It is one of the main ferry crossings in the country. The theoretical distance between the two terminals is 19 km but as the route is periodically affected by shoals this distance can increase with 2 km or 3 km. Despite marking of the navigable channel and the presence of experienced pilots, the ferries sometimes run aground during bad visibility, where they may have to remain for several hours. During such conditions the service is suspended. This causes huge losses in transport of perishable goods. The location of the terminals (link span pontoons) must be shifted from time to time because of shoaling or erosion.

The Bhuapur - Sirajganj service is the next large ferry crossing the Jamuna, it is notably minor than the Aricha ferry service. But sometimes it becomes the main transit point due to law and order problems at Aricha or the manifestation of rackets in that area.

The minimum crossing length amounts officially to 11 km, but it appears that through the changing channel configuration and char formation, even in the high water period, this distance is notably more. With the falling water the east bank approach to Bhuapur terminal dries out and the terminal pontoon must then be shifted to deep water south from Bhuapur

Ghat. From here the crossing distance to Sirajganj is 16 km but the road distance has increased with 17 km. The dry season terminal cannot be used in the wet season as it is located in area which becomes flooded. For this reason the Bailey bridge which spans the Daleswari river in the road to the dry season terminal must be removed before each high water.

With the planned construction of the Jamuna Bridge just south of Sirajganj, it is most likely that the importance of both transit points will be reduced. The Bhuapur ferry service will most probably be terminated, whereas the Aricha ferry service will attract less traffic of trucks and busses.

3.3.2 Railway Ferries

The most important rail link ferry is the Bahadurabad - Fulchari service, which serves as a link between the central region mainline (Dhaka - Mymensingh - Jamalpur) and the west bank meter-gauge railway network.

The ferry service is performed with two self-propelled vessels for passengers and five flat top barges for goods-wagons. The latter are being side-towed by powerful tugs of which four nos are available. The passenger ferry service matches the arrival of the trains and is performed round-the-clock. The freight transfer is preferably executed in daylight only, but continues at night according to the demand.

The length of the route is about 18 km at high water when the ferry can almost cross over in a straight line to the railhead. Another railhead which is located on a siding 15 km to the south, has been abandoned since the mainstream deflected from the bank. The route length increases up to 35 km when a detour must be made to the north almost as far as Balashi and then another 10 km downstream to reach the Fulchari railhead

Another railway ferry link is found between Jogannathganj and Sirajganj. It is a most important link with the broad gauge railway network in the western part of the country. The passenger traffic on this ferry, although much lower than at Bahadurabad - Fulchari, is still considerable.

Passengers transfer is performed by the same type of vessel as used on the Bahadurabad - Fulchari route. However this is a daylight only operation, although the channel is said to be marked for night navigation also. The service is reported to be suspended during up to 2 months in certain years, which is a serious matter since the traffic on this route amounts to more than a half million passengers per year. Since Sirajganj is linked to the broad-gauge system only, no freight cars (from the east bank meter-gauge system) are ferried across.

The length of the ferry route is some 24 km at high water, but increases to 43 km in the dry season when a deep channel to cross the river can only be found some 10 km to the south of Sirajganj (this is the same channel as used by the BIWTA road ferry, using its dry season terminal).

The impact of the construction of Jamuna bridge on the above ferries is difficult to predict. Although the bridge has been designed to carry railtrack also, it is still questionable whether the connecting infrastructure will be realised and when. This infrastructure would comprise a meter-gauge railtrack connecting Sirajganj with the metre-gauge track passing through Bogra, and also a new and direct rail track between Dhaka and Bhuapur, following the connecting highway to be build. The latter would supersede the time consuming rail detour via Mymensingh. It appears safe to assume that for the time being, these works will not be completed and that the Bahadurabad - Fulchari railway ferry will continue its existence.

3.3.3 Others

Other services are performed by the more or less organized sector of wooden launch operators. According to the BIWTA records some 10 launches are active on the Aricha - Nagarbari route, whereas 24 launches operate from Sirajganj on a more or less regular basis between Chilmari and Raumari or Bahadurabad.

There is an undefined number of non-registered and irregular ferry services from the unorganised sector executed with country boats, all along the river, but their routes and frequencies have not been traced so far. They fulfil a demand because the population of the chars has no other means of transport than country boats either or not mechanized, to reach the markets on the mainland or for other purposes. It is strongly recommended to investigate this in detail when the exact locations of training measures are established, so as to avoid a negative impact on their operations.

3.4 TRAFFIC FLOWS

3.4.1 Passenger and Vehicle Traffic

The annual traffic as recorded by BIWTC on the Aricha - Nagarbari run amounted in 1991/92 to 3.7 million persons and 320,000 vehicles out of which 275,000 are trucks.

The Bhuapur - Sirajganj run reports an annual traffic of 13,000 passengers and some 27,000 vehicles of which 25,000 are trucks. About 1.5 million passengers are travelling annually on the Bahadurabad - Fulchari railway ferry. On the Jogannathganj - Sirajganj railway ferry the passenger traffic amounts to 600,000 passengers per year.

To estimate the amount of crossings for the char population, the Kurigram ferry can be taken as a basis. This ferry transports yearly an estimated amount of well over two million people across the Dharla river, while the population on the other side is only 250,000. Consequently a conservative estimate for the chars alone amounts to more than 2 million people crossing the river every year.

3.4.2 Freight Traffic

There is presently little organised activity on the Jamuna. Organised means in this context the traffic done by steel-hull vessels and wooden launches, which on the Jamuna is exclusively performed by the private sector. With unorganized is meant the traffic by shallow draught country boats, which can either be sailed and rowed or in growing numbers mechanically propulsed.

There are only three recognised ports used by the organised sector; all located on the west bank viz.: Baghabari, Sirajganj and Chilmari.

The Baghabari activities are definitely linked with the Aricha area, and recurrent measures may help there to improve the draught and the safety of the access channel to the Baral river, on which the BIWTA IWT Terminal is located.

The transit of goods through the IWT Terminal is considerable and well over 300,000 tonnes, although BIWTA statistics are showing much less than that. Similarly the traffic at Chilmari, which is 95% POL, is underevaluated in the official statistics by a factor which cannot be less than 50%, and may be many times more. The number of vessels plying the Jamuna in the reach between Bahadurabad and Chilmari averages 14 per month, while the statistics register no more than 5 vessels per month.

One petroleum company does not report any traffic at all to this place, while it maintains a floating storage there and has a fleet of 3 vessels regularly calling.

The Jamuna Fertilizer Factory at Jogannathganj, which was recently inaugurated, will produce 560,000 tonnes of fertilizer per year. A large part of its market is found across the river, in North Bengal. Thus it is natural that the plant will contemplate the use of water transport to distribute its products. For this reason care should be taken that the approach channel to the factory site, which is already full of shallows, does not silt up in the long term under the proposed recurrent measures. To enter this trade will be difficult for the organised sector because there are no port nor storage facilities on the bank of the Jamuna. But the unorganised sector may have a chance to enter with mechanized country boats, as in Baghabari.

Some unorganised sector freight transport can be estimated as follows:

The chars are inhabited by some 300,000 people, who need essentials to be brought to them from the mainland. Assuming this to be 3.3 kg per week per head, this amounts to 52,000 tonnes per year, which is more than the officially registered Chilmari traffic.

Furthermore, whatever is produced on the chars and not consumed locally, has to leave by water for the mainland to be sold on the markets. This amounts to some 50,000 tonnes per year; in particular jute, reeds and paddy.

There is also a pottery industry on the banks of the Jamuna, and large water containers or jars are exported to Dhaka via the waterway. They would not stand the road journey. As all the above activities are spread over hundreds of islands, only small boats come into account for this type of transport.

From ratios developed from FAP 3.1 studies and the 1983-84 Agricultural Census, the country boats on the chars as well as on the attached and setback lands from Aricha to the border may well number 20,000 and may perform an annual traffic of 600,000 tonnes.

Finally the Indian transit transport should be mentioned. The total goods movement to and from Assam over the last 10 years, ranged annually between some 50,000 and 100,000 tonnes. This would correspond to about 50 return trips per year. A peak was reached between 1985 and 1989. Since then the movement has been in decline. The goods movement to Assam is sometimes 1.5 to 3 times the reverse movement.

4 RIVER TRAINING STRATEGIES

4.1 GENERAL

Strategies have been comprehensively discussed in the main report under Section 5.1. Their scenarios are summarized in section 4.2 of this annex, for a good understanding of the conclusions as drawn in Chapter 5 on the effect of the strategies and measures on IWT.

For setting the stage, one could assume that no river training shall be done at all. The apparent conclusion is that the river will continue its shifting towards the west under simultaneous erosion of the banks, including those locations where terminal activities are or might be taking place. Flooding of the adjacent land will continue and shifting of navigable channels through sedimentation and erosion will continue as unpredictable as before. Maintaining the navigable depth may turn out to become more problematic and more labour intensive each year.

There is also the risk that the main stream breaks through the west bank to the Bengali river, which would cause a major shift as happened in the past with (old) Brahmaputra and Jamuna river. The effects of this on navigation are unpredictable. A number of scenarios that might prevent the above situation, have been considered.

4.2 POSSIBLE SCENARIOS

Three possible scenarios have been identified as a result of technical studies. They can be summarized as follows:

i. Jamuna stabilized as an anabranched flood channel through "hard" measures;
ii. Jamuna stabilized as an anabranched flood channel through both "hard" and recurrent measures;
iii. Jamuna stabilized as a braided river with a reduced width.

The first scenario corresponds to the solution proposed by a Chinese/ Bangladesh team. It aims at stabilizing the Jamuna river in its present planform by creating hard points, so called "nodal points", by means of revetments and groynes or similar structures at regular intervals on both sides of the river and at the head of main islands. Provision is made for additional protection works on the banks which would remain erosion prone between the nodal points. Monitoring is required till no more erosion is observed; protection works are then completed and would only require simple maintenance.

The second scenario is similar to the first one but additional protection works between nodal points are mostly replaced by recurrent measures such as the use of surface screens, bottom vanes, bend cut-off, intended to deviate the stream from threatened banks. With this scenario, permanent monitoring and recurrent measures are required till the river is considered stabilized and "hard" protection works can be constructed at a minimum cost to arrive at a permanent solution. Recurrent measures may also be used continuously as a substitute for "hard" works.

The third scenario starts with the prevention of the westward drift of the Jamuna River. Hard points are thus constructed on the west bank and recurrent measures are used as in the second scenario to protect the west bank between the hard points. A counter effect of this protection may be a shift of the erosion process towards the east bank. Recurrent measures will then be applied to protect the east bank against erosion and to gradually reduce the width of the main channel. Existing islands may partly disappear and the accretion of new land along the east bank will approximately replace the eroded land areas.

The implementation of either of the three scenarios is envisaged within 3 main phases:

i. In the first phase (years 1993 to 1998) FAP 21 Test structures and the River Bank Protection 1 Project which are in the pipe-line are implemented. Simultaneously the efficiency of recurrent measures is tested.

ii. In the second phase which may last about 10 years, hard protection works are implemented on the west bank in vulnerable areas and possibly complemented by recurrent measures.

iii. In the third phase which will probably require a longer time, possibly at least till year 2050, river training works assisted by permanent monitoring are completed.

5 IMPACT OF STRATEGIES ON IWT

5.1 GENERAL

The influence of civil works on a river, which may have an impact on inland navigation, is basically determined by the following physical changes:

(i) Fairway Modifications
 a) length variation
 b) shortcut routes
 c) feeder routes
 d) shelter
 e) width variation
(ii) Access to Tributaries
(iii) Embankment Improvement
(iv) Current Flow Variation
(v) Depth Variation
(vi) Modified Orientation

Each of these changes may occur isolated or in combination and thus neutralize, decrease or increase the negative or positive effect on navigation and goods transport.

5.2 THE EFFECT PER CATEGORY OF VESSEL

5.2.1 <u>Steel Hull Cargo Vessels and Tankers</u>

They represent the deepest draughting vessels for long range and transit trade on the Jamuna. They will always encounter a main fairway which, with ongoing river training measures, at minimum will remain as it was in terms of sinuosity, depth and width, but probably will improve. Depth improvement would be most important for the 30 km long stretch upstream of Sirajganj and upstream of Chilmari till the border, which at present are reported to have 'controlling depths' which are 0.25 m less than the remainder of the river.

As a spin-off from embankment stabilization they may profit from the creation of more IWT terminals, as has been dwelt upon in Section 3.4.

The opening or closing of secondary routes and the access situation of (secondary) tributaries is of no concern to this category. However, the improvement of access to major tributaries as the Baral river, where dredging is always needed at the confluence, and in future to rivers such as Dharla to Kurigram, would be an asset if river training measures would have that effect.

The fact that, with a more stable fairway, orientation through a more permanent position of islands and headlands will improve for the pilots, is an indirect positive effect.

Shelter might be an important aspect in those cases where the long range and transit traffic is used to stop for the night. It can be visualised that reliable and permanent places of shelter in deep water would emerge from river training measures.

5.2.2 Railway and Road Ferries

Representing the principal cross-river traffic, these vessels are vulnerable to any changes that may occur in the secondary channels which they necessarily have to use on part of their crossing. A good example can be found on the east side of the Jogannathganj - Sirajganj railway ferry crossing. The channel which is used along the east bank gets water from a bifurcation about mid river, some 10 km upstream of the ghat. If, through river training measures less water would flow into that channel, then reconstruction of landing points for railway ferries and road ferries may be necessary. River training measures can be used also to maintain sufficient discharge into that channel, to guarantee undisturbed ferry services.

The remaining variables are of less importance, with the exception of the embankment stabilization, which would be the main benefit for this type of traffic.

5.2.3 Small Launches and Mechanized Country Craft

Representing the irregular, but notwithstanding important local trade, these craft ply all the secondary and tertiary channels which their draught allows. They are the first to suffer from detoriation of those channels by artificial means. Depth variation may not be the severest menace, but closing would force them to make detours and to leave the relative shelter of these secondary and lesser channels for the main stream where, under circumstances, wind rain and waves may threaten their existence. As the movements of these craft is hardly known, it would be the subject of a first ranking investigation as soon as a site for training measures would have been per-selected.

A positive effect will emerge from embankment stabilization, which would allow for more permanent cargo transfer points with some infrastructure on a suitable spot near a village of settlement, than at present.

Access to tributaries of secondary size is of utmost importance. Closing the mouth of a river as has happened for the Manos river with a regulator without locks for at least country craft or small launches, deprives the sector from access to a vast area of waterways with innumerable potential customers.

5.2.4 Non Mechanized Country Craft

Although this type of craft represents a rapidly diminishing category, it must be remembered that for very local activities (fishing, short crossings, nearby transport) a number of these craft always will be around. What has been mentioned as negative for the mechanized sector is even more serious for this class.

5.2.5 General Conclusions

The long range and transit trade with steel vessels will not suffer from any river training measures and only profit, either direct or through spin-off.

The large road and railway ferries may see their cross-river operations improved when their particular problems are properly accounted for in the measures.

The small craft trade and the country boat sector is the most vulnerable sector and they may suffer from measures which do not take into account their particular way of operation. They may however profit from an expansion of their area of operation when secondary tributaries are (re)opened and landing places stabilized.

5.3 SOME CONSIDERATIONS ON THE 'NO-CHANGE' STRATEGY

The 'no-change' strategy implies nevertheless the continuation of the present bandalling, which is meant to obtain a depth that permit a vessel draught of 1.80 m during the dry season and 2.40 m during monsoon. In October 1992, the permitted draught was 3 m between Aricha and Chilmari and 2.30 m between Chilmari and the border,

If no bandalling would take place the effects would be disastrous for navigation viz. :

- The LAD would return to what it was during and immediately after the war of liberation (1971 to 1973) permitting draughts around 1 m.
- The 'cross-river' navigation route length would increase up to 4 times the direct distance.

5.3.1 Effect on the Bahadurabad - Fulchari Railway Ferry

In 1911, the river was flowing at the Bahadurabad-Fulchari ferry crossing along a pattern rather similar to that found today (2 main branches, on the outer bend of which the ferry heads were situated). But the eastern side was slightly silted, and a seasonal ghat at the present location (Kulkandi) was probably necessary in the dry season. In February 1981, on the contrary, the old Bahadurabad railhead (Fari Thana) was operative, and on the western side a 16 km long railway branch line on an embankment was used to reach Konalpara where a deep channel existed. Today, the Fulchari-Kulkandi route is used, involving the use of a 6 km branch line.

Consequently, the shifting channel causes an average railway extension by 5.5km on shore. Similarly, the river channel used to cross from one anabranch to the other varies in position between Kalasona (25°16'30" N) and Hatbari (24°58' N), 34km apart. Conversely, the total crossing length varies today between 18km (Munna channel) and 46 km (Hatbari channel), with an average length 37km (P-K route). Table A.10-1 gives the time taken and the route followed from 1989 to 1991. If the Fulchari-Fari route were used, the length would vary between 52 km and 24 km, the average being again 37 km.

Thus the no-change solution means an unpredictable average 19 km increase in the Bahadurabad - Fulchari ferry route (minimum 0 km and maximum 28 km). All in all, the 'no-change' case leads to an average 24.5 km increase over the shortest distance available, and 28 km more than the distance as-the-crow-flies.

The westward movement has not been taken into account, since it implies corresponding reduction in the shore links. However, the Konalpara branch line would be washed away. Reconstruction of same would include 16 km embankment with railtrack, as well as the dwellings in the railway estate.

5.3.2 Effect on Country Side Navigation

The countryside navigation link between Jamuna and a number of secondary tributaries became blocked by the construction of the west bank embankment between 1968 and 1973, viz.:

- Ichamati and Banjani rivers (Sirajganj district)
- Monas, Belai and Dakuria (Bogra district)
- Gaghot, Sharai and Manos rivers (Rangpur district)

At first sight, the no-change solution implies natural reopening of these tributaries since the existing regulators are likely to be washed away in the course of time due to the westward movement of the Jamuna. It must be assumed that the regulators will be reconstructed as soon as they are washed away.

However if this time navigation locks would be included, the impact on the level of small craft traffic in the main stream would be significant.

Transport of agricultural produce in these districts was previously maintained through these rivers. After the construction of the regulators road transport took over. But the road system, used from 1973 onwards was no compensation for what was lost in waterway infrastructure.

Building of navigation locks may be considered desirable. In these districts, there are still a large number of domestically used country boats, not yet mechanized, and a good number of commercially operated country boats, most of which mechanized. It must be remembered that Bangladesh enjoys as much waterways (22152 km) as metalled roads (24491 km), although BIWTA manages only 5968 km of demarcated waterways. The rest is used by country boats, which are increasingly becoming mechanized.

The condition of all but the 7559 km of 'high roads' makes travel on them uncomfortable and slow, if not hazardous. Non-metalled roads are hardly passable during rain, and herringbone bricks revetment are usually so run-down that a jeep can only travel there at a snail pace, specially because of the slow moving traffic. A trip on a feeder road, less than 3 m wide, could only be done at 15 km/h average speed, which is well within the capability of mechanized country boats or launches.

Consequently, in rural Bangladesh, water-borne transport is not slower than road transport. Thus middle distance traffic (inter district) could very well have been done directly from the Ghaghat and Manos river banks to Jamalpur and Tangail, if locks were provided. This possibility does not exist at the moment because the regulators were built without passage for boats, and a number of marketing opportunities are lost since road transport to the eastern side is circuitous and hampered by a ferry crossing.

In a 1986 survey, one third of the villages affected by the west embankment construction, complained about the loss of inland navigation access to the Jamuna river. A similar problem exists also on the east bank, in particular for the Chatal river. Apart from that, natural conditions have reduced the access to the Dhaleshwari river to a few months per year. Where rivers can still be reached, those country boats that are mechanized are regaining their part of market share against trucks, as can be seen in Baghabhari.

5.4 EFFECTS OF THE ASSUMED RIVER TRAINING STRATEGIES

5.4.1 Scenario 1 - Anabranched Flood Channel Through 'Hard' Measures

Phase I (1993-1998)

(1) Implementation of FAP1 and FAP21 hard points and Jamuna Bridge river training works

Bank protections and groynes will produce some local effect, but the width of the channel is such that there will be no need for the boats to come close to the structures.

(2) FAP 22 pilot project

The test site of the surface screens when placed in a channel may affect navigation or one of the ferry routes. When the exact location is known, a survey of river routes and ferry crossings must be done to fully assess the impact on navigation. So that continuity of navigation and ferry service can be maintain through an alternative route.

The lower part of the Jamuna up to Sirajganj, will have to be studied in detail because of the increased traffic found there, induced by the building of the Jamuna bridge training works and the production of Jamuna fertilizer factory.

Phase II (1998-2010)

(1) Implementation of major hard points at vulnerable places along the west bank at mutual distance of about 30 km.

(2) No recurrent measures

Basically a continuation of the Phase I measures is taking place, and comments as above are still valid. However, with an increasing number of hard points, some longer chars may develop over the years, which may increase the detour some ferries have to make.

Longer stable chars mean also less cross channels for rural transport from one char settlement to the other. A network of roads or tracks might compensate somewhat for the loss of waterway routes, but they are no real alternatives for boat transport. Roads are also likely to be destroyed after each flood.

Phase III (2010-2050)

(1a) Implementation of major hard points along the east bank too, with mutual distance some 30 km.

(1b) Additional hard points between major hard points along both banks.

(1c) Upstream protection of mega-chars.

(2) No recurrent measures

This phase has more impact on navigation in the sense that it aims to fully stabilize the mega-chars in the centre of the river, protected at their upstream end against erosion. In this way more or less stable lateral channels (anabranches) may develop. The central mega-chars may have to be flood-protected.

At the Bahadurabad-Fulchari ferry crossing an average 5 km may have to be added to the route. However at that horizon the Jamuna bridge will have been completed and by then a railway may be in operation over the bridge. The railway ferry will then be suspended or may be deviated to Chilmari for passengers only. This will take 3 hours upstream and 2 hours downstream.

The local depth may increase in all 3 phases. The places where this may be of interest for navigation are mainly the 30 km long stretch upstream of Sirajganj, and the stretch upstream of Chilmari up to the border with India.

5.4.2 Scenario 2 - Anabranched Flood Channel Through 'Hard' and Recurrent Measures.

Phase I (1993-1998) as in scenario 1

(1) Implementation of FAP1 and FAP21 hard points and Jamuna Bridge river training works

(2) FAP 22 pilot project

Phase II (1989-2010)

(1) Implementation of some hard points on the west bank.

(2) Recurrent measures mainly along the west bank and in a few places along the east bank.

Basically, the same comments as for scenario 1 - phase I and II apply. In this concept recurrent measures to protect vulnerable sites are used in addition, thus replacing the construction of a number of hard points. The recurrent measures comprise: an estimated number of 6 bend cut-offs by means of dredging and the closure of about 12 branches through siltation induced by surface screens during the period of phase II.

The cut-offs are traditional measures for improving navigation in free-flowing rivers, and do not bring any difficulty to IWT, providing of course that one channel remains always open for through navigation. It may reduce the route length of some local ferries, plying between the mainland and the chars but this is unlikely to have a major impact on the revenue of boatmen.

The closure of (secondary) branches will have more impact, in particular on the small boat trade and ferry services. The reductions of criss-crossing channels through the chars will also lead to larger distances to travel on foot for the inhabitants of these chars. On selection of the closure sites, the economic and sociologic implications can be assessed by studying in detail the local and short range vessel movements.

Phase III (2010 - 2050)

(1a) Implementation of major hard points along the east bank too, with mutual distance some 30 km.

(1b) No additional hard points between major hard points

(1c) Upstream protection of mega-chars.

(2) Recurrent measures to prevent erosion between major hard points.

The effect of recurrent measures as commented on for phase II may have an even stronger impact. For instance, the main islands, with their elongated shape, will affect cross-navigation requiring good conditions to perform small boat navigation along the mega-chars for goods and persons transport.

5.4.3 Scenario 3 - Braided River with Reduced Width

Phase I (1993-1998) as in scenario 1 and 2

Phase II (1998-2010) as in scenario 2

Phase III (2010 - 2050)

(1) *Recurrent measures to prevent bank erosion between major hard points spaced 30 km apart along the west bank.*

(2) *Recurrent measures along the east bank to reduce the width of the river.*

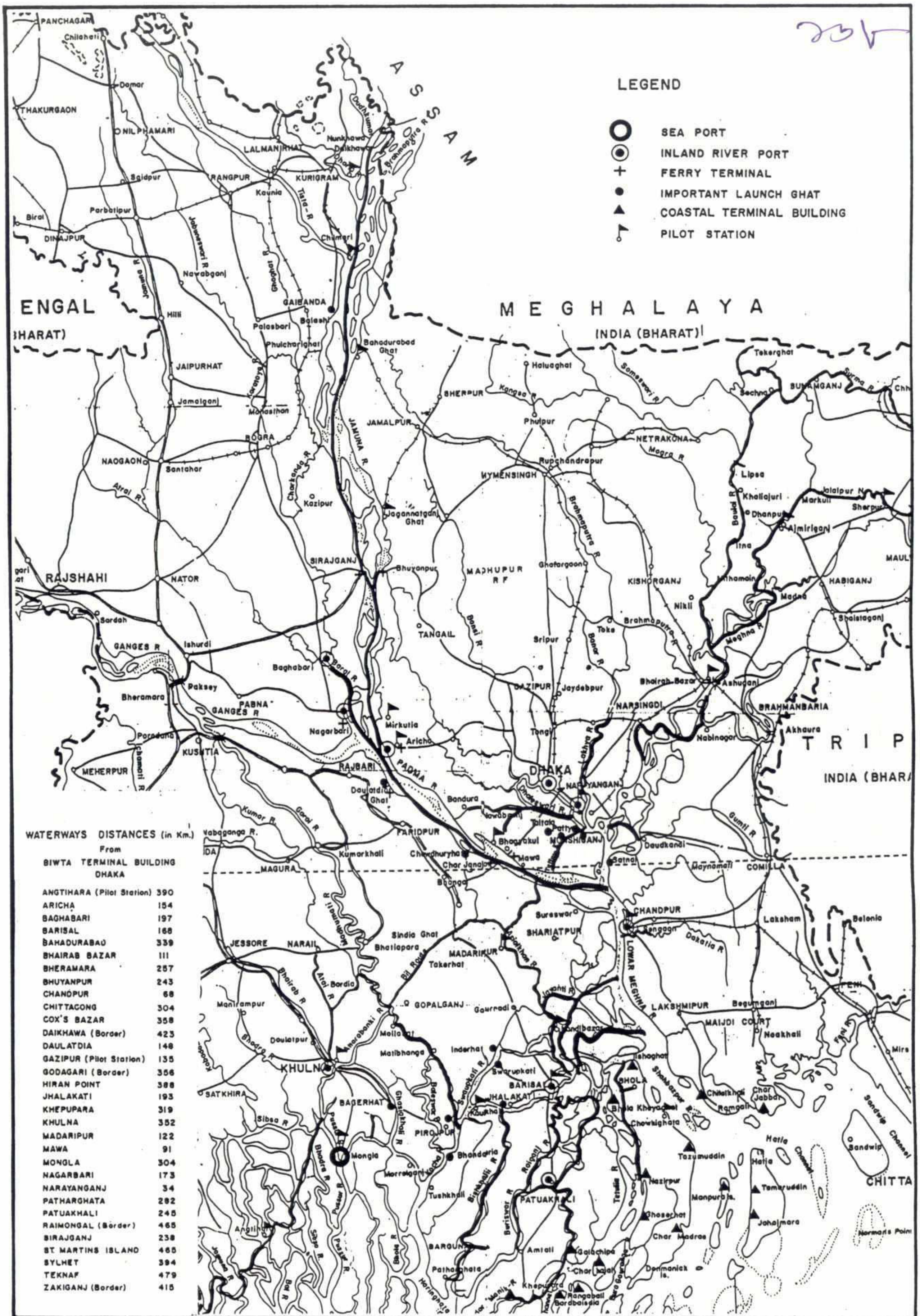
During this time span the effect of the measures will gradually be felt to their fullest extent, the effects being reduction of route length and deeper channels at the limiting points. The exact influence of this scenario on the reduction of the river length is yet to be found through the experiments carried out in phase I. For the main branch navigation it would appear to be more favourable at any rate than the anabranch scenarios and far more than with the 'no-change' strategy. It is too early to estimate the depth improvement, but double the value as achieved with the anabranch scenarios seems a fair estimate.

5.5 CONCLUDING REMARKS

In the first two scenarios, the deepening effect of the channel is likely to be limited, because the flow will remain divided among two branches. The third scenario will probably produce a more pronounced smoothing of the shoals (crossings between two deep pools). A depth improvement of about double the value as achieved with the anabranch scenarios (1 and 2) seems viable and would bring more benefit to the long range and transit traffic.

Table A.10-2 represents an attempt to assess the results of the three scenarios. In general it might be concluded from this table that each scenario will benefit to the naviagation. The initial differences in benefits are slight but show some preference for scenario 3. To actually quantify the impact will be difficult, because it is too early to predict with some degree of certainty the traffic on the Jamuna river up to the year 2050.

However for an idea about the effect of fairway depth improvement with related deeper draught the following example is of interest. It was calculated that for Jamuna navigation, a draught increase by 40 cm (i.e. scenario 3) and 20 cm (i.e. scenario 1 and 2) over the shoals, would result in a better payload of +38% and +19%, the unit cost of the ton*km being lowered by some 28% and 14% respectively.



WATERWAYS DISTANCES (in Km.)
From
BIWTA TERMINAL BUILDING
DHAKA

ANGTIHARA (Pilot Station)	390
ARICHA	154
BAGHABARI	197
BARISAL	168
BAHADURABAD	339
BHAIRAB BAZAR	111
BHERAMARA	257
BHUYANPUR	243
CHANDPUR	68
CHITTAGONG	304
COX'S BAZAR	358
DAIKHAWA (Border)	423
DAULATDIA	148
GAZIPUR (Pilot Station)	135
GODAGARI (Border)	356
HIRAN POINT	388
JHALAKATI	193
KHEPUPARA	319
KHULNA	352
MADARIPUR	122
MAWA	91
MONGLA	304
NAGARBARI	173
NARAYANGANJ	34
PATHARGHATA	282
PATUAKHALI	245
RAIMONGAL (Border)	465
SIRAJGANJ	238
ST MARTINS ISLAND	465
SYLHET	394
TEKNAF	479
ZAKIGANJ (Border)	415

INLAND WATERWAYS MAP OF BANGLADESH

FAP – 21/22

BANK PROTECTION AND RIVER TRAINING / (AFPM) PILOT PROJECT

FINAL REPORT

FIG. A.10 – 1

	Sher-e-Bangla		Sonargaon		Titumeer		Mirjumla		Dist.
1989	BHD-TMG	TMG-BHD	BHD-TMG	TMG-BHD	BHD-TMG	TMG-BHD	BHD-TMG	TMG-BHD	KM
JAN	3	2.8	2.8	2.5	5.3	5.5	6	6.5	37
FEB	3	2.8	2.8	2.5	5.3	5.5	6	6.5	37
MAR	3	2.8	2.8	2.5	5.5	5.5	5.3	5.5	37
APR		2.8	2.6	2.5	5.5	5.5	5.5	5.5	37
MAY	2.8	2.6	2.5	2.3	5.5	5.5	5.6	6	37
JUN	2.8	2.6	2.3	2.3	5.5	5.5	5.5	5.5	35
JUL	2.8	2.6			5	5.3	5	5.3	35
AUG	3.5	3.6			5	5	5.3	5.5	35
SEPT	3.7	3.6			5	5	5.1	5.3	35
OCT	3.5	3.5			5	5	5.1	5.3	37
NOV	3.5	3.3	2.3	2.1	5.3	5.3	5.5	5.6	37
DEC			2.1	2	4.1	4.1	4.8	5.3	35
Av. time	3.1	3.0	2.5	2.3	5.1	5.2	5.4	5.6	36
Av. Speed V	11.3	11.8	14.1	15.3	6.9	6.9	6.6	6.3	
1990	BHD-TMG	TMG-BHD	BHD-TMG	TMG-BHD	BHD-TMG	TMG-BHD	BHD-TMG	TMG-BHD	KM
JAN			2.2	2.2	4.5	5			34
FEB			2.2	2.1	4.3	4.6	5.5	5	34
MAR	2.5	2.3	2.2	2.1	4.5	4	5.5	5	34
APR	2.5	2.3	2.2	2.1	4.5	4	5.5	5	34
MAY	2.5	2.3	2.3	2.1	4.5	4	5.5	5	34
JUN	2.5	2.3	2.3	2.1	4.5	4	5.5	5	34
JUL	2.3	2.5	2.3	2.1	4.5	4.1	5.5	5	34
AUG	2.4	2.1	2.1	2	5	4.5	5.5	5	34
SEPT	2.3	2.1	2.1	2			5	4.5	34
OCT	2.3	2.1	2.3	2	5	4.5			34
NOV	2.5	2.6	2.6	2.5	5	4.5	6.5	6	34
DEC	3.2	3.1	2.8	2.6			8.5	8	46
Av. time	2.5	2.4	2.3	2.2	4.6	4.3	5.8	5.3	35
Av. Speed V	13.9	14.4	14.9	15.8	7.5	8.0	5.9	6.5	
1991	BHD-TMG	TMG-BHD	BHD-TMG	TMG-BHD	BHD-TMG	TMG-BHD	BHD-TMG	TMG-BHD	KM
JAN	3.3	3	2.8	2.6			7.5	7	41
FEB	3.3	3	3	2.8	7	6	7.5	7	41
MAR	3.4	3.1	3	2.8	7	6	7.5	7	41
APR	3.3	3	3	2.8	7.5	7	8	7.5	41
MAY	2.6	2.3	2.6	2.3	6.5	6	6.8	6.6	34
JUN	2.6	2.3	2.5	2.3	6.5	6	6.8	6.6	34
JUL	3.2	2.5	2.5	2.3	6.5	6	6.8	6.6	34
AUG	3.2	2.6	3.3	2.6	7	6.5	7.5	7	41
SEPT	3.2	2.3	2.8	2.3	6.6	6	7	6.5	41
OCT	3.7	2.3	2.6	2.3	6	5.5	6	5.5	41
NOV	3	2.7			6.5	6	6	5.5	41
DEC	3	2.7			6	5.5			37
Av. time	3.1	2.7	2.8	2.5	6.6	6.0	7.0	6.6	39
Av. Speed V	12.2	14.3	13.7	15.2	5.8	6.4	5.5	5.8	

Names of channels: Northern: Kalasona(37km), Nichantipur(35km), Manna(18km)
(P-K route) Southern: Patilbari(35km), Mollapara(39km), Hatbari(46km)

Time : expressed in hours
Speed : expressed in km/hr
BHD : Bahadurabad, left bank
TMG : Teestamukh, right bank

Table A.10-1: Time taken in the crossing of the Jamuna at Bahadurabad by the railway ferries

Scenario	Phase	Measures	Type of Navigation: Long Range	Short Range	Local	Contributing factor: Current	Depth	Length
1 Anabranched Flood Channel	1	hard points surf. screens guide bunds	0 ro +1 +1 or +2 +3	0 or -1 0 +2	+2 0 or -1 +1	0 ro -1 +1 +2	+1 +2 +1	+1 +1 -1
	2	hard points	+1	0	+2	0	+1	+1
	3	hard points	+1.5	0	+1.5	0	+1.5	+1.5
Total			+6.5 or 8.5	+1 or +2	+5.5 or 6.5	+2 or +3	+6.5	+3.5
2 Anabranched Flood Channel	1	hard points surf. screens guide bunds	0 or +1 +1 or +2 +3	0 or -1 0 +2	+2 0 or -1 +1	0 or -1 +1 +2	+1 +2 +1	+1 +1 -1
	2	hard points surf. screens	+1 +2	0 -1	+2 0 or -2	0 +1	+1 +2	+1 +2
	3	hard points surf. screens	+1 +3	0 -1	+2 0 or -2	0 +1.5	+1 +2.5	+1 +3
Total			+11 or +13	-1 or 0	+2 or +7	+4.5 or +5.5	+10.5	+8
3 Braided River with Reduced Width	1	hard points surf. screens guide bunds	0 or +1 +1 or +2 +3	0 or -1 0 +2	+2 0 or -1 +1	0 or -1 +1 +2	+1 +2 +1	+1 +1 -1
	2	hard points surf. screens	0 or +1 +3	0 or -1 -1	+2 0 or -2	0 or -1 +1.5	+1 +2.5	+1 +3
	3	hard points surf. screens	0 or +1 +3	0 or -1 -1	+2 0 or -2	0 or -1 +1.5	+1 +2.5	+1 +3
Total			+10 or 14	-3 or 0	+2 or +7	+3 or +6	+11	+9

0 = indifferent or unchanged
- 5 = very negative
+ 5 = very positive (50% improvement)

Table A.10-2: Impact assessment on navigation for the three scenarios