

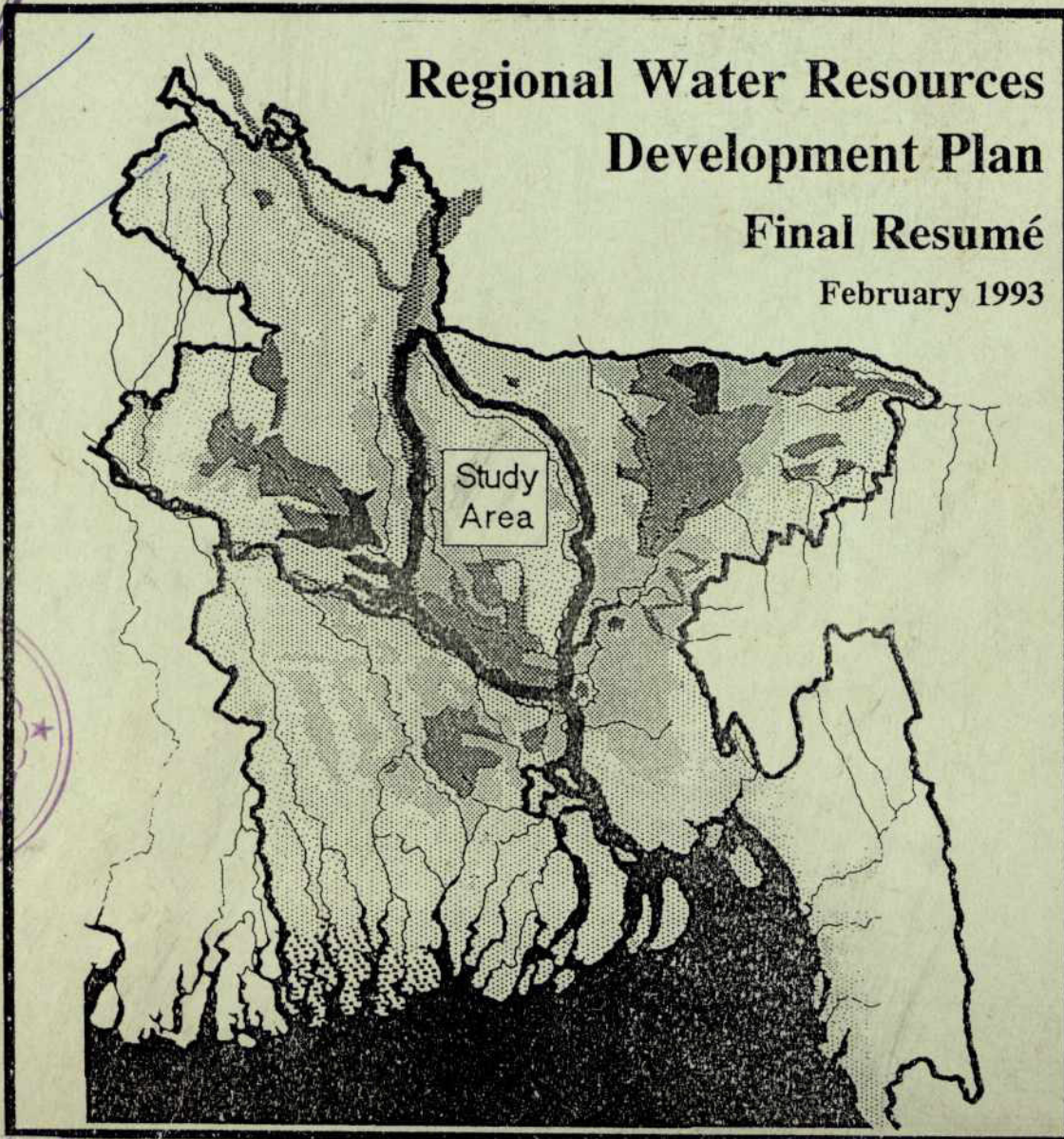
Government of the People's Republic of Bangladesh  
Flood Action Plan  
**FAP 3**  
**North Central Regional Study**



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**Commission of the European Communities  
and  
Caisse Française de Développement  
Project ALA/90/03**



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BCEOM, Compagnie Nationale du Rhône,  
Euroconsult, Mott MacDonald International,  
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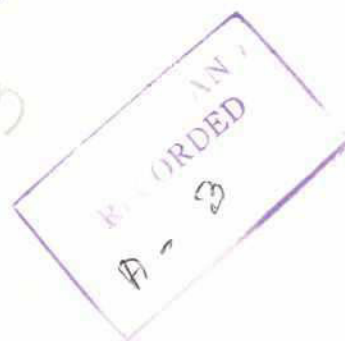
# Flood Action Plan FAP 3 North Central Regional Study

Final Resumé

February 1993



MTD-53  
07.02  
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Financed by :

Commission of the European Communities and  
Caisse Française de Développement  
Project ALA/90/03

Consortium:

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**NORTH CENTRAL REGIONAL STUDY, FAP 3**  
**Regional Water Resources Development Plan**

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## FINAL RESUMÉ



### R.1 North Central Regional Study

#### R.1.1 Introduction

The North Central Region Study (NCRS) forms component three (FAP-3) of the Flood Action Plan and covers an area of 12,000 sq.km., between the Jamuna, Padma, Meghna, Old Brahmaputra and Lakhya rivers, see Figure R.1.

This Final Resumé summarises the Regional Water Resources Development Plan (RWRDP) which is presented fully in the Final Report. The Final Report consists of a Main Volume with ten Supporting Reports and presents a Regional Plan with an emphasis on the flood control and drainage measures required to achieve a sustained development of the regional economy, taking into account social and environmental factors. The NCRS focuses on areas where flooding and impaired drainage hamper economic activity and identifies a series of measures to alleviate these adverse effects and to develop the land and water resources.

The North Central Regional Study has comprised two phases. Phase 1 of the NCRS was a reconnaissance study and took place in April to June 1990. Phase 2 commenced in March 1991 and has involved the evaluation of alternative water development strategies and the preparation of a regional water resources development plan, including the identification of priority projects and detailed project planning. The prioritised projects are studied at pre-feasibility level and the Terms of Reference for subsequent Feasibility Studies have been prepared.

The North Central Regional Study has been jointly financed by the Commission of the European Communities (CEC) and the Government of France initially through Caisse Centrale de Cooperation Economique, CCCE (now renamed as Caisse Francaise de Développement, CFD).

#### R.1.2 Flood Action Plan

The NCRS forms component three (FAP-3) of the Flood Action Plan. The Flood Action Plan comprises more than twenty-six components and supporting activities and is being coordinated by the Government of Bangladesh through the Flood Plan Co-ordination Organisation (FPCO) and the World Bank.

The Flood Action Plan aims to identify, plan, design and construct high priority projects which are technically, economically, environmentally and socially feasible. The plan follows a staged approach which focuses initially on:-

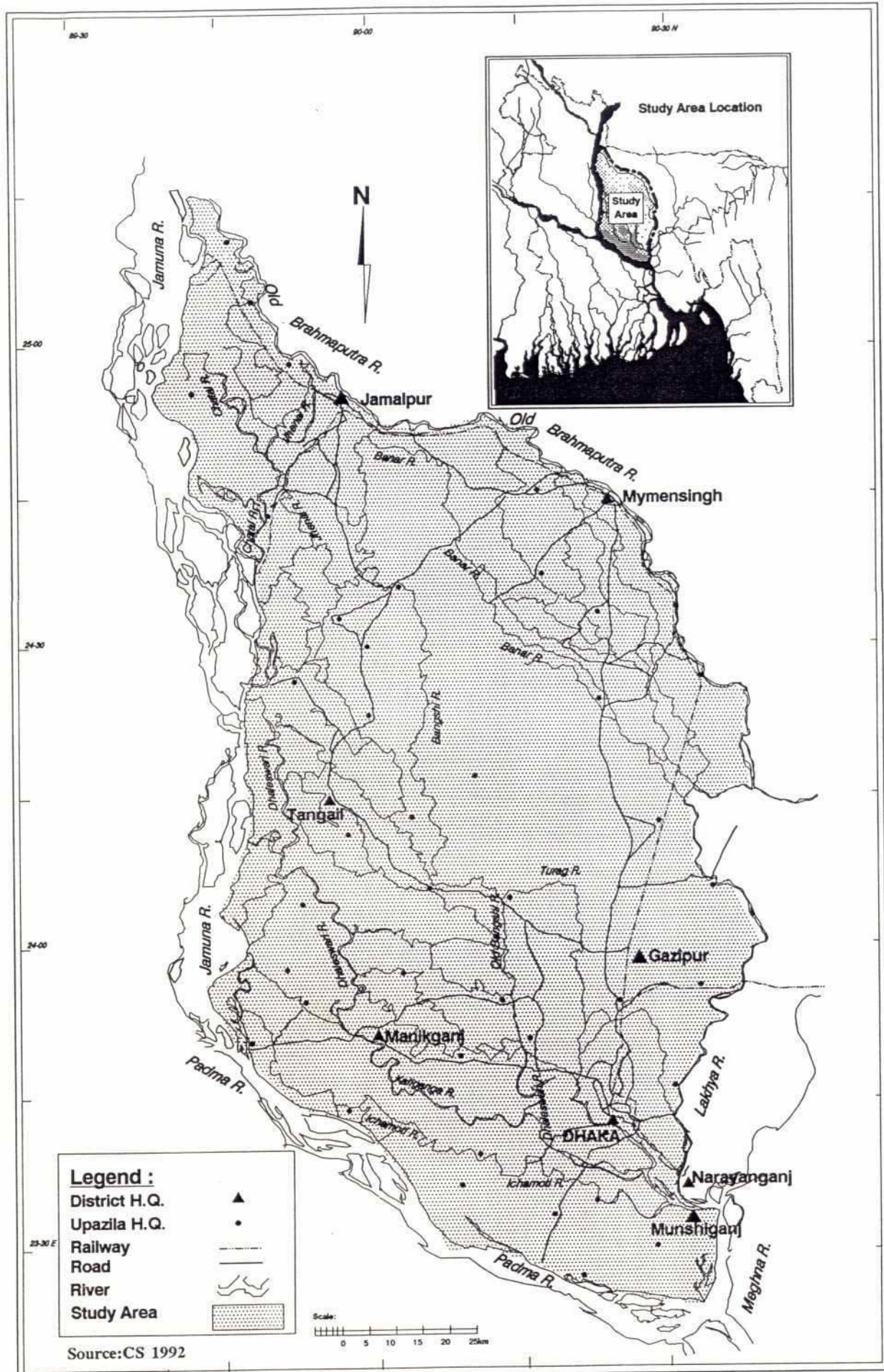
- measures to control flooding and improve drainage in areas bordering the main rivers, the regional rivers and distributaries.
- regional studies of flood control and drainage, together with supporting activities to provide inputs into the planning and design of the main components of the Action Plan.

The North Central Regional Study is one of several studies which need to be undertaken during the first stage of the Flood Action Plan. The initial stages of the Plan are designed as an integrated series of studies which in the most part are self complementary. The outcome of the supporting studies have been used where available in the development of the North Central Region Water Resources Development Plan.

The main focus of the Flood Action Plan is that defined in the Eleven Guiding Principles which are listed in Table R.1. These provide the framework for the development planning being undertaken.



## The Study Area





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**TABLE R.1**  
**The Eleven Guiding Principles**

1.	Phased implementation of a comprehensive Flood Plan aimed at: <ul style="list-style-type: none"> <li>- protection of urban, rural, commercial, industrial and public utility centres and communication networks;</li> <li>- controlled flooding, wherever possible and appropriate, to meet the needs of agriculture, fisheries, navigation, urban flushing, soil productivity and recharging the surface water and groundwater resources with minimum dislocation of the environment.</li> </ul>
2.	Effective land and water management of protected and unprotected areas, involving compartmentalisation, drainage, irrigation, drainage decongestion, land use, cropping patterns, environment, ecology, erosion/sedimentation control etc.
3.	Strengthening and equipping the disaster management machinery including building infrastructure for quick and effective communication and transmission during disasters.
4.	Improvement of the flood forecasting system and establishment of a reliable and comprehensive flood warning system with adequate lead times and at the same time evolving techniques for dissemination.
5.	Safe conveyance of the large cross-boundary flow to the Bay of Bengal by channelling it through the major rivers with the help of embankments on both sides.
6.	Effective river training works for the protection of embankments, infrastructure and population centres, linked wherever possible with the reclamation of land in the active river flood plain.
7.	Reduction or distribution of land on the main rivers through diversion of flows into major distributaries or interception of local runoff/local rivers by channelling through major tributaries or special diversions.
8.	Improvement of the conveyance capacity of the river networks to ensure efficient drainage through appropriate channel improvements and ancillary structures to provide regulation and conservation.
9.	Development of flood plain zoning as a flexible instrument to accommodate necessary engineering measures and allocate space for habitation patterns, economic activities and environmental assets.
10.	Coordinated planning and construction of all rural roads, highways and railway embankments with provision for unimpeded drainage.
11.	Encouraging maximum possible popular participation by beneficiaries in the planning, implementation, operation and maintenance of flood protection infrastructure and facilities.

### **R.1.3 Activities of Particular Relevance to NCRS**

The NCRS is being carried out within the overall framework of the Flood Action Plan (FAP) and both provides information to, and depends on information from, other FAP studies. The approach to planning and impact assessment follows the guidelines on Project Assessment prepared by the FPCO (FPCO 1991b). Two FAP studies which are being carried out to Feasibility Study level are within the North Central Regional Area:-

- **FAP 3.1**, the Jamalpur Priority Project Study, is being carried out concurrently with the latter half of the North Central Regional Study, Phase 2. The interaction between the two studies is important, and development strategies for the Jamalpur area must accord with the overall development strategies for the Region as a whole and thus form an integral part of the Development Plan. Close liaison has been maintained between the two studies to ensure a coordinated approach to the work.



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- **FAP 20.** One of the two pilot areas for the Compartmentalisation Supporting Study (FAP 20) is located around Tangail, within the NCRS area. This study began in mid-1991 and is planned to continue for 4 years. The objective of the project is to test the compartmentalisation concept. The study addresses the complex social and environmental aspects of such local level development and carries out planning in close consultation with central and local government agencies and the public. The results of the study are critical to the future incorporation of the compartmentalisation concept within the regional plan.

Other relevant activities in the North Central Regional Area are the proposed site of the **Jamuna Bridge**, which, in principle, has been given the go-ahead for construction. The Jamuna Bridge Authority's (JMBA) plan to cut off the northern intake of the Dhaleswari has direct implications on the NCR and in particular the area around Tangail including the FAP 20 pilot area. The impact of the bridge on water levels and the river morphology is significant and thus the NCRS has to consider all possible development scenarios both with and without the Jamuna Bridge being implemented. The impact of the Jamuna Bridge on the environmental aspects is a complex issue and is beyond the scope of the present NCRS, it has however been investigated in a separate study, the Dhaleswari Mitigation Study (JMBA 1991).

The **Jamuna Fertiliser Company (JFC)** plans to facilitate access to their factory by improving the existing BWDB embankment from Bhuapur to the factory site at Tarakandi. The JFC is giving this a high priority and has started construction through the Roads and Highways Department in 1992. The road should assist with the control of flooding from the Jamuna for a 30km stretch of the river, and the NCRS and the FPCO have communicated to the RHD the recommended formation level.

## **R.2 Regional Overview**

### **R.2.1 Floods**

The disastrous floods of 1987 and 1988 focused the world's attention on the problems of flooding in Bangladesh and flooding remains one of the major factors controlling food production of the North Central Region. A substantial proportion of NCR is flooded annually (see Figure R.2) and in years such as 1987 and 1988 the majority of western & south-western floodplains of the Region are flood affected.

Flooding in the North Central Region can originate from 3 sources: direct rainfall, direct overbank spillage from the major boundary rivers and overbank spillage from the internal regional rivers, see Figure R.3. It is possible for each phenomenon to occur separately or in combination with any other. The proportionate contributions of rainfall, Jamuna and local rivers varies between years and within flood seasons.

The pattern of river levels generally experienced in the region shows a 2-peaked response, the first peak being generated by internal regional rainfall excess, normally in June/July, and the second peak resulting from high cross-boundary flows in the major rivers, normally in early September. The flood of 1988 was made worse by the unusual coincidence of peak floods in both the Jamuna and the Padma rivers whereas the 1987 floods resulted from unusually high regional rainfall together with high Jamuna/Padma river levels.

The rainfall experienced within the region amounts to some 2000 mm per annum (decreasing from north-east to south-west), generally occurring over a 5-6 month period. In consequence of this, large volumes of excess rainwater accumulate in the depressions and low-lying areas. During the pre-monsoon and monsoon seasons, (from May to October), the predominantly high water levels in the major boundary rivers coupled with the high water levels in the regional rivers

Figure: R.2  
Average Annual Depth of Inundation

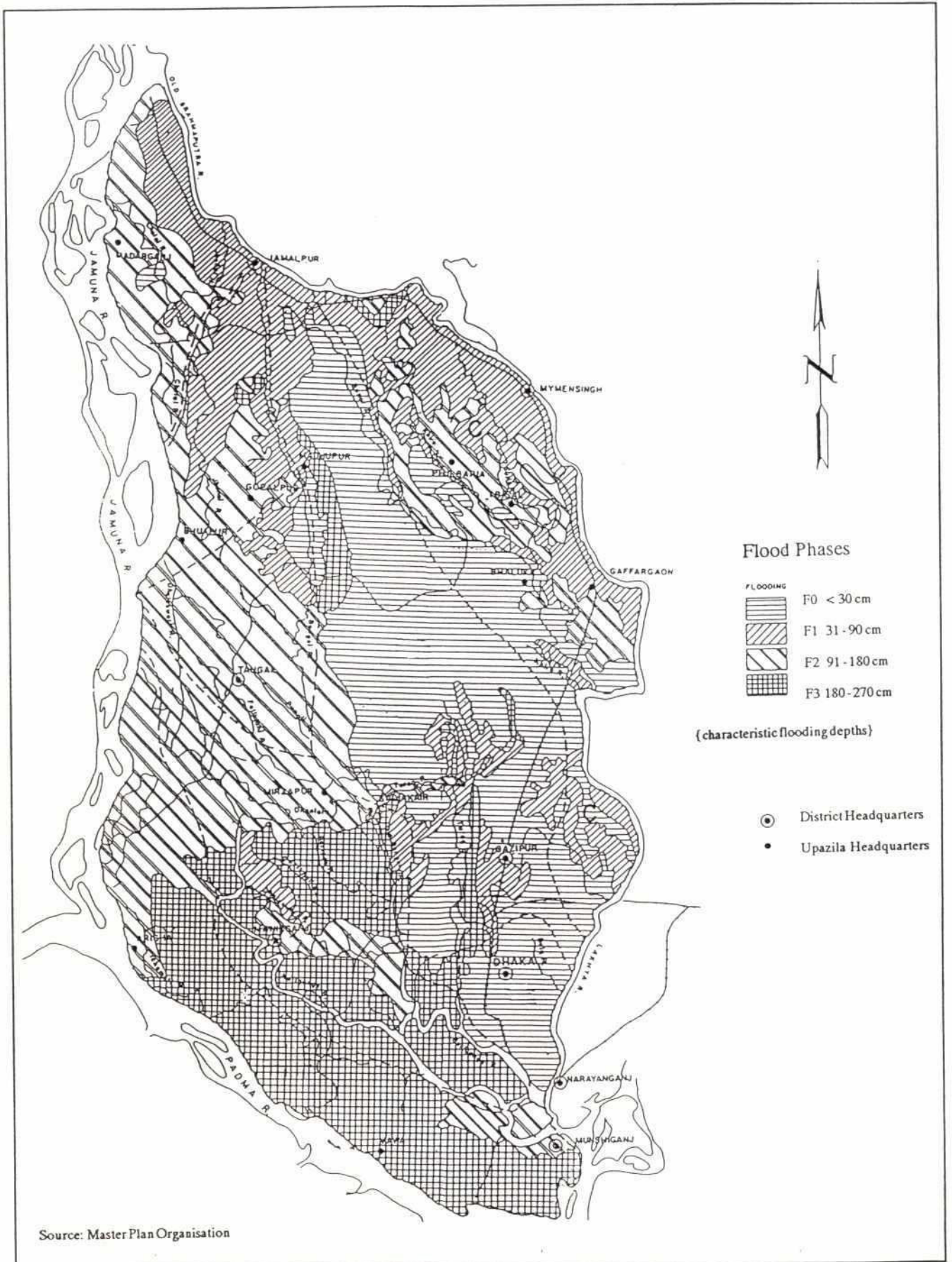
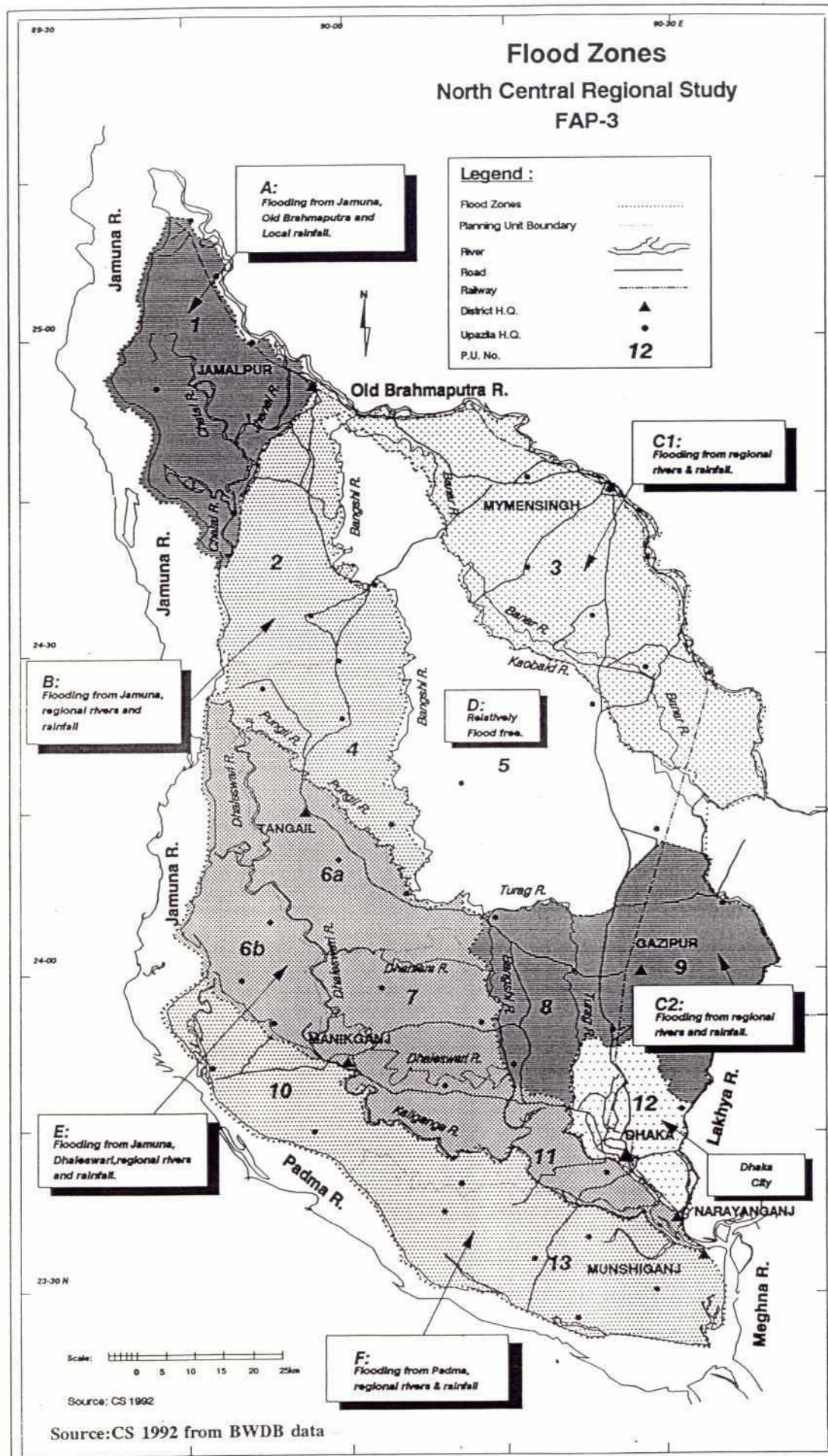




Figure: R.3



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conveying spills from the Jamuna, prevent the withdrawal of excess rainfall from the internal flood plains. As long as the commanding water levels in the boundary rivers remain high, the levels in the regional rivers also remain high and the removal of water from, (or transfer through), the region is severely inhibited. The Meghna-Padma at the south-east corner is tidal influenced, and this causes further reduction of drainage in the Region, thus keeping flood levels high.

Ingress of floodwater from the Jamuna River can occur via direct overbank spillage, the precise location of which can vary from year to year, or through well-defined existing river channels which offtake from the Jamuna. Most of the direct overbank spill occurs between the northern intake of the Dhaleswari and the Dhaleswari offtake from the Jamuna some 30 kilometres to the south. The characteristics of this spillage will be changed by the proposed cut-off of the Northern Dhaleswari offtake for the construction of the Jamuna Bridge.

As a result of the inter-connection between the Jamuna River and the western rivers of the region, these regional rivers perform a dual function. During the monsoon season, when the water levels in the boundary rivers are high, they act as "conduits", transferring water from the Jamuna to the Meghna, with little or no spare capacity to accommodate accumulated floodwater resulting from rainfall excess. Indeed, the incapacity of some of the regional rivers to carry the required volume of overflow from the Jamuna serves only to exacerbate an already major flooding situation.

## R.2.2 Rivers

The river and drainage system of the North Central Region is characterised and influenced by the 3 major rivers forming its boundary:- the Jamuna, Padma and the Old Brahmaputra-Lakhya-Meghna system.

The Jamuna River to the west of the project area carries runoff from the Himalayan mountain chain; the river has a broad braided bed with large sand shoals and islands, (chars). It is very unstable morphologically, with severe bank erosion, resulting in recorded shifts in bank alignment of over 1 kilometre in a single year. Some 200 years ago the Jamuna was a small regional river but the Brahmaputra changed its course leaving the Old Brahmaputra as a dying smaller distributary and choosing the Jamuna as its main course. The mean annual peak discharge of the Jamuna, calculated from measurements made at Bahadurabad, is approximately 67,000 cumecs, with the 1 in 100 year flood discharge estimated at 108,000 cumecs, (FAP-25, 1992).

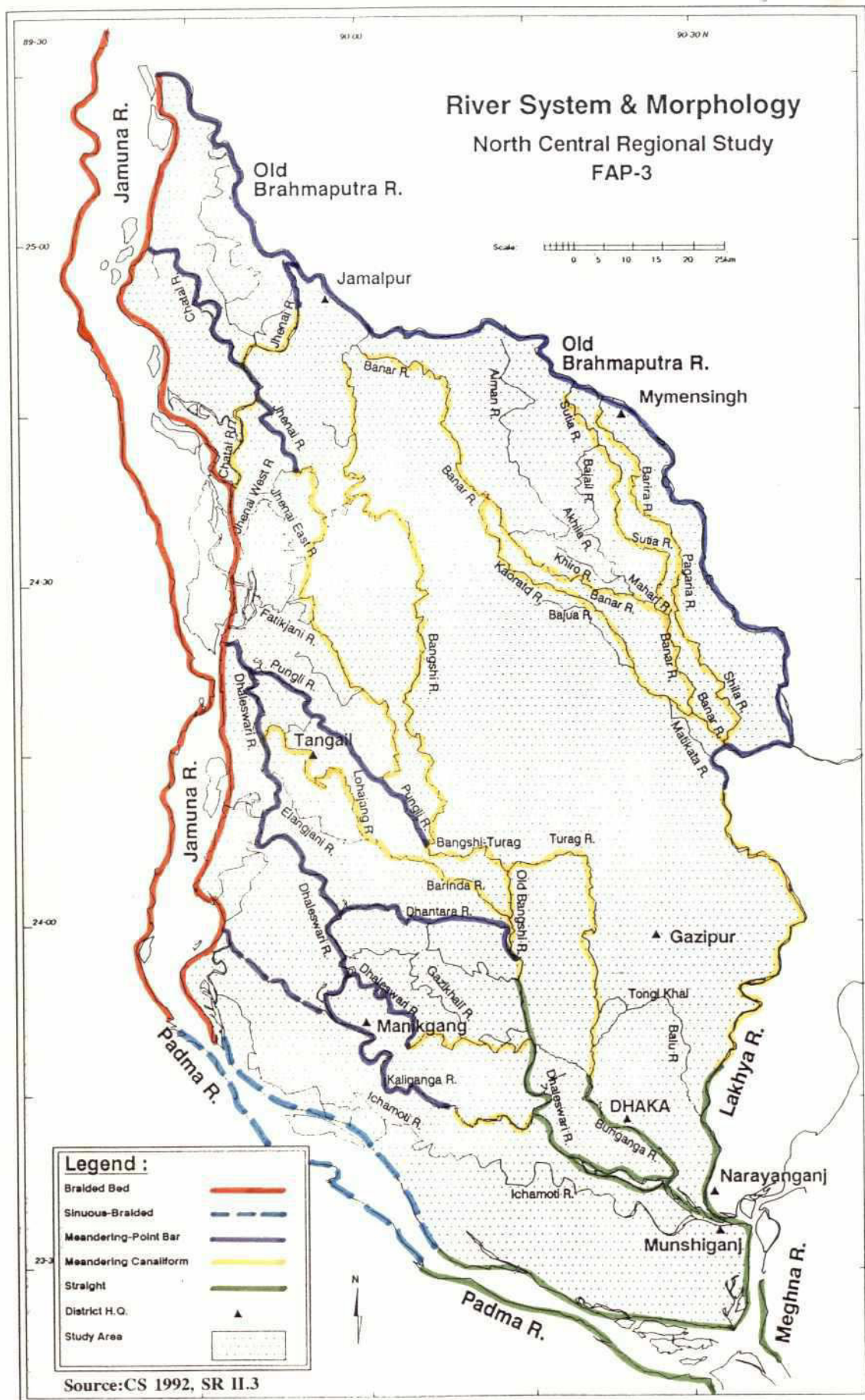
The Padma River forms the southern boundary of the region and conveys both the waters of the Jamuna and the Ganges. The mean annual peak discharge is estimated at 88,000 cumecs and the 1 in 100 year discharge at 140,500 cumecs, (FAP-25 1992). At the south-east corner of the study area, the Padma combines with the Meghna to drain an area of some 1.55 million square kilometres in total, only a small percentage of which lies in Bangladesh.

The old course of the Brahmaputra River forms the northern and part of the eastern boundary of the study area. The mouth of this river has been steadily silting over the years since the river changed its course and the flows down this branch are a fraction of the original. The mean annual peak flood, calculated from discharge measurements made at Mymensingh, is 3,120 cumecs, which is 4.8% of the mean annual peak flood of the Jamuna. The remainder of the eastern boundary of the study area is delineated by the Lakhya River, a distributary of the Old Brahmaputra River. The interior rivers may be categorised as falling into 3 distinct systems (see Figure R.4)

- the Dhaleswari-Kaliganga system in the south-west
- the Bangshi-Turag system in the central part
- the Banar-Lakhya system in the eastern part



Figure : R.4



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The Dhaleswari-Kaliganga system comprises the major distributaries of the left bank of the Jamuna, ( Old Dhaleswari, Dhaleswari, and a number of un-named but significant spill channels), together with their distributaries, (Louhajang, Elangjani, Barinda). Downstream from its offtake from the Jamuna, the Dhaleswari bifurcates, the major channel now called the Kaliganga to the south of the diminished Dhaleswari. The two channels reunite at Kalatia, the Dhaleswari at this point having "captured" the Bangshi River.

The Bangshi-Turag system provides the central spine drainage of the region. It is fed partly by spill from the Jamuna through the Northern Dhaleswari intake via the Pungli River, partly by the accumulated runoff from the north-west of the region, (Jhenai River, Fatikjani River), and partly from the direct runoff into the Bangshi from the western slopes of the Madhupur Tract.

The Banar-Lakhya system to the east of the Madhupur Tract is mainly rainfall fed, with direct contribution from the Old Brahmaputra through the Lakhya River. Downstream of Toke, the Lakhya River is the main branch of the Old Brahmaputra. This system is unaffected by flows in the Jamuna, although extreme levels in the Old Brahmaputra can result in spillage at certain locations.

The complete river system is complex with peak and average discharges varying considerably from year to year.

### R.2.3 Drainage

The regional rivers in the west of the North Central Region are predominantly characterised by having river banks (levees) which are elevated above the surrounding flood plain. This is a result of either man-made intervention, in the form of embankments, or a natural phenomenon of built-up levees, typically exhibited by rivers subject to regular flooding of sediment-laden waters. The consequence of this physical characteristic serves to determine the system response to rainfall and river flooding.

Drainage of the North Central Region takes place at 4 levels: the boundary river system (primary), the regional river system (secondary), the khal system (tertiary), and the beel system (quaternary). The mechanism by which the region drains relates directly to this hierarchical system and its interconnections. Excess rainwater accumulates first in the depressions, (beels), until these have reached their capacity. Gradually the extent of inundation increases until the small khals linking the depressions begin to flow. These khals form an interlinking network within the internal drainage system and they are also the means by which the transfer of water between the regional rivers and the flood plain takes place.

The key to the drainage of the North Central region lies in the prolonged influence of the high river levels in the boundary rivers over the regional river levels. Unless the levels of the lower Meghna can be reduced at times of high flow, the drainage outlet from the North Central region will remain congested. Limited improvements can be made to local drainage conditions within the region, but these will ultimately be at the expense of the downstream reaches, however restricting the inflow from the main rivers into the distributaries would decrease flooding by limiting the water entering the regional drainage network.





#### R.2.4 Land Resources

The NCR land resources consist of four main physiographic units:-

- Young Brahmaputra and Jamuna Floodplains
- Old Brahmaputra Floodplain
- Padma Floodplain
- Madhupur Tract

The soils occur in complex patterns, but consist mainly of two types - Floodplain soil type or Madhupur Tract soil type. **Floodplain soils** comprise a pattern of sandy to loamy soils in the higher parts of the floodplain ridges grading into clay in adjoining basins, with the southern (downstream) floodplains being more clayey. The moisture retention capacity is moderate in most loamy soils, low in sandy and clayey soils and most soils need to be puddled for transplanted rice. The floodplains are generally classified as good agricultural land.

**The Madhupur Tract Soils** are underlain by Madhupur clay with variations in depth, drainage and degrees of weathering. Most soils, both deep and shallow, are well to moderately well drained. They are strongly acid, low in organic matter and have a low moisture retention capacity. Fertility is variable, mostly moderate to low. Iron toxicity may occur in valleys which stay wet during all or most of the dry season. The Madhupur Tract can be classified as moderate agricultural land, except the shallow red and brown soils which have a low potential for both agriculture as well as forestry.

#### R.2.5 Climate

The climate of the area is tropical monsoon, with average annual rainfall from 1400 mm in the Tangail, (south-west), region to 2200 mm in the Mymensingh, (north-east), region. The south-west monsoon winds usually begin in June and last through to October bringing heavy, persistent rains.

#### R.2.6 Agriculture

Agriculture is the main output of the Region (except for industrial activities in the cities). Cropping patterns are to a great extent determined by the seasonal floods, with cropping systems and management practices adapted to the local flood regimes and to the availability of irrigation water.

In most of the Madhupur Tract, with permeable soils and limitations of droughtiness, crop production is concentrated in the Kharif-I and Kharif-II season. Whereas where suitable groundwater exists, especially in the floodplain areas (and to a lesser extent in the Madhupur Tract) cropping patterns have changed, with the introduction and rapid expansion of tubewell irrigation, so that the use of HYV's have increased and rice production has risen considerably.

In 1990-91 an estimated 829,000 Ha of the study area was cultivated, (net cultivated area, NCA). This is 73% of the gross area. Out of this NCA 323,800 Ha (39% of the NCA) has been irrigated. The total area planted to crops amounts to 1,576,350 Ha which is equivalent to a cropping intensity of 188%, but ranging from 109% to 218%, see Section 3.2. The main crop in the study area is rice. An estimated 1,070,625 Ha were harvested in 1990-91, being 129% of the NCA or 68% of all crops planted. The total rice production is 2,919,600 Tons of paddy (1,950,000 Tons of rice).

The farmers grow a wide variety of crops, which are broadly classified according to the growing seasons into 3 groups:

- Kharif-I and Kharif-II crops grown during the kharif season, which is the main cropping season. Kharif starts in March and ends in October. It is characterized by a monsoon climate with high rainfall and high temperatures. The crop environment during this season is less favourable for high yields because of the uneven distribution of rainfall, variable flooding depths, low solar radiation, high temperatures and high humidity. Rice is the predominant crop during the kharif season.
- Rabi crops grown during the rabi season, a dry season which covers the period from November to February and which is characterized by scanty or no rainfall, low temperatures and clear skies. Crop environment during this season is very favourable for high yields, because of high solar radiation, low humidity and wide variations between day and night temperatures. However crops are restricted to areas with adequate soil moisture.

### **Rice**

In the study area rice is the most important crop and is grown throughout the year. Special adapted varieties have been developed for each growing season under rainfed, irrigated or flooded conditions. The varieties are also adapted to the preference of the rice growers and the consumers.

Among the different groups of rice "aus" is grown during the Kharif-I season, "T Aman" (transplanted aman) during the Kharif-II season and "B Aman" (deep water aman) requires both Kharif seasons to mature. All three groups of rice are rainfed cultivated. During the rabi-season irrigated "Boro" rice is grown. Estimated total production of paddy in 1990/91 season was some 2.9 million tons. 23% of the Aus area is planted to HYV's, 56% of T.Aman and 94% of Boro.

### **Other Crops**

Crops other than rice cover 59% of the NCA, mostly planted during Kharif-I and Rabi seasons. The main crops are jute, wheat, oilseeds, vegetables, pulses, spices and sugarcane. The areas around Dhaka are known for the production of vegetables, potatoes and sugarcane (for chewing purposes). Production of pineapples, bananas, papaya and jackfruit is locally important in areas of the Madhupur Tract and as some parts of the Old Brahmaputra Floodplain.

### **Yield Projections**

During the last 15 years rice production has steadily increased. National and the North Central Regional trends show annual rice production increases in the order of 2%. This increased production is almost entirely due to increases in yields through the expansion of HYVs, with little increase of area of rice grown. Similar yield increases have been experienced in pulses, oilseeds and jute whereas the yields of sugarcane, vegetables and fruits have been gradually declining.

### **Irrigation**

The use of irrigation has increased significantly in recent years, allowing in particular for boro rice to be grown. This increase has been achieved mainly through abstraction of groundwater (groundwater potential is not limiting for the majority of the Region although parts of the Madhupur Tract and the Old Brahmaputra floodplain do show a potential groundwater deficit).



### R.2.7 Livestock and Forestry

**Livestock** in the NCR are an integral part of the farming system, in spite of the fact that land is not available for grazing and scarcity of animal feed. The animals live almost entirely on the by-products of crops grown for human consumption, and the quality and stamina of animals used in the farm for land preparation and threshing are very poor especially on smaller farms. Cattle assist with the vital task of land preparation but the availability of draught animals in the NCR is generally not adequate. The estimated number of draught animals is 1,350,000, (675,000 draught animal pairs).

Sheep, goats and poultry are raised by most rural households. These animals live off farm residues and on scavenging, providing meat, skins and eggs. Mutton and chicken meat fetch higher market prices compared to beef. The total number of poultry is estimated at more than 9 (nine) million birds, and the number of poultry farms in the NCR is on the increase.

### Forestry

The parts of Madhupur Tract that extend in Savar (Dhaka District), Kaliganj and Kapasia (Gazipur District) and Muktagacha (Mymensingh District) have reserve forests, but, due to the increasing population pressure along with the expansion of habitat and industry, the forest land in the NCR is diminishing very fast. Forest trees are felled randomly and the programme of afforestation is meagre.

### R.2.8 Fisheries

Fisheries form a significant resource of the area particularly in the floodplains. Flooding in the North Central Region, whilst being disruptive and at exceptional times highly damaging, also provides benefits, one of which is a very important, self-sustaining floodplain fishery (although some floodplain fisheries have fallen into a poor condition). A large number of fish species migrate from rivers to reproduce, feed and grow on the floodplains.

Exploitation of the open water fisheries goes on throughout the year but intensifies considerably during the monsoon when seasonal river and rainfall flooding connects the various components of the aquatic system: main rivers, tributaries, canals, beels, ditches and floodlands to provide an integrated biological production system when fish and prawns breed and increase in number and biomass. Closed water culture fisheries relate mainly to numerous small ponds scattered throughout the region which are stocked with various species of carp whose fry are obtained either from natural sources such as traditional fry collection centres on the Jamuna, Old Brahmaputra and Dhaleswari rivers or, increasingly in recent years, from private and government hatcheries.

Most of the fish production in the NCR (75-85% by weight) is derived from open water capture fisheries, the greatest proportion being provided on the floodplains. These areas typically support open-access, part-time subsistence fishing carried out by a large majority of rural households. In contrast, rivers and beels tend to be exploited by full-time professional fishermen who must pay a charge fixed by lease or license.

Taken together, the capture and culture fisheries of the NCR produced an estimated 35,000 tonnes with a value to fishermen and farmers of about 1,109 million Taka. Fish is an extremely important component of the diet of people in Bangladesh, providing about 70-80% of the total animal protein intake. The most recent estimate of just over 26,000 tonnes of fish from the capture fisheries of the NCR provides sufficient animal protein to feed about 3.5 million people (4.7 million people if pond culture fisheries are included).

### R.2.9 Socio-economics

The NCR covers about 9 per cent of the country's total land area, but has some 15 per cent of the country's population; with a **population** of about 16 million (1992 estimate), 21 per cent (3.4 million) of whom live within the Dhaka metropolitan area. The population density for the region stands at some 1200 inhabitants/km<sup>2</sup> (820 inhabitants/km<sup>2</sup> excluding Dhaka) compared to the national average of 760 inhabitants/km<sup>2</sup>. The annual population growth rate for the region is currently higher than the national average, at an average of 2.9 % per annum.

Agriculture, although gradually declining in importance, will remain the most important sector for years to come. Control over land remains the single most important factor, and this control will continue to determine the nature and effectiveness of all development interventions in the country. As in the rest of the country, the **land ownership** in the North Central Region is highly skewed with high percentage of rural households being landless and marginal (owning below 0.4 ha). More than 50 per cent of the rural households are landless and/or marginal farm households.

The farming households are predominantly small and marginal owning land area up to 0.4 ha. These farms, however, account for not more than 30 per cent of the land area, and the concentration of land with a small group of land-owners is continuing with increasing incidence of land-mortgage and resulting distressed selling of land by poorer land-owners. Households owning no land or small areas tend to increase their operated area by entering different tenurial arrangements with land-owners controlling/owning larger land areas. The most common tenancy practice being share-cropping.

As regards **access to land operation**, the farming households for the region are close to the national average at about 53% owner occupied, 36% owner-tenant operated and 1.4% tenant operated.

**Access to Income Earning Opportunities** is a significant problem for the majority of the population. About 60 per cent of the civilian labour force remains employed in agriculture, with manufacturing as the second largest employer providing employment to 41 per cent of all industrial and non-farm employment in the North Central Region. In general there has been a rapid increase in urban labour force which is supplemented by a significant positive trend in the relative share of women participating in the labour force. Growing landlessness, uncertainty of agricultural production due to vagaries in nature, increased poverty and an increasing incidence of the break-up of families are forcing women to enter into the labour market. Currently females account for 10 per cent of the total workers.

With the recent intensive diffusion of seed-fertilizer-water technology an increased demand for non-farm goods and services has been generated. The population pressure on scarce land is leading to landlessness in the rural areas, and it is mostly the landless and the marginal farmers who constitute the rural labour force. The rural sector has limited capacity to absorb the rapidly growing labour force. However the potential of agriculture for creating employment cannot be exploited fully due to backward technology and lack of investment in modern agricultural technology.

There are significant differences in wage rates in different regions of the country and between the urban and rural sectors, with higher rates for unskilled industrial workers than for agricultural labourers. These differences explain the trend of rapidly increasing urban population as a result of influx of rural/urban migrants mostly consisting of landless and near landless households.

Given the limited expected rate of further development in the urban sectors, additional employment opportunities should be generated in the rural areas. Emphasis may have to shift towards **diversification** and the development of livestock and



fisheries for generating additional income, and the issue of fisheries development merits special attention in developing flood control and drainage interventions. The high population numbers and the unemployment situation are such that whatever initiatives are taken in the agricultural sector, there will still be surplus labour for whom employment opportunities will have to be created in the non-crop sector. As mentioned above, in the rural areas non-crop activities would include fisheries, livestock, rural infrastructure and rural industries, specially cottage industries. However, lack of institutional credit means limited expansion of rural industries and thus a limited labour absorption capacity. The development of rural infrastructure is dependent on external resources and its labour absorption ability will depend on external factors.

The **social infrastructure and access to basic services** is good relative to the rest of the country. Although there is a relatively high proportion of the national highways inside the NCR (some 15%), the minor unmetalled road mileage is not well developed. The region has a well developed navigational network; and people living in the flood plain are generally dependent on water transport in the rainy season. Even in dry season it is often easier to carry goods by boats than by bullock carts to the market.

The **literacy rate** in the region is generally below the national average, although Dhaka district was higher. The number of primary schools in the region is about 9000 of which about 87% are government schools. About 90% of all primary schools are in urban areas where 36% of the total population is located. Drop-out rates remain high and in 1988 the rate was 66.0 and 69.3 for boys and girls respectively. 74 per cent of existing secondary schools are in urban areas. The North Central Region has the best facilities for provision of pre and post graduate general and professional education in the country.

Acute shortage of **health facilities** are characteristic even for relatively developed area like Dhaka and Narayanganj. About half of all available hospitals, dispensaries, hospital beds and family welfare centres are in Dhaka district. Tangail and Jamalpur have relatively poorer infrastructure for providing medical assistance. In recent years significant improvement has been achieved in the field of sanitation, and the number of households having access to potable water in the NCR districts is reported to be very high. The situation regarding sanitary latrines is poor with only 5 to 10% of households in the NCR Districts using sanitary latrine. Some strong action is being carried on health and sanitation improvement activities in some NCR Districts such as Dhaka, Manikganj, Mymensingh, both with governmental efforts and NGO activities.

The **incidence of poverty** in the region is high. The expansion of Boro crops has improved the situation in the summer months but the autumn lean season (coming after the planting of Aman) affects the rural population severely as harvest is still more than a month away. The worst affected are the agricultural labour households, consisting of the landless and the marginal farmers. This is also the time of low job availability, and low wage rates with a decline in wages in the order of 30 to 40%. As wages decline, consumption of food by households also declines, with the most affected group being the daily labourers. It has been estimated that around 80 % of agricultural labour households were below the poverty line.

Successful water resources development is dependent on its acceptance by the local community and public participation is important in this regard. A public meeting has been held in Mymensingh to discuss the Draft Plan which heard the views of some Members of Parliament and other representatives of the Region. This has resulted in the inclusion in the RWRDP of certain additional regional schemes which although not receiving a high priority in terms of a response to flooding problems alone, are included as they have significant irrigation and agricultural development content which makes them significant for the overall water resources development of the Region.

### R.3 Methodology

The Region was initially divided into thirteen Planning Units (PUs), see Figure R.4, to assist in classifying the characteristics of the region, and to allow alternative development strategies to be prepared for different PUs. These PUs have been delineated using hydrological, soils, land use, population intensities and socio-economic characteristics. The PUs are defined to assist in the planning process, they are not development units and options may need to be implemented over more than one PU at a time.

Subsequently, the characteristics of the PUs have been compared and the results indicate that the NCR can be broadly categorised as falling into 5 characteristic sub-regions (see Figure R.5) on the basis of biophysical and socio-economic features:-

- |                               |                 |
|-------------------------------|-----------------|
| • Jamuna Flood Plain          | 35% of NCR area |
| • Old Brahmaputra Flood Plain | 20% of NCR area |
| • Madhupur Tract North        | 19% of NCR area |
| • Madhupur Tract South        | 11% of NCR area |
| • Padma Flood Plain           | 15% of NCR area |

The natural and socio-economic environment is described on the basis of these sub-regions and a water development strategy developed.

### R.4 Water Development Strategy

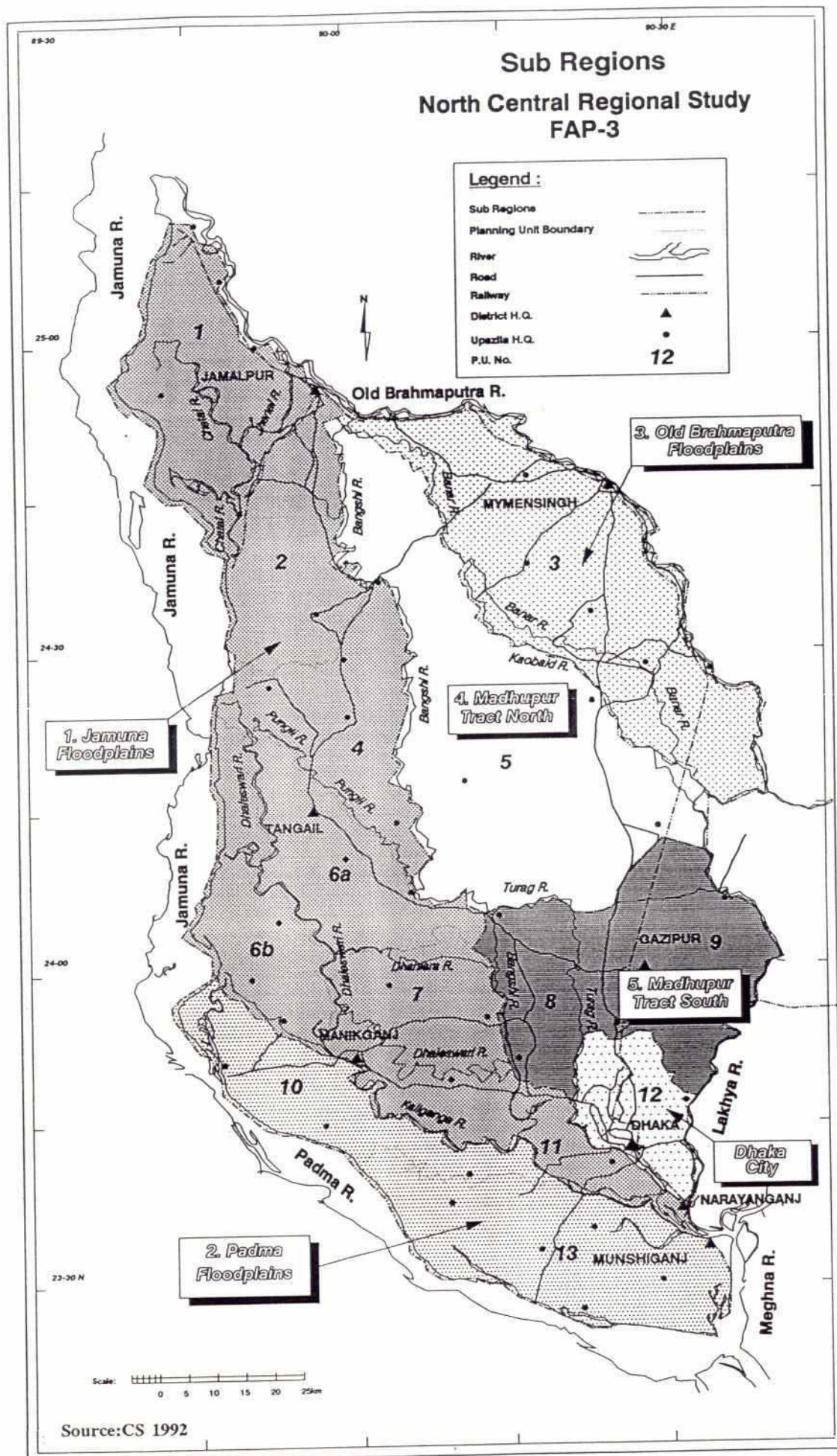
A water development strategy is proposed and the water resources characteristics, are considered along with socio-economic, environmental and national planning aspects:-

- identify economically viable developments
- identify areas where high agricultural value can be added from controlled flooding interventions
- priority to heavily distressed sub-regions
- develop first where socio-economic frameworks exist to sustain growth
- involve local people in the planning and management of flood control and drainage programmes
- promote local economic initiatives induced by agricultural, livestock and fisheries improvements
- allow for mitigatory measures wherever groups/persons are adversely affected by a development
- use embankments for several socio-economic purposes
- economic promotion through improved institutional measures
- sub-divide region into regional planning units to facilitate the planning process
- develop environmental management programme so as to sustain the region's resources





Figure: R.5



## R.5 Development Options

Development options have been formulated and include:-

- fully controlled flooding and drainage, based on full flood control along the major rivers by embankments and fully gated structures, and major drainage improvements;
- semi-controlled flooding and drainage, where flooding depends partly on embankments with fully gated structures, and partly on natural openings or semi-regulated ones.
- compartmentalisation (water management systems including required institutional agreements and comprising peripheral inlet/outlet structures, internal water control works, channel improvement, and infrastructure improvements).
- development of unprotected or partially protected areas in terms of flood proofing (both rural and urban), flood preparedness and early flood warning systems

Within the various sub-regions of the North Central Region, compartmentalisation is expected to play a key role in all future development scenarios. The compartmentalisation of protected areas creates water management units organised by the local beneficiaries and supported technically by the local institutions.

## R.6 Preliminary Screening of Development Options

Appropriate flood mitigation actions are summarised for each PU in the Study. After considering the main physical development constraints, PU's 1,2,4,6,7 and 10 are considered as priority development areas. Inside these PU's several planning actions are described in technical and economic terms with or without combination of regional schemes (linking together for instance PU1 and PU2, also PU2 and PU4 for which flood mitigation measures are clearly interrelated). Alternative scenarios have been taken into consideration for the above priority planning units which take include the possible implementation of Jamuna Bridge.

In addition to planning for the development of these priority planning units the Regional Water Resources Development Plan (RWRDP) also assesses the other planning units (PU's 3,5,8,9,11,12 and 13), and recommends local planning and water management measures.

## R.7 Planning Process

An inventory of development alternatives and components is given, but irrigation development has not been considered as a particular option (being outside the scope of the TOR for the Study). It is assumed that irrigation will be developed by the private sector without any heavy public investment.

The planning process was multi-disciplinary and involved the use of a hydraulic model with engineering and economic analyses together with agricultural, fishery, socio-economic, institutional and environmental studies. These were incorporated into a multi-criteria analysis of the identified scheme alternatives.



## R.8 Pre-feasibility Studies

A pre-selection of possible projects prioritised pre-feasibility studies on five regional schemes:-

The **Jamalpur Priority Project, scheme RS1** (also known as FAP 3.1) located at the northern upstream corner of the NCR, which was identified early in the FAP as being suited for priority development (the FAP 3.1 Feasibility Study has been carried out concurrently with this NCRS).

Both the FAP 3 and 3.1 analysis of RS1 show that a low cost engineering option (Option B) is the most viable option for the area. An alternative flood proofing and local drainage option (Option A) would provide benefits in terms of security from floods but it is difficult to justify this option on economic grounds as the assessment of costs and benefits of flood proofing have not yet been well quantified.

Option B allows for the best use to be made of the advantages of the JPPS area. An option is being developed by FAP 3.1 that will utilise the existing embankments where appropriate and keep construction costs down to a minimum. FAP 3 calculate that such an approach would give an IRR of 12% (without taking into account the costs or benefits of flood proofing). If allowances are made for indirect benefits (of damages avoided and increased agricultural benefit) then the IRR increases to more than 13%.

The **Jamalpur to Bhuapur Development Scheme, RS2** covers an area of 149 000 ha (116 000 ha NCA), consisting of PUs 2 and 4. The area is already partly flood protected by the Jagannathganj-Jamalpur railway embankment and the BWDB embankment from Bhuapur to Jagannathganj.

The prefeasibility analysis shows that this scheme gives a high economic return (18 % IRR, NPV of Tk. 476 million). This is largely due to the existing hydraulic infrastructure which has reduced the required investment capital. In social and environmental terms, it is also relatively attractive as fishery resources are relatively low in the area and as the embankments are already largely in position, there is a relatively small additional impact on flood levels outside the embankments resulting from the scheme. The significant initiative of the scheme is the compartmentalisation concept, and RS2 can be seen to be an extension of the FAP 20 Pilot Project which is located immediately downstream.

The **Dhaleswari - Kaliganga Development Scheme, RS3** covers an area of 150 000 ha (117 000 ha NCA), consisting of PUs 6a and 7. The area includes within it the FAP-20 Compartmentalisation Pilot Project at Tangail. Limited embankments already exist in the area, particularly in the FAP 20 area; but most of the Dhaleswari-Kaliganga remains unembanked.

The proposed development is to construct embankments for controlled flooding along the Dhaleswari-Kaliganga from Joker Char (near the Pungli offtake) down to Kalatia. The possible development has been split into two phases and should be considered as either with (RS3A) or without the Jamuna bridge (RS3B)

The prefeasibility analysis shows that this scheme with controlled structures (RS3A1C+RS3A2C) gives the highest economic return (IRR of 22%, NPV of Tk. million 1700). However it is a large scale scheme requiring substantial capital investment (Tk. million 2700, US \$60 million) and the consequences of such a development need careful investigation before it can be justified. The impact on the adjacent areas of PUs 6b, and 10 plus the environmental consequences need to be fully estimated. The scheme would affect a major floodplain fishery area (one of the largest remaining unembanked fishery resources areas), and the consequences of such an interference may have far reaching effects beyond the NCR.

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It is therefore recommended that RS3 be taken through to feasibility study, but that time is allowed for preparatory studies to be made to establish fully the environmental, hydrological and socio-economic characteristics of the area and the consequences of such a development.

The **Bangshi River Improvement and Drainage Scheme, RS4** would improve the flow capacity of the main drainage channel for the western part of the region. The river would be straightened, widened and deepened for a total length of 81 km. The work would start at Kalatia (constraints downstream of this point are determined by the high water levels backing up from the Meghna/Padma confluence) and be implemented upstream to include strengthening and improvement of the Bangshi river east of Basail.

The prefeasibility studies show that this scheme on its own would not be economically viable (IRR of 6%). But RS4 is also found to be complementary to other regional schemes, and thus the scheme is recommended to be studied as a possible addition to the scope of works to both RS2 and RS3 feasibility studies.

The **Muktagacha - Bhaluka Development, RS5**, covers an area of 172,000 ha in PU3. substantial areas are flooded annually from local rain water and runoff from the adjacent Madhupur Tract. There is little direct flooding from the adjacent Old Brahmaputra but drainage from the area is restricted at the south-eastern end by high water levels in the rivers. Groundwater conditions are unfavourable and it is estimated that only 60% of the eventual irrigation demand can be met from groundwater. The aim of development in the area would be to increase agricultural production by improving the drainage and water management. The area would benefit from improved water supply, possibly through the diversion of surface water from the Old Brahmaputra.

The **Bhuapur - Aricha Development, RS6**, forms an alternative to RS3. The upstream section is the same as RS3 (following the left bank as far as Dhula), but instead of following the Dhaleswari downstream of Dhula, another embankment would be constructed on the south side of the Dhaleswari offtake following the left bank of the Jamuna down to Aricha and finally connecting up with existing BWDB embankment works close to Harirampur. The scheme forms part of the earlier proposed Dhaka South West Project.

This scheme is potentially a large scale development, but it involves major changes to the present hydraulic regime of the major rivers (Jamuna, Padma, & Dhaleswari). The prefeasibility analysis has shown the scheme to be economically marginal (IRR of 11%); and there are major potential environmental consequences that are envisaged as a result of the scheme. The scheme is seen to be even more complicated to assess than RS3 and should have a high risk factor applied to its assessment. It is not recommended for further study in the medium term but should be reconsidered at a later date in the RWRDP.

## **R.9 Regional Water Resources Development Plan**

The Regional Water Resources Development Plan (RWRDP) has been developed using a multi-criteria approach with the economic and sensitivity analyses of engineering and agricultural/fishery benefits/disbenefits being supplemented with more qualitative assessments on socio-economic and environmental impacts.

The RWRDP is presented below, but the success of the complete plan is subject to certain recommended institutional changes and to making the best use of experiences gained in the related FAP supporting studies. The priorities are based on the conclusions, described in the multicriteria analysis.



The anticipated developments have been categorised as suitable for short, medium and long term development:

### Short Term

Short term development is considered as those schemes that could be prepared and implemented within the next 6 years (see Figure R.6). These schemes consist of priority projects that are expected to have a relatively small environmental impact on adjacent areas, and thus require only 1 to 2 year feasibility study.

The schemes included in this category are :

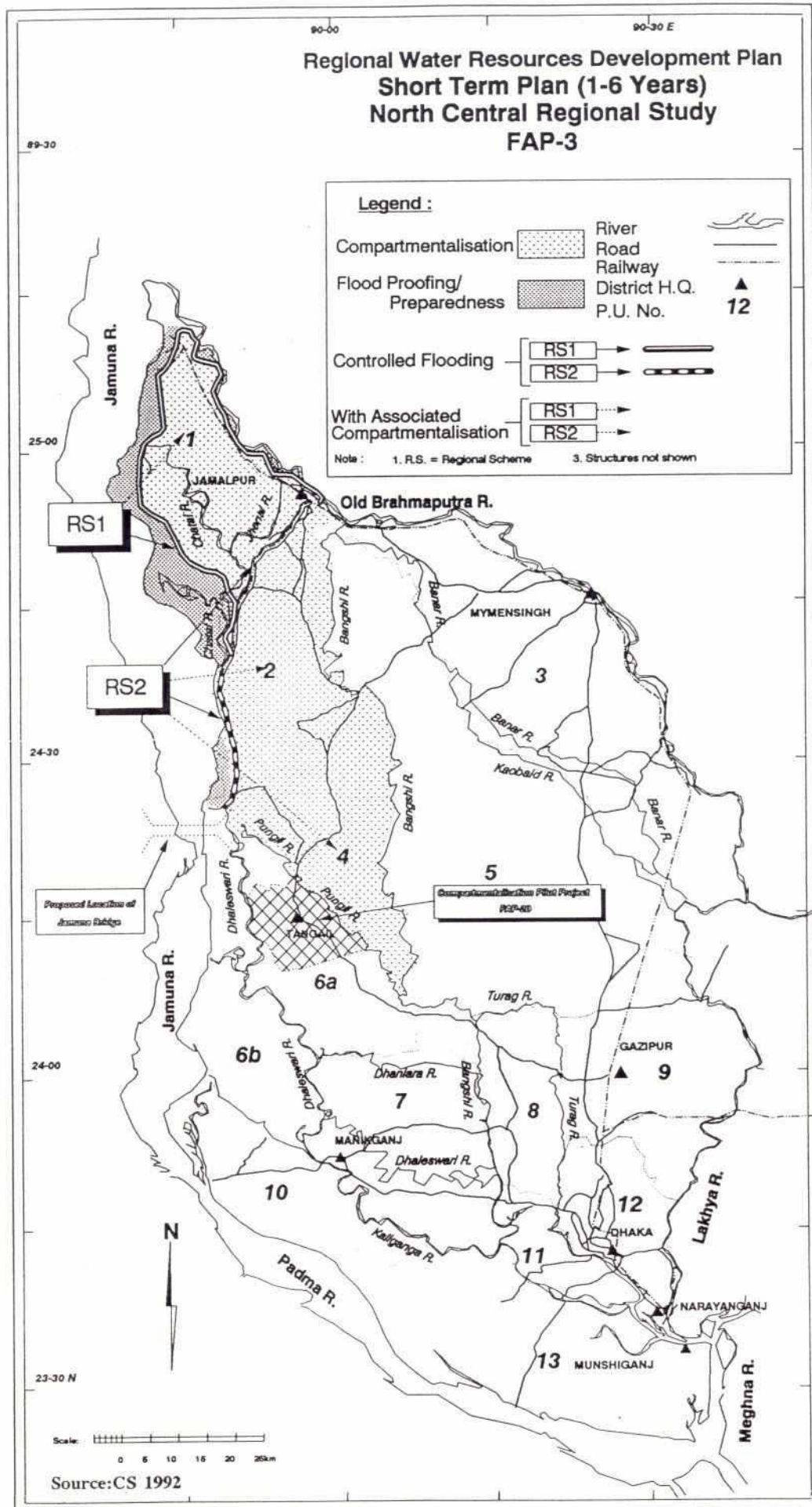
- (i) **RS1b (FAP 3.1).** RS1 was identified in the early stage of the FAP during 1990 as a priority project and the feasibility study for this scheme, the Jamalpur Priority Project is already under way. The FAP 3.1 schedule is to complete project preparation by 1993, thus allowing for implementation to begin in 1994 (Year 2).
  - (ii) **RS2.** Significant structural elements of the RS2 (Jamalpur to Bhupur Development) are already in place. The main control embankments consisting largely of the existing railway embankment (from Jamalpur to Jagannathganj) and the existing BWDB embankment from Jagannathganj to Bhupur. (The Jamalpur Fertilizer Co. are already funding further improvements, in 1992, to this embankment to be used as a road). The scheme complements the development of RS1b and will also benefit from control to be made under RS1b on Baushi and the Jhenai Bridges.
- The significant benefits envisaged from this scheme result from the compartmentalisation that would be developed in the area. The findings of the adjacent FAP 20 Tangail compartmentalisation project will be relevant in this respect.
- (iii) **Flood Proofing and Mitigatory Measures.** Flood proofing will be required in the unprotected areas adjacent to the RS1b and RS2 schemes. This consists mainly of the char land area and active flood plain left outside of the embankments. Other mitigatory measures may be required for certain disadvantaged groups. There include the landless and fishermen. Detailed initiatives will have to be developed at the Feasibility Study level and may include such measures are multipurpose use of embankments and integrated fish development projects.

### Medium Term

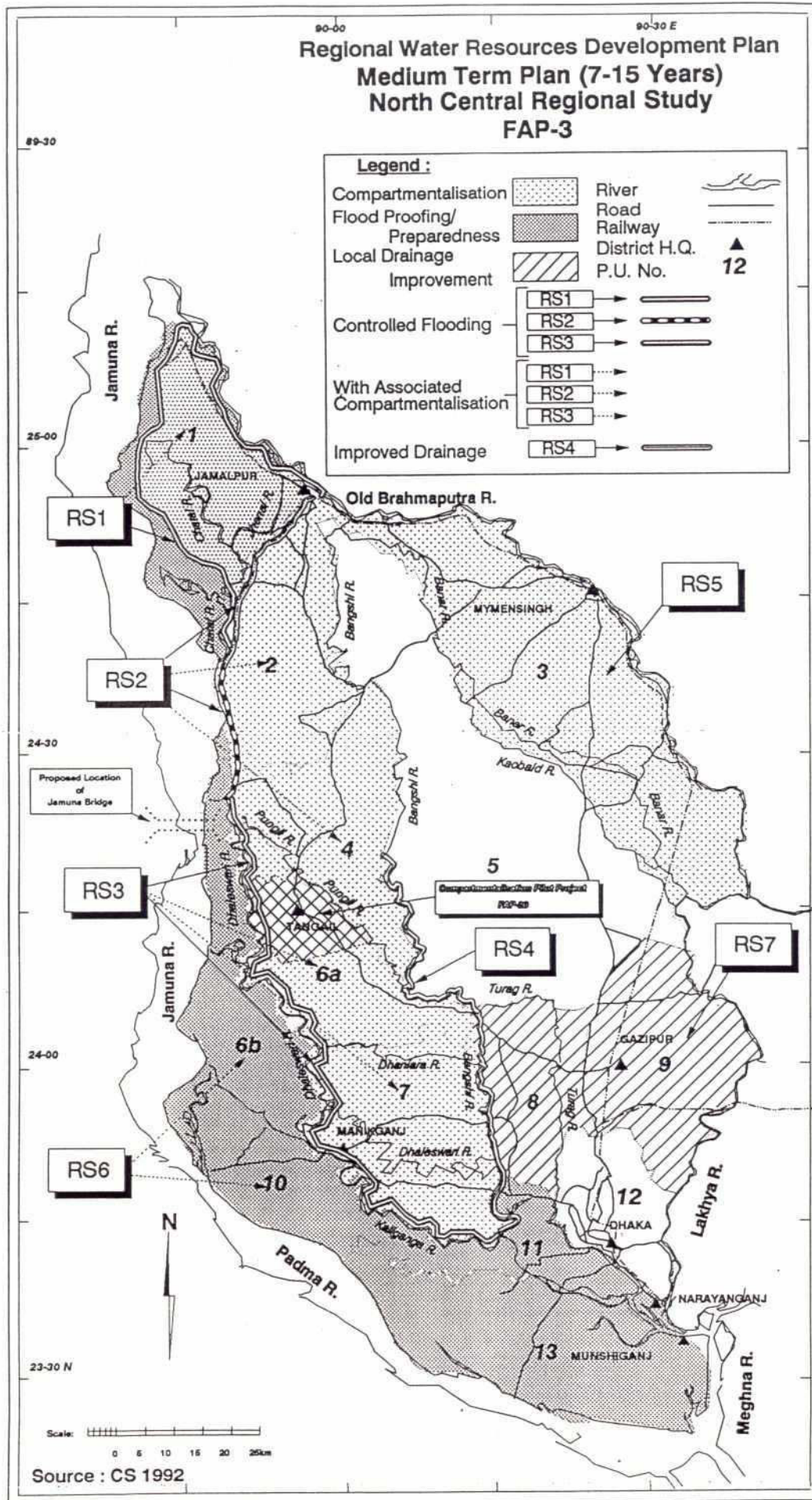
Medium term development is classified as implementation within 7 to 15 years (see Figure R.7). These medium term schemes require several more years of study, before a fair appraisal can be made on their advisability.

- (i) **RS3.** This scheme (Dhaleswari-Kaliganga Controlled Flooding and Compartmentalisation) would be a major development. It shows significant potential benefits to agriculture indicating a large net present value. However the impact of such a development on the existing environment, nearby areas and related sectors such as fisheries will be very significant. Such a large scale development (engineering funding is estimated at Tk. million 2730, approximate US \$60 million) requires a comprehensive feasibility study, and time for the implications of such a development to be analysed and considered.

Figure: R.6







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- (ii) **RS4.** The investigations of regional drainage has shown that the high water levels at the south-east corner of the region (the Padma-Meghna influence) create a serious restriction to the drainage out of the region. Although local drainage improvement is still seen to be a viable option, see (iii), there is limited scope for effective improvements to the regional drainage. The pre-feasibility studies have revealed that improvements to the Bangshi river (scheme RS4) will bring justifiable benefits, but an improved regional model is required before this potential scheme can be recommended for feasibility analysis.
- (iii) **RS5 and RS7, Compartmentalisation and Local Drainage.** Although not a high priority in terms of major flooding, agricultural production in areas of PUs 3 and 8 have been found to be hampered by local flooding primarily caused by impeded drainage. It is recommended that after observation of progress on compartmentalisation and local drainage improvements recommended in the short term plan (FAPs 20, 3.1 and RS2), that consideration be given to carrying out feasibility studies for similar programs in PUs 3 and 8.
- (iv) **Flood Proofing and Mitigatory Measures**  
Flood proofing will be required in those areas unprotected by RS3. This may include large areas of PUs 6b, 10, 11 and 13. Consideration should also be given to carrying out flood proofing in these areas, even without RS3. The viability of RS6 (see below) has to be questioned and thus flood proofing may be the most appropriate development option for these areas.

Other mitigatory measures may be required, as described in short term (iii) above. Fisheries are particularly significant in the RS3 area and the feasibility study should consider the impact on this sector in detail before recommendations can be made.

### Long Term

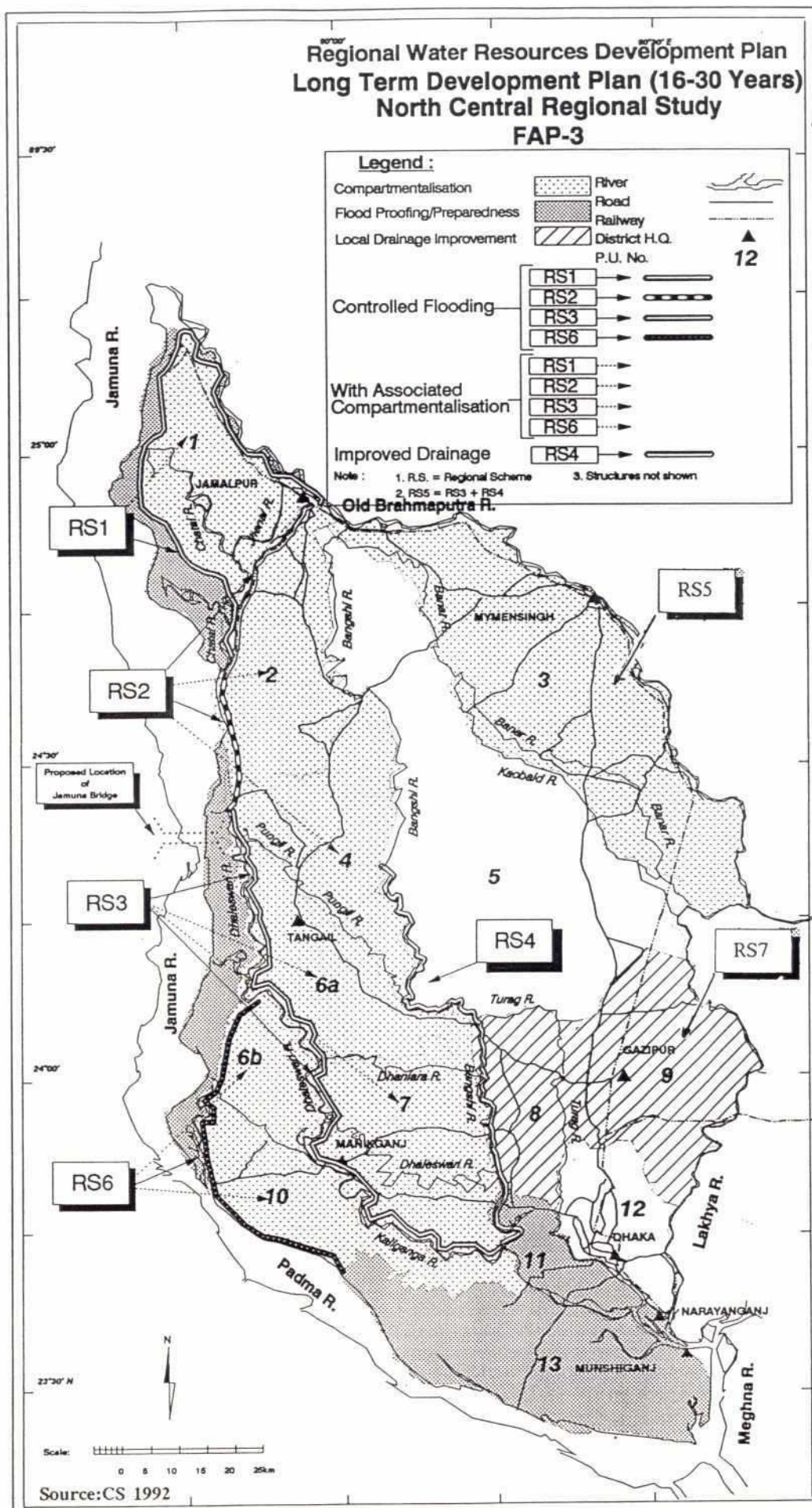
The long term plan (16 to 30 years), see Figure R.8, shows the possible long term development that best utilises the natural resources of the region. The time scale given is arbitrary being dependent on so many unpredictable factors.

- (i) **RS6.** The possibility of controlled flooding being extended to incorporate PU10 and 6b has been investigated. This option has the potential of making major changes to the flooding characteristics of the region but only shows marginal economic viability. The scheme would be consistent with the South-West Dhaka Project plan (proposed in the 1960's and part completed) but is an option which should be viewed with caution as if completed it would have major environmental impacts. The scheme would potentially change the hydrological system dramatically. Advice has previously been given (FAP 1990) that such drastic measures should not be contemplated at this stage. However, the possibilities still remain of such a development becoming practicable and it has therefore been included as a possible development in the long term plan.
- (ii) **Other Measures** In addition to the other short and medium term measures already described, there is the potential for making local drainage improvements to PU9. However this again is limited by the high water levels in the Lakhya-Meghna-Padma system.





Figure: R.8



The RWRDP, as described above, has been scheduled to fit into a regional development programme as shown in Figure R.9. The program allows for development to place in a logical sequence and for maximising the benefits of complementary activities (such as RS1b with RS2; and RS4 with RS3) where possible. It also allows for making the best use of existing facilities, by concentrating on RS2 and RS1b in the first years.

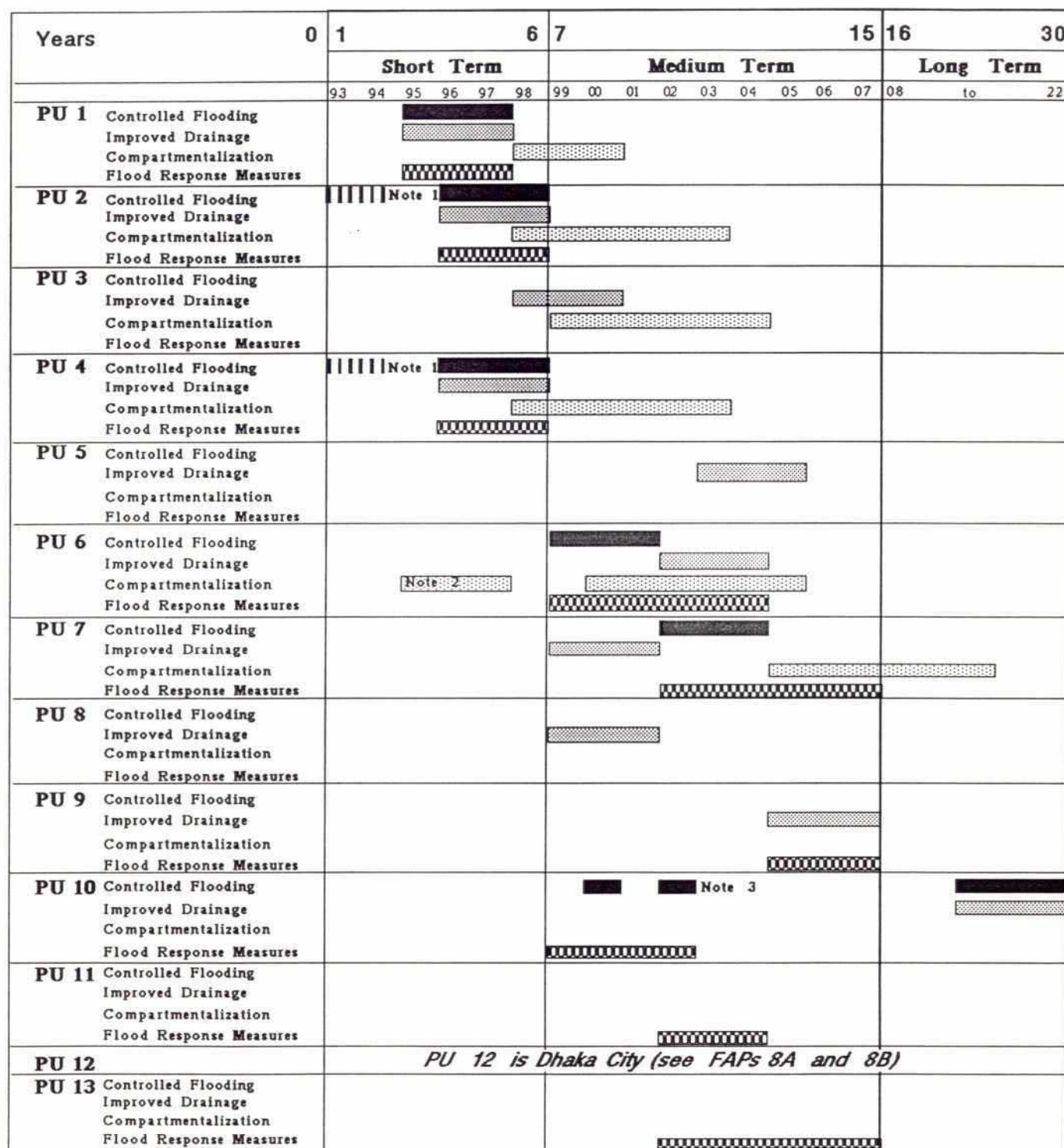
The schedule is fundamentally one of implementation from upstream to downstream (RS1b to RS2 to RS3). This is an indication of the fact that the worthwhile regional initiatives are seen to be those of controlled flooding (with associated compartmentalisation and local drainage) rather than regional drainage.





An overall planning horizon of 30 years has been used for the plan, but only those schemes that would fit into the first 15 years are considered worthy of further investigation at this stage.

The financial requirements in the medium term (first 15 years) are shown in Table R.2.



## Regional Water Resources Development Plan- Programme



-  Controlled Flooding  
 Improved Drainage  
 Compartmentalization  
 Flood Response Measures (e.g. flood proofing/preparedness/early warning)

Note :

- Existing BWDB embankment is to be improved by RHD under funding from Jamuna Fertiliser Factory in 1992/93.
- FAP 20's compartmentalisation is expected to be implemented in PU6
- Embankment works will be needed associated with developments on the Dhaleswari-Kaliganga in PUs 6 & 7.

**Table R.2**  
Financial Requirements of the Short and Medium Term Plans (Tk. million)

Description of Works	Plan Year															Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	(Tk.ml.)
<b>Regional Schemes (1)</b>	41.7	69.6	500.8	500.8	500.8											1613.5
RS1 Jamalpur Priority Project		36.0	60.0	400.0	400.0	400.0										1296.0
RS2 Jamalpur to Bhuapur Development			14.2	14.2	23.7	23.7	255.5	255.5	255.5	85.2	85.2	85.2				1097.8
RS3-Phase 1 Dhaleswari to Kaliganga Devpmnt.						21.6	21.6	36.1	36.1	360.6	360.6	360.6	120.2	120.2		1557.9
RS3-Phase 2 Dhaleswari to Kaliganga Devpmnt.			197.0	197.0	197.0	197.0	197.0	197.0	197.0	197.0	197.0	197.0				1969.9
RS4 Bangshi River Improvement			*	*	*	*	*	*	*	*	*	*	*	*	*	Note (2)
Flood Response Measures (2)			*	*	*	*	*	*	*	*	*	*	*	*	*	Note (3)
Fishery Initiatives (3)			*	*	*	*	*	*	*	*	*	*	*	*	*	Note (4)
Institutional Strengthening (4)			*	*	*	*	*	*	*	*	*	*	*	*	*	
<b>Total Financial Requirement</b>	41.7	105.6	772.0	1112.0	1121.4	642.3	474.2	488.6	488.6	642.8	642.8	642.8	120.2	120.2	120.2	7535.3

Notes: 1. The Regional Schemes include for the capital cost of compartmentalisation

2. \* Flood Response Measures include for Flood Proofing, Preparedness and Early Warning. Costs should be determined after FAPs 10, 14 and 23 have reported.
3. \* Although fishery initiatives are described in PSR III, the costs are to be determined after FAP 17 has reported.
4. \* Institutional strengthening costs to be determined after FAP 20 and 26 have reported.
5. Annual operation and maintenance costs have not been included in the Table.

? Why?  
What is the  
proposed?  
The contract?  
did not complete  
the study as per  
requirement  
Why he is depending  
on other



