

Improved System for Disaster Mitigation and
Environmental Management in Bangladesh

Volume 1

**Flood Disaster Management and Environmental
Impact Studies for Urban and Rural Areas**

Proceedings of the
UNCRD-BUET Joint Research Project
24-26 February 1997
Dhaka, Bangladesh

United Nations Centre for Regional Development
Bangladesh University of Engineering and Technology

UNCRD Proceeding Series No. 17

United Nations Centre for Regional Development (UNCRD)

February 1997

Editing Staff:

Yujiro Ogawa, Disaster Management Planner, UNCRD

Yuzo Nagano, Associate Expert, UNCRD

Qudrat-e-Khoda, UN researcher, UNCRD

Seiko Hirabayashi, Junior National Expert, UNCRD

S.I. Khan, Chairman, Gram Bangla

Mozammel Haque, Professor, BUET

Opinions expressed in signed contributions are those of the author(s) and do not necessarily those of the United Nations Secretariat, the United Nations Center for Regional Development, and Bangladesh University of Engineering and Technology.

Designations employed and presentation of material in this publication do not imply the expression of any opinion whatsoever on the part of the United Nations Secretariat or of the United Nations Centre for Regional Development concerning the legal status of any country or territory, city or area, of its authorities, or concerning the delimitation of its frontiers or boundaries.

No part of this publication may be reproduced in any form or by any means without permission in writing from the United Nations Centre for Regional Development.

PREFACE

Against the background of the unprecedented flood disaster and the cyclonic storm surge respectively in 1988 and 1991 in Bangladesh, UNCRD and BUET have conducted a joint research over a period of four years (1991-1995) on Improved System for Disaster Mitigation and Environmental Management in Bangladesh.

These researches, however may be considered more as social engineering research designed to protecting the lives of the people living in dangerous areas prone to natural calamities like flood and cyclone disasters than pure engineering research for flood and disaster control. Sixteen research projects have been completed in four years. The result of this kind of valuable and useful study needs to be disseminated to a wider section of the society. And, it is only through the practical application of the findings of these researches that the society could immensely benefit from. With a view to accomplishing this task, therefore, UNCRD and BUET have organized the joint seminar (24-26 February 1997) to share the knowledge generated through the research with a large number of people.

The publication is a compilation of sixteen research papers. Volume one consists of six papers of the project titled *Flood Disaster Management and Environmental Impact studies for Urban and Rural Areas*, and volume two contains ten papers of the project titled *Towards an Improved System for Cyclone Disaster Management in Bangladesh*.

I hope that these studies will contribute greatly to the development of Bangladesh in general and, to the mitigation of disaster management, in particular.

Hideki Kaji
Director, UNCRD

February 1997

Volume 1
Flood Disaster Management and Environmental Impacts Studies
For Urban and Rural Areas

CONTENTS

Session- I

M.H. Rahman..... 1

A.K.M.N. Islam

Environmental Impacts Assessment of Greater Dhaka Flood Protection Structures

Md. Mujibur Rahman..... 23

Md. Abdul Karim

Impact of Dhaka City Flood Protection Embankment on Surface Water Quality with Specific Reference to Industrial Liquid Waste Disposal

Jahir Uddin Chowdhury..... 45

Muhammad Abdul Momin Khondaker

An Assessment of the Impacts of Dhaka City Flood Control Project

Session- II

Roxana Hafiz..... 53

Sarwar. Jahan

Md. Zahid Hossain Khan

Effect of Greater Town Dhaka Flood Protection Embankment of the Changes in the Trend of Settlement Pattern and Land use in the Fringe Areas of Embankment

Mir Shahidul Islam..... 67

Md. Nazmul Alam

Master Plan of Flood Shelter/Evacuation Site Functioning as Community Centre for Disaster Management and Rural Development

Mohamad. A. Mohit..... 81

Md. Golam Mustafa

Institutional Development Programme for Local Level Flood Disaster Management and Rural Development in Bangladesh

ENVIRONMENTAL IMPACTS ASSESSMENT OF GREATER DHAKA FLOOD PROTECTION STRUCTURES

M.H. Rhaman

Associate Professor,
Department of Civil Engineering, BUET.

A. K.M. N. Islam

Research Associate,
INTEP, Department of Urban Engineering, The University of Tokyo.

ABSTRACT

Bangladesh suffered two serious floods during monsoon period of the year 1987 and 1988. During that time Dhaka, the Capital City of Bangladesh experienced an unprecedented degree of flood level, 1.5m higher than normal level for a period of up to four weeks. At that time 2.5 million, i.e. 60% of total population of the city were directly affected. In this situation, the Government of Bangladesh decided to construct flood protection structures to surround the Greater Dhaka City (GDC) area. The first phase of this work has already been completed. The construction of the flood protection structures was so hurriedly done that there was serious deficiency in planning, design and construction processes. Due to construction of two types of protection structures, namely reinforced concrete wall and embankment, the facility cannot be used as roadway, the construction of conventional earthen embankment without proper soil investigation may cause several types of embankment failures. The embankment breach followed by flooding is likely to cause greater damage to lives and properties. In this study, these aspects are clearly identified with recommendations for proper remedial measures. A comprehensive guideline to improve waste management system in GDC, proper environmental impact analysis of the project with the solution of major environmental issues and a cost-effective solution of flood protection structure with better serviceability is reported in this paper.

1. INTRODUCTION

Greater Dhaka City (GDC), the Capital of Bangladesh is situated in the central part of the country and is surrounded by the rivers and Khals on all four sides. Tongi Khal and Turag river on the north, Buriganga river on the south, Balu and Sitalakhay rivers on the east and Turag and Buriganga rivers on the western side (Figure 1). The area of GDC is 265km². The GDC enjoys a typical monsoon climate. The temperature varies from 70 to 94 degrees Fahrenheit in summer and 50 to 85 degrees Fahrenheit in winter. Monsoon started in July and stay up to October. This period accounts for 80% of total rainfall. The average annual rainfall is about 2.0 x 10³mm. The population of the city stood 4.8 million in 1990 (JICA, 1991). During the period from 1981 to 1990, the GDC population grew at an average annual rate of 5.5%. At that time the built-up area increased from 104 km² (39% of city area). During monsoon period of the years 1987 and 1988, Bangladesh suffered two of the most serious floods. At that time GDC experienced an unprecedented degree of flood level, 1.5 m higher than normal level for a periods of up to four weeks. Conservative estimate of floods suggest that loss due to annual flood is about Tk.250 million, and the damage due to a 10 year flood and a 40 year flood (same on 1988 flood) are Tk.530 million and Tk.750 million respectively. (source: Dhaka Flood Protection project briefing. Office of Executive Engineer, Dhaka O & M Div-II, BWDB). In this situation, the government of Bangladesh (GOB) decided to construct flood protection structures to surround the GDC areas in collaboration with other international support agencies. The first phase of this has already been completed. the construction of these works was so hurriedly done that it lacks assessment of impact of these structures on GDC environment. Therefore, this study focuses on the impacts assessment of GDC flood protection structures for major environmental issues.

2. STATUS OF FLOOD PROTECTION AND DRAINAGE STRUCTURES

Bangladesh Water Development Board (BWDB), Dhaka Water and Sewerage Authority (DWASA) and Dhaka City Corporation (DCC) are mostly involved in Implementation of flood control, erosion protection and drainage aspects of GDC flood protection structures (GDCFPS). Bangladesh Army (ARMY), Rajdhani Unnayan Katripakha (RAJUK), Civil Aviation Authority of Bangladesh (CAAB) are also involved in actual construction process of GDCFPS (embankments and walls) at different section as shown in Figure 1 and Table 1. The construction of these structures started in March, 1989 and phase- I works, as shown in Figure 1, has already been completed in 1992.

However, serious problems have developed in large portion of the phase I works. Table 1 summarizes these problems (FAP 8B, 1991). From Table 1 and field investigation, it is clear that the existing earthen embankment is unstable in large section of phase I work where it crosses old portion of silted up channels. There are severe cracks in reinforced concrete walls. This is happening due to construction irregularities like material properties, construction procedure and lack of advanced construction methods. The construction of protection structures through low-lying areas, without providing adequate drainage facilities, has caused internal flooding. This will increase surface water pollution problem within the GDC areas. Again the construction of Flood walls, alternative to embankment, in many places to save few families make the embankment discontinuous. This also reduces the stability of entire structures and prohibits the use of protection structures as road way. The cross-section of phase I conventional earthen embankment is shown in Figure 2-1 and an alternate proposed cross-section of reinforced earth embankment is shown in Figure 2-2 (Kabir, 1992). From Figure 2-1 and 2-2, it is clear that a considerable saving in land and earthwork can be achieved by adopting this type of design. In proposed design, the surface area of the embankment exposed to river flow is a fraction of that which has been constructed. Hence, there will be substantial cost saving in erosion protection work. Again the proposed embankment will almost eliminate breaching possibility during high floods, which will cause severe loss of lives and property as people will live in a more relaxed and unprepared manner than before. The use of small width (29.3 m) embankment can also eliminate land acquisition problems. This will improve overall embankment stability and will provide a continuous structures so that entire section can be used as roadway. Therefore, the construction of this type of embankment will be cost effective compared to conventional earthen embankment.

3. ENVIRONMENTAL IMPACTS ASSESSMENT

3.1 Flood Protection

This project will protect the capital city (265 km²) of Bangladesh from perpetual floods. This is a nerve centre for major national activities. To assess the impact, it is required to understand what a flood can do. In 1988, Dhaka city was flooded to an unprecedented degree with a flood level 1.5 m higher than normal for periods of up to four weeks. About 200 km² i.e. 77% of the total area of 265 km² were submerged to depths ranging between 0.3 m to over 4.5 m, and about 2.5 million people i.e. 60% of the city population of 4.8 million were directly affected by the flood. Even Dhaka was completely cut off by air link from the rest of the world due to submergence of the only

International Airport of Bangladesh. It was a moral, political and economic setback. To assess the flood damage, it has been divided into four groups:

- 1) General property damage
- 2) Public property damage
- 3) Income and sales loss
- 4) Disruption in utilities service

The general property damage potential includes (i) houses (ii) household articles (iii) buildings for commercial activities (iv) equipment and stock (v) theft and transportation damage due to flood (vi) agricultural products (vii) poultry and (viii) cattlehead.

The public property damage potential includes (i) public buildings (ii) airports (iii) electricity facilities (iv) telecommunications facilities (v) road and (vi) drainage facilities.

The income and sales loss potential includes (i) day labourer s income loss (ii) shop sales loss (iii) industrial production loss (iv) export earning loss due to shipment delay (v) export contract loss due to production stoppage (vi) electricity consumption loss (vii) public transportation income loss and (viii) vehicles running cost loss.

The utilities service disruption includes (i) water supply system (ii) sewerage system (iii) garbage collection (iv) electricity supply and (v) telecommunication facility.

Construction of GDOFPS will protect the above mentioned damages. It will protect damage potential of Tk. 250 million every year, Tk. 530 million once in 10 years and Tk. 750 million once in 30 years from ravages of floods (in terms of 1990 value and 1990 situation, consider 1 US\$ = Tk.40). Considering increased activity in the year 2000, the 10 year flood damage will be Tk. 700 million at 1990 value (FAP 8B, 1991). This will ensure about 4.8 million people (in 1988) or 7 million people (in 2000) a flood free life offering opportunities for happiness and prosperity of intangible value.

3.2 City Development

After the completion of GDCFPS, the entire Dhaka area will become a flood free zone. The low lying areas having regular floods will become much important areas. As a result, more areas will come under development, and lot more housing, commercial

place and industries will start functioning. The present built-up area of Dhaka city is 114 km² (43) and it will cover 177 km² (67%) by 2010 (Islam, 1992). But this estimation is without considering the rapid in-migration after the functioning of GDCFPS. Hence, it is obvious that by 2010, the built-up area will be more than this estimated value, probably 80 to 85%. The perimeter of existing built-up areas, which are now used for agricultural purpose will become main development areas. Again as rehabilitation works after flood need not to be done, more development work will happen. Roads, buildings, parks etc. will be constructed and maintained better. Moreover, government and public will be encouraged to invest more in development works.

3.3 Road Communication Development

According to GDCFPS plan, some portion (about 30 km) of the dike will be used as road. Actually, most of the Phase 11 dikes are road cum-embankments. It will provide a good alternative route for city transport system. It may also help in easier transport of goods from river side to city centre. That portion of dikes which will not be used as paved road, will also act as a road for local people for walking. It can be recommended that part of dike which is not planned to act as a road (phase I embankment) can also be converted to act as a road. Actually, an improved road could minimise the possibility of breaching during high flooding.

3.4 Agricultural Development

GDCFPS will have a positive impact on agricultural activities (Figure 3-1 to 3-6). Yield will increase (as for example, HW, T. Aman yield will be increased from present 1.30 ton/ha to 3.50 ton/ha, Figure 3-1 to 3-6). Although, after the construction of dikes, some agricultural land will be converted into other profitable land use and fertility will be reduced due to non-flooding, but overall agricultural activity will increase. This is because (i) Effective use of land i.e., two or three crops will produce in one year. Currently, 45% of total area which is used for agricultural activity remain under water for up to 3 to 4 months. After GDCFPS this period will be used for cropping (ii) Reduction of crop damage. Flooding from both the rivers and unexpected rain causes considerable damage to crops. Protection against these will protect crops and allow additional crops to grow. (iii) Investment of money and labour will increase in agricultural land due to safe return. Hence, it is anticipated that future agricultural activity will increase.

3.5 Environmental Aesthetics

Trees can be planted on dikes. This will give a pleasant look. Before covering the slopes of the dikes, horticulturalists or botanists must be consulted. Things to be looked after about the perennial tree species in such a way:

- that must be aesthetically pleasing
- that produce economic products
- that do not attract burrowing animals that threaten the integrity of the dike (as would large trees whose roots may create large holes if the trees are blown over)
- that do not significantly alter the roughness of the channel (esp, for river side of the dike).

3.6 Integrity of Dikes

A grave concern is already expressed in the previous sections about the integrity of the dikes and the engineering design of the whole project. Already some section of the dikes failed even in the absence of flooding (Table 1). A dike breach followed by flooding is likely to have much greater impacts and cause a much higher level of property damage and loss of life than that of the situation before GDCFPS. Since, a dam-break hazard will be sudden and unexpected. The people will start to live in a relaxed manner, GDCFPS may convert the pre-GDCFPS flood hazard into a much more serious hazard. From field survey it experienced that there are numerous large gaps at many points in the wall section. It is supposed that these gaps will be closed by local peoples with sandbags. Whether the sandbags can be obtained in appropriate quantities and an appropriate time have appeared as a major concern. Moreover, these cut gaps may weaken the effectiveness of entire wall system. Discontinuous embankments also reduce the total stability of the structure.

To overcome these problems, a thorough engineering review of the soil condition, design, construction stability must be done first. A massive repair work should then be undertaken to maintain the stability of the project. A good inspection and maintenance work must be practised. Finally a comparative cost analysis of different protective structures should be prepared, so that in the next phase the authority can choose appropriate type of structures.

3.7 Dike Routing

The dike routing of GDCFPS is questionable. It is gathered that the fixation of the embankment alignment was largely influenced by local powerful people, political and

social motives. Several segmented concrete flood walls of average length of 61 to 121 m are constructed at different places. It is surprising that construction of flood walls alternative to embankment in each of the above places saved only a few families from being displaced. The construction of reinforced earth embankment might eliminate this problem and would help to construct a continuous embankment in place of embankment cum wall that have been constructed. Then the whole length of embankment from Tongi to Mirpur Bridge (phase I) might be used for road traffic which also could help to reduce the traffic congestion. In that case, the construction of some proposed feeder road to the GDCFPS could also with proper review of phase I work, appropriate dike routing of phase II must be made.

3.8 Severence

In some cases, the dikes and walls made it difficult to access for riverside activities mainly business. According to Azam (1990), of the 1040 subjects interviewed, some 227 had property within the area required for the dike. Of the 227, some 20 had property on both sides (i.e. inside and outside) of the dikes, i.e. houses and toilets, bathrooms, tubewell etc. being on opposite sides of the dike. To resolve these: (i) one type of solution is being incorporated now is to leave gaps in the dikes to allow access to establishments outside the dike. Gaps will be filled with sand bags during the flood season. But then a clear planning is required including who will supply these sandbags, where will these be stockpiled, who will be responsible for blocking the gap, who will pay for all of this and how can timely implementation be assured. (ii) Roads can be constructed over the dike crest at some points without keeping gaps to provide access to outside of the dikes. (iii) Relocation of dwellings of commercial enterprises to areas inside the dikes. (iv) Make careful review for this problem before construction of phase II.

3.9 Resettlement

In many cases the people whose property has been taken for the construction of GDCFPS have not been treated. Sometimes the practice was often to force out the family living in the acquired land, to pay for his land and property at a price less than equitable free market value, and to furnish little nothing for rehabilitation costs (cost to the displaced family for moving and for lost income before becoming re-established in gainful employment). But the legal basis for acquisition of property for the GDCFPS rests in a 1989 bill passed in the National Assembly. The bill calls for consideration to be given to compensating owners for land at market value and for damages to standing crops

or trees, damages due to severance from the owners, other property and for expenses for relocation of residence and business. According to Azam (1990), of the 1040 persons interviewed, 227 had land in the area required for the GDCFPS of which 35 had their entire houses acquired. Of the 227, only 20 reported that they had received full compensation, 162 reported that they received part of the compensation and 45 reported that they had not received any compensation. In most of the 45 cases stated above, middlemen misappropriated the money cheating the illiterate landowners. Reasons for partial compensation was about 10% of the compensation paid for land acquired for embankment construction in all the 227 cases was found below the prevailing market value. The ratio between the prevailing market value and rate of compensation paid varied from 2 to 5 times. In most cases, the reasons behind these was that the owners commonly declare the value of their land to be low in documents of registration in order to reduce stamp duties which are based on the declared value of the land. Some of the recommendations in this regard are: (i) Existing laws, regulations and practices are not adequate. A policy must be made for equitable land acquisition process keeping the present day situation in mind. (ii) For phase II, this problem must be handled carefully. (iii) Apart from monetary help, some other type of help can be introduced like transportation or shipping, unemployment allowance for interim period, providing suitable job etc.

3.10 Extra Damage Outside Protected Area

If water is not allowed to enter into the entire 265 km² of protected area, water level will rise outside the dam. According to an BWDB engineer, BWDB's evaluation of extra flooding outside the diked area estimated that the extra water rise at peak flood would be from 1.0 to 1.5 m. There are some social points of this problem. People outside the project area think that due to the construction of GDCFPS, they are now more flood-prone, the flood level will be higher there, hence they feel that they will suffer from GDCFPS. This negative attitude may lead to sabotage of the dike system. First hand discussion with local people also confirms this. Some of the recommendations are: (i) Economic evaluation be made between damages within protected area and outside for various flood height so that, an optimal management can be done. (ii) Engineering evaluation be made for backwater curve for outside the protected area to find actual impact. It is understood that this is being done under FAP-8A (JICA, 1991). (iii) A social awareness program be taken up for people living outside the protected area for their risk and potential damage. This is required for reducing the risk of sabotage.

3.11 Migration of Population to Protected Area

The 265 km² of Dhaka city will be a free zone after the completion of GDCFPS. As a result, number of people will move within the protected zone mainly from adjacent areas. Even now, without flood protection in-migration of rural people towards Dhaka is very high as it is an expected center of employment. Between 1961 and 1981, population of Dhaka increased from 754,000 to 3,857,000 at an annual exponential rate of 5.8 percent (Bangladesh Bureau of Statistics, 1991). The population of Dhaka "Pull area" (the RAJUK area which acts as a magnet for in-migration, most of it is inside the protected area but some is outside) has a population of 7 million now, 9.86 million in 2000 and 13.48 million in 2010 (FAP 8B, 1991). These figures do not include the added in-migration after the extra benefit of GDCFPS. The main reason of relocation of rural people is perceived employment opportunity. Hence the most of the in-migrant are poor people and they will certainly increase the slum population (Table 2). Again, the people now living in RAJUK will have a tendency to move within the protected area as most of them have their job within the protected area. The medium and rich people will face some barrier to move but the poor are relatively mobile and these people will form quick slum within the protected area. The present in-migration rate (5.8%) without GDCFPS, is already creating tremendous impact on city living standard. The highly increased in-migration rate after GDCFPS will pay havoc on water supply, sewage disposal, garbage collection, public health, surface and ground water quality, gas, electricity, traffic, employment, law and order, education and all development. This will severely reduce the quality of life of all people living within the protected zone. It can be noted that, till now 55% of city population have DWASA fresh water supply (Figure 4), only 15% have DWASA sewerage service (Fig.2), and 50% of the solid waste generated are collected by DCC. Again, after the formation of new slums, solid waste generation will be more, but the slum dweller will not pay tax. Hence DCC have to collect more garbage with same resources. Now, DCC spends Tk.26 per person per year for solid waste management, after rapid in-migration, the efficiency will decrease in terms of per capita expenditure, unless they spend more. It is hence, recommended that (i) An investigation should be taken up to find the actual migration rate after GDCFPS, migration pattern, settlement pattern and its impact. (ii)Development of all public utility infrastructure to meet the increased demand. (iii) Discourage migration by social work.

Table 2. Slum Formation Rate

3.12 Road Traffic Disruption:

Actually the existing embankments or walls are not creating any problem to the city traffic system. But there will be some interference during flood seasons when the gaps in the dikes and walls, normally kept open for traffic are blocked. As a result, a number of residences and business establishments will be cut off. A solution should be found out not only to improve the overall effectiveness of the project but also to minimize the risk of sabotaging of the system by affected people. An immediate solution is that the relocating the people affected by severance problem.

3.13 Canal Traffic Disruption

The construction of GDCFPS will block the natural way out of the canals to the rivers. Some of these canals like Gajaria Khal connecting to the Balu river serve as an important commercial boat traffic route. Hence, GDCFPS will completely annihilate this service. Alternative transport means like roadway must be constructed urgently. Again, dikes may alter channel capacity of the river in the vicinity of the dikes through localized sediment deposition. A survey in this regard should be taken up in near future.

3.14 Surface Water Pollution

Currently, there are a number of drainage canal systems located like a net within the Dhaka city, collecting water and discharging into surrounding rivers. The construction of the flood protection structures will replace these natural drainage channels with a planned water regime using pumps to discharge waters to the rivers. But the quality of these water is extremely poor (Table 3). These canals serve as the recipient body for storm sewage, for septic tank effluent, for bucket latrine wastes, for uncollected garbage deposition, unauthorized domestic and industrial waste connection and urine and feces from Katcha latrine and open defecation areas. Moreover, it also includes the street wash carrying leachate of high pollution potential ($BOD_5 = 5000 - 15000 \text{ mg/l}$, $COD =$

5000 - 17000 mg/l, Rahman, 1993) from solid waste and sewer line overflow from manholes. Due to deposition of these pollutant, the water quality of canal becomes severely bad, sometimes it becomes septic with zero dissolved oxygen (Table 3). Previously, these water moves to river from many points. But now they will remain stagnate for a day or two, waiting for being pumped out during flood season. Some urban poor (as 45% population do not have definite water source) may use this water for their household washing and make themselves exposed to health hazard. The water quality of the lagoons are given in Table 4. From the table 4, it can be seen that the lagoon water is polluted although not in alarming degree. But it has to be noted that total GDCFPS is not yet functioning. The water quality will deteriorate further within a couple of years. From Table 3, it can be seen that the lake water quality is deteriorating as they are linked with canal system. Hence, lagoon water quality will certainly degrade as canal systems will discharge into these lagoons. Again, this polluted water will move to the river by only five pump stations during flood season and through only five sluice gate at other time. Hence, river will experience severe point source pollution. Even now, the water quality of river Buriganga is not good, when these polluted mix with river water at many points thus utilizing the river self assimilating capacity. When all these polluted water will mix with the river water at five concentrated points, river self purification capacity will fail, thus the river resources will be unusable and aquatic life will be destroyed. Again, after the GDCFPS, rapid in-migration will increase the production of pollutants and worsen the surface water quality problem. This is probably the most significant problem of GDCFPS.

To minimize this problem the following recommendations are made:

- i) Create public awareness among the slum dwellers adjacent to the lagoons and other stagnant water pools not to use the stagnant water for any household purpose.
- ii) Safe water supply by either DWASA pipe line or local deep tubewell must be ensured
- iii) More public toilet will reduce the open defecation.
- iv) Proper management of sewerage system (including manhole) are essential.
- v) Proper sanitation facilities for all dwellers.
- vi) Steps should be taken for better collection, transportation and deposition of solid waste management.
- vii) Prevent industrial waste deposition in open place, Khals or in sewer lines.
- viii) Better agricultural management.

- ix) A good national policy is needed for environmental management.
- x) Penal action must be imposed.
- xi) Proper coordination is also needed among various government agencies.

3.15 Groundwater Pollution

After the construction of GDCFPS, all runoff route will be cut off towards the river. There will be five lagoons from which waters will be either pumped in rainy season or discharged through sluice gates in dry season. The lagoon water will contain various pollution load. These polluter have to wait for a day or two in the pool before being pumped out into the river. This is a stagnant pool situation and water will percolate the soil. Immediately, the upper water table aquifer will be polluted. Before GDCFPS there was no stagnant water pool, but now there will be some stagnant water pool for most periods of the year. As a result, risk of ground water contamination will increase. Shallow hand pumps drawing water from upper water table aquifer near these lagoons will soon be unusable. Due to this, water supply to slum dwellers adjacent to pool area will be either from polluted tube well or from polluted pool. And ultimately this will cause severe health hazard. Actually right now, at any given time, 31 % to 45% of the slum population is suffering from disease (Report of Task form, 1991) mainly due to water and air pollution. Due to ground water movement, a large number of shallow tube-well of surrounding areas as well as some deep tube-well discharge will be contaminated. Ground water pollution is irreversible to some extent and it takes many years to make it back to its original position. Since the water supply system at the peripheral Dhaka is not good, people have to depend on these contaminated wells.

3.16 Public Health

GDCFPS will cut the existing drainage channels as well as surface runoff leading to the rivers and resulting the formation of stagnant ponds behind the dikes. These ponds will be highly polluted by organic chemicals and pathogens (Table 3). The water from these ponds may be often used by slum dwellers for household washing purpose, posing a severe health risk. Further, stagnant ponds are regularly used by slum dwellers for bathing, which is risky. From the experience of already existing pools it can be stated that some of the pools are being used simultaneously for both defecating and bathing.

These pools also lead to ground water pollution and thereby tube-well water contamination. This will create health hazard to a larger area and to the larger community. Again, the ponds could become the breeding ground for disease vectors, mosquitoes, etc. This will also make the city life uncomfortable. Even now, proper health facilities are not available to all slum dwellers. After the occurrence of much more slums, the public health condition will be worse. To overcome this, slum development as well as social awareness preventing in-migration is essential.

3.17 City Drainage System

The existing city drainage system includes a complex network of lakes interlinked with a number of Khals discharging into the surrounding rivers (Figure 6). They are super-linked by some open drains and piped drainage system. The existing condition of drainage system is extremely poor due to land reclamation for expanding development settlement by filling up part of lakes, Khals and Bills. This degraded the water quality of lakes and Khals. The dissolved oxygen levels are very low in large reaches of Khals and lakes, and even anaerobic septic condition prevail at some points due to inflow of sewage and industrial effluents with high pollution potential (Table 5) and impaired outflow and drainage (Table 3). The deteriorating quality has seriously degraded the aesthetic, recreational and fishing values of these water bodies and has sometimes converted into nuisance and malodor.

After the constitution of GDCFPS, every natural drainage will be blocked it may worsen the already sick drainage system. In the plan of GDCFPS, there are provisions for five pumping stations to discharge the drainage water into the river in rainy seasons and of five sluice gates to do the same in dry seasons. During the rainy season, which usually lasts for about seven to eight months, the proper functioning of pumping system is essential. The cost of pumping is a permanent cost. Till now, it is not decided whether the pumps will be operated by diesel engines or electric engines. Both involve some set up cost and fixed running cost in addition to the cost of pumps themselves. Again, how effective will be the total pump out operation to drain all incoming water is questionable. Further, the most significant negative impact will be the serious environmental consequences in the case of a pumping system failure.

To reduce the problem, proper design and operation of the pumps are important. Enough spare parts and repair tools be stockpiled at the site in case of sudden breakdown. Mechanics and operators should be available at all times in case of emergency. They must be inspected time to time for better management.

3.18 City Sewerage System

Actually, if the city sewerage systems function properly, GDCFPS should not have any interaction with the sewer system. Only one question can be raised that water elevation outside the dikes will be higher than inside, and the sewerage system may not drain properly during floods. This is evident as without GDCFPS, the functioning of the sewage system is greatly impaired during floods. Hence, the pump capacity of the existing lifting station should be increased and the discharge canal through which treated sewage make their way to river must be improved. But 85% of the city population are not covered by DWASA sewerage system (Figure 5). Most excreta from open Kutcha latrine or open defecation (30%) goes to the river without on-site treatment. Again, part of piped sewer discharge are by-passed to the river by canal system without treatment. These create a great deal of pollution to the Khal, lagoon and river system and also create ground water pollution. A much improved sewerage system and properly equipped treatment plant is necessary to overcome this problem. Moreover, due to rapid in-migration after GDCFPS, this problem will be worsen.

3.19 Fisheries

Fish are a very important component of the local diet, and fishing is one of the major economic activity of riverine villages. Most of the local fish population within the protected area are, to some extent, dependent on periodic flooding. After GDCFPS, this practice will be cut off. Hence, to continue with this business the fisherman of the low lying area of Dhaka have to buy young fish, have to apply nutrients into the ponds or lakes. This will certainly offset the whole activity. One of the solutions is to allow floodwater to enter the protected area in a controlled manner. The other solution is to supply young fish, fertilizer and other nutrients to the fishermen at a subsidized rate. River fisheries will also be reduced after GDCFPS. Before the dike system, the polluted drainage water mix with the river at very many points. Due to self assimilating process, the dissolved oxygen level remains upto the minimum requirement except some highly polluted points. But after GDCFPS, the total polluted drain water will go to the river at only five points. With this excessive pollution loading, a large reach after these points will remain septic or anaerobic. No fish can live within this zone. Occurrence of this zone at a certain interval will prevent fish to move freely. As a result, fish will experience some discrete pool of water in between two anaerobic zones. This certainly hamper their natural growth and reproduction. The only way to improve this condition is to improve incoming water quality.

3.20 Soil Erosion

As stated earlier, most of the dikes are not properly constructed. Hence, soil will be eroded from construction area and borrow pits. As a result drainage channels, river channels and low lying agricultural areas will receive sediment loads causing water quality deterioration and loss of agricultural production. Hence, proper requirements for soil erosion control should be included in the contract specification and strict supervision must be practice during construction.

4. CONCLUSIONS

The concept of GDCFPS appears to be sound in providing protection to the country's capital area, provided that the system is properly designed, constructed and operated. Actually, any development work must be preceded by an EIA which identifies all negative impact and ways to overcome that. This project started without EIA. Naturally, some negative impacts are now appearing in this project. The most significant planning and construction deficiency is that of the stability and integrity of the dike and wall system. Failure of dike will lead to catastrophic damage which will be more hazardous than previous stage. If dike and wall system remain workable with proper maintenance practice, the Greater Dhaka city flood protection with some additional benefit in agriculture, communication and city development.

Some of the negative impacts are inevitable like in-migration of rural people and canal traffic disruption etc. These can be taken care of by proper policy making, sound implementation and effective maintenance. A very significant problem is

associated with the surface and ground water quality. Even without the GDCFPS, the river, Khal and lake water quality in and around the Dhaka city is extremely poor. After the GDCFPS, it will aggravate much more as large number of in-migrant will increase the polluting load within few years. Besides implementation of some big engineering projects, solution of the problem depends largely on social aspect. The primary sufferer of water pollution problem are the urban poor and since an engineering solution can not be provided over night, the problem can be minimize by creating awareness among general people.

Socio-economic impacts of the project on the urban poor are very significant. Actually, they are the most direct beneficiary of the project and probably, they are the worst affected by the project. First, they faced severance and resettlement problem due to wrong dike routing. Some of them, then, lost their jobs due to reduction in fisheries, change in agricultural, canal traffic disruption and finally, they are exposed to public health hazard due to water pollution and rapid in migration of rural poor. Again, they will get blessings from GDCFPS, as they can live a flood free life and there will be job opportunities with increased industrial, agricultural and business activity along with rapid city development.

ACKNOWLEDGEMENT

The authors gratefully acknowledge financial assistance from United Nations Centre for Regional Development (UNCRD), Japan.

REFERENCES

1. Azam, A.K.M.S. "Severance, Land Acquisition and Resettlement Study of Dhaka Flood Protection Project", July, 1990.
2. Bangladesh Bureau of Statistics "Statistical year Book of Bangladesh", July, 1991.
3. Flood Action Plan (FAP) 8B "Interim Report No.1 of FAP 8B, Dhaka Integrated Flood Protection " submitted by Louis Berger International, Inc. in association with Associated Consulting Eng (Bangladesh) Ltd. Desh Upadesh Ltd. and Technoconsult International Ltd., May 1991.
4. Islam, A.K.M.N, "Impact of Greater Dhaka City Flood Protection Works on the Environment with Specific Reference to Domestic Waste Disposal", M.Sc. Eng. Thesis, BUET, June, 1992
5. Japan International Cooperation Agency (JICA), "Greater Dhaka Flood Protection Project" Interim Report on FAP 8A, March, 1991.

6. Kabir, M.H. "Geotextiles in Dhaka Flood Embankments" Seminar on Use of Geotextile Technology in Bangladesh, 23rd Feb 1992.
7. Rahman. M.H., "Waste Management in Greater Dhaka City". Int. J. Env. Educ. & Inf., UK, 1993.
8. Report of the Task Force on Social Implication of Urbanization, Planning Commission of the Government of Bangladesh, Feb., 1991.

IMPACT OF DHAKA CITY FLOOD PROTECTION EMBANKMENT ON SURFACE WATER QUALITY WITH SPECIFIC REFERENCE TO INDUSTRIAL LIQUID WASTE DISPOSAL

Md. Mujibur Rahman

Professor,
Department of Civil Engineering, BUET.

Md. Abdul Karim

Assistant Professor,
Department of Civil Engineering, BUET.

ABSTRACT

In an effort to protect Dhaka, the capital city of Bangladesh, from devastating floods like the one in 1988, the Government of Bangladesh, in collaboration with other international support agencies, has undertaken construction of flood protection embankment along greater Dhaka boundary. In view of the severity of the 1988 flood, and considering that the project would bring enormous benefit to the city population through flood free life and thus enabling quicker development and economic growth, the Government of Bangladesh immediately embarked on implementing the project in phases without going for a feasibility study or an environmental assessment (EA) for the project. Several studies, however, were undertaken during implementation of the first phase of the project, in response to numerous public and media concerns about the lack of any environmental considerations in project planning and consequent potential hazards and environmental degradation that might result from the project. This paper presents some major outcomes of a study which particularly looked at the impact of Dhaka city flood protection project on surface water quality due to industrial liquid waste disposal.

Two areas namely Hazaribagh tannery area and Tejgaon industrial area, where most of industries of greater Dhaka city are concentrated, were considered for the study. Of these two areas, the Hazaribagh tannery area is already affected as the construction of flood protection embankment has completed along this westerly part of the city.

The study reveals that waste discharges from the industries in Hazaribagh area have greatly impaired the quality of water bodies impounded due to construction of the embankment. The tannery discharges are continuously getting accumulated in the impounded water body within the city side of the embankment making the water body

completely unsuitable for any intended use. Laboratory investigation of selected water quality parameters (e.g., BOD, COD DO, Cr) confirms the deterioration of water quality of the areas. Furthermore, the adjoining residential areas are badly affected by emission of odors from Hazaribagh tannery discharges and this effect has substantially increased after the construction of the embankment.

The study also finds that water of Bugunbari Khal (canal) which receives industrial discharges from Tejgaon industrial area is already heavily polluted and was found completely devoid of dissolved oxygen during dry weather period. Construction of the second phase of the flood protection embankment along the eastern boundary of the city would only accelerate the process of degradation of the Khal water quality if appropriate measures are not taken.

1. INTRODUCTION

During the monsoons of 1987 and 1988, Bangladesh suffered two of the most serious floods on record. Vast areas of the country including the capital city of Dhaka were flooded to an unprecedented degree with flood levels about 1.5 meters higher than normal. During 1988 flood, in Dhaka city alone it is estimated (Louis Berger International, 1991) that about 77% of the total metropolitan area of 260 km² were submerged to depths ranging from 0.3 to over 4.5 meters, and that about 60% of the total city population of about 4.5 million were directly affected. Damages caused by the 1988 flood were also estimated to be in excess of Taka 700 million.

In view of the severity of the 1988 flood, the Govt. of Bangladesh immediately undertook a project of constructing embankment and flood protection walls around the greater Dhaka boundary in an effort to protect the people and properties within the city. A project feasibility study was not done and no environmental impact study was conducted prior to project implementation. Considering the urgency of the situation, the Govt. of Bangladesh at once embarked upon implementing construction activities of the project using its own resources. It was assumed that the project would only bring enormous benefit to the city population through flood free life and thus enabling uninterrupted development and faster economic growth. The first phase of the project, to provide flood protection facilities to the westerly half of Dhaka city, was initiated in early 1989 and has already been completed in 1990. This part of Dhaka includes the most highly urbanized areas and covers about 87% of the city population.

There have been, however, numerous public and media concerns about the lack of any environmental consideration in project planning and consequent potential adverse

impacts on the environment which might result from the project. In response to such concerns, a "Progress Environmental Impact Assessment" (PEIA) was carried out by the Department of Environment (1990). The study corroborates the concept of "Dhaka Flood Protection Project" (DEPP) in providing protection to the country's capital area, provided that the system is properly designed, constructed and operated. The study (Department of Environment, 1990) however, identified deficiencies in project planning and implementation, the major deficiency being the absence of a project feasibility study including an EIA which would ensure that the project is environmentally sound as well as viable from economic, financial, institutional and engineering points of view.

Among other major deficiencies are lack of attention to the adverse socio-economic impacts of the project on the urban poor; absence of comprehensive studies on location and routing of dikes and walls, and on the scheme of gates and pumps for preventing flooding in the protected area; and possible adverse impact on the city's existing drainage system. The PEIA study also recommends that a project feasibility study be undertaken for completion of DFPP, including consideration of environmental as well as economic and engineering aspects - the safety and stability of the already built dikes and wall system in particular.

Several concurrent studies carried out in 1988 and 1989 to develop a comprehensive flood policy and program for Bangladesh ultimately led to the formulation of a "Flood Action Plan" (FAP), a unique 'global program' with the World Bank playing the coordinating role. The overall FAP includes some 26 components, some of which e.g., FAP-8A & FAP-8B have implications for and relate to Dhaka flood protection project and are supported by the Asian Development Bank and the Govt. of Japan (JICA). The progress EIA study (DOE, 1990) also suggested that its recommendations to overcome the deficiencies of DFPP be closely reviewed and be integrated into the overall FAP program.

The present study is a joint initiative by the United Nations Center for Regional Development (UNCRD) and the Bangladesh University of Engineering & Technology (BUET). The joint collaboration had several components to study the impact of Dhaka city flood protection project on issues such as changes in land use pattern, domestic waste disposal and industrial waste disposal. This particular study concerns the impact of Dhaka city flood protection embankment on the disposal of industrial wastes.

1.1 Objectives

The broad objective of the study has been to look at the impact of the flood protection project on the changes in quality of the surface water bodies within the city, particularly, due to industrial liquid waste discharges. In this paper the major findings of the study have been presented. An attempt has also been made in this paper to forward several important recommendations relevant to the study in order to improve the deteriorating situation of the water environment within the city.

1.2 Study Method

In an effort to achieve the broad objective of assessing the impact of DFPP on the water quality of the impounded water bodies with special attention to water bodies receiving industrial discharges, the entire study program was divided into four major categories.

A preliminary field survey was undertaken to have a direct observation of the general conditions of the already built flood protection works (Phase 1); a door to door questionnaire survey was conducted at various industries in order to better appreciate their existing waste disposal system; a data collection drive was made to relevant organizations, particularly to the Department of Environment, to collect pre-project and post-project water quality data in and around Dhaka city; and finally a laboratory test program was carried out to assess the quality of water bodies impounded by the erection of flood protection embankment and receiving industrial discharges.

2. DHAKA FLOOD PROTECTION PROJECT

Dhaka is situated in the central part of Bangladesh and is surrounded by rivers Buriganga, Turag and Balu as shown in Figure 1. At the southern most end, Buriganga meets Sitalakhya and flows southward to join Meghna, a large river of the country.

The climatic condition of Dhaka is tropical with monsoon dominating a major part of the year (May to September). Average rainfall in the area is of the order of 2000 millimeters occurring mostly during monsoon resulting in regular yearly floods during this period. Average temperature varies from about 20 degrees Celsius in December and January to about 30 degrees Celsius in April to September (FAP-8B in Louis Berger International, 1991).

The land use pattern in Dhaka city (total area of 260 km² includes 19% residential area, 8% commercial, industrial and institutional area, 11% roads, streets etc. 4% rural settlement, 4% agricultural lands and 12% various water bodies. The central part of the city is adequately high but the extensive flood plains and adjoining low lying areas within Dhaka city is usually inundated to varying depths every monsoon.

There are three major groups of drainage Khal (natural canals) system in the city. They are (1) Ibrahimpur-Kallayanpur Khal flowing towards Turag on the west, (2) Begunbari-Dhanmondi Khal flowing towards Balu river on the east and (3) Dholai-Segunbagicha Khal systems draining towards Buriganga river on the south as shown in Figure 2. Apart from heavy rainfall and water level rise in the surrounding rivers, a major cause of flooding of Dhaka city has been the choking up of these natural drainage system mostly due to unplanned encroachment of drainage area.

In the wake of the devastating 1988 flood, the Govt. of Bangladesh established a committee for flood control and drainage of Dhaka with the primary objective of preparing a flood control plan for Dhaka Metropolitan area. The committee submitted a detailed scheme for phased investments in flood protection and drainage for greater Dhaka area primarily based on previous JICA (1987) study on storm drainage system improvements for Dhaka city and Jensen Report (1988) on causes of 1988 flood and recommended solution. The Govt. of Bangladesh approved the committee's scheme in March 1989 and immediately commenced the construction of first phase of the project with its own resources

2.1 Flood Protection Works

The first phase of the flood protection works commenced in early 1989, under a priority program of the Govt., to provide flood protection facilities to the westerly half of Dhaka city which includes the most highly urbanized areas and covers about 87 percent of the city population (Louis Berger International, 1991).

The major components of this phase of works, as shown in Figure 2, included approximately 29.2 km of embankment, about 8.1 km of reinforced concrete flood walls along the westerly perimeter of the city adjacent to the Turag and Buriganga rivers, and approximately 13.65 km of road-cum-embankment raising/construction on a north-south spine running from Tongi in the north and to Syedabad in the south. Construction of gated sluices for venting of internal drainage was also part of this priority program. Construction of all embankments are considered to be adequate for floods of about 100 years recurrence interval.

The second phase of the Dhaka flood protection project would include construction of embankment-cum-road from Demra in the south to Tongi railway bridge in the north, along Balu river, the eastern boundary of greater Dhaka city. Construction of such embankment-cum-road would require 2 to 3 years time. Also, the whole flood protection scheme will need installation of 5 pumping stations, at locations indicated in Figure 2, for pumping out impounded water due to local rainfall. However, as an interim measure, until the completion of the second phase, certain roads would be raised to 1988 flood level to prevent water entering from eastern side and a large number of small (2 cusec) pumps would be made available for pumping out rain water.

2.2 Present Status of Flood Protection Works

Flood protection works under the Phase I scheme has mostly been completed by the end of 1991. All embankments and flood protection walls have been constructed except about 2.8 km long wall and four sluice gates along the south-western part where local residents placed strenuous objection against wall constructions. The second phase of the flood protection works along the easterly boundary of Dhaka has not yet (till August, 1992) been commenced. The PEIA study (DOE, 1990) and the Dhaka Integrated Flood Protection, FAP-8B study (Louis Berger International, 1991), through their field investigation programs, have found problems in completed portions of the flood protection works which concern (1) embankment stability (2) severe cracks in flood protection walls and (3) internal flooding adversely affecting the local residents. The FAP-8B study (Louis Berger International, 1991) suggests, in order to complete the western embankment and provide effective flood protection, several important tasks to be performed immediately which include (1) construction of the incomplete portion of flood walls and regulatory structures, (2) reconstruction of the unstable sections of the west embankment, (3) provision for erosion protection, (4) internal drainage canal improvements, and (5) further investigations to fully appreciate the extent of damage on the western embankment and preparation of a remedial action plan.

2.3 Impacts on Various Environmental Aspects

The primary objective of the Dhaka flood protection project, as mentioned earlier, has been to protect the people and properties within the city from devastating floods like the one in 1988. Such flood protection projects are to be based on sound assessment of impacts on various environmental factors in order to minimize possible

adverse impacts. However, as dictated by the urgency of situation, neither a feasibility study nor an environmental assessment of the project could be done during its planning and design stages. A 'Progress Environmental Impact Assessment' (PEIA) has been performed by the Department of Environment (1990) followed by a 'Preliminary Environmental Impact Assessment' under the FAP-8B study (Louis Berger International, 1991) during some later stage of implementation of the first phase of the project. Both the studies identified a number, of significant environmental impacts which include (1) integrity of design and construction for dikes/walls, (2) Dike routing/location, (3) Severance problems, (4) Resettlement, (5) City drainage and sewerage systems, (6) In-city flood level control/economic evaluation, and (7) Interference with utilities/traffic.

A number of additional impacts have also been identified and discussed (Louis Berger International, 1991). These include (1) Impacts on agriculture, (2) Migration of population to protected areas (3) Interference with commercial waterways, and (4) Impacts on public health. Although the preliminary environmental impact assessments did not provide any quantitative assessment of the concerned environmental issues, they did, however, recommend guidelines for further studies on important environmental aspects being affected by the flood protection project. Review of all the salient environmental aspects by the previous studies is beyond the scope of this paper and one is referred to the original reports of those studies. Since the major thrust of the present study (Karim and Rahman, 1992) has been to assess the impacts of Dhaka city flood protection project on surface water quality associated with the disposal of industrial wastes within the embankment area, the subsequent section of this paper will focus on this particular aspect.

3. IMPACT OF DFPP ON SURFACE WATER QUALITY DUE TO INDUSTRIAL DISCHARGES

Though predominantly an agricultural country, Bangladesh has made significant strides towards industrialization in an effort to achieve rapid economic growth. Many different types of industries in different industrial zones have been set up based on both indigenous and imported raw materials. According to the census of manufacturing industries, the total number of industries was 3740 in 1983-84 which grew to 4793 in 1987-88 (Bangladesh Bureau of Statistics, 1991) and the rate of industrial installation is increasing day by day. The important types of industries include tanneries, textiles, pharmaceutical, chemicals, rubber and plastics, iron and steel, pulp and paper, sugar,

fertilizer, jute processing etc. Proper attention however, has not been given to the pollution potential of these industrial installations.

There are about 451 industries located within the flood protection project of Dhaka metro area. Table 1 shows area wise distribution, types and number of industries situated in different areas within the flood protection embankment. The locations of industries in different areas of Dhaka are also shown in Figure 2, in which the encircled number indicates the number of industries located in that particular area. Industrial wastes, particularly liquid wastes are being discharged into nearby canals and their transmission routes are indicated by arrows.

As can be seen from Table 1 and Figure 2, about 160 tanneries and one chemical industries are concentrated in Hazaribagh area along the western embankment of Dhaka, and about 156 textile, pharmaceutical, chemical and other large and small industries are concentrated in Tejgaon industrial area and the rest are scattered in different areas e.g., Mirpur, Motijheel and Old Dhaka area.

Particularly in Old Dhaka area industries are rather sparsely located. Hazaribagh and Tejgaon are therefore, considered to be the two major industrial zones within Dhaka city.

3.1 Disposal of Industrial Wastes

Dhaka, a major industrial centre of the country, is faced with serious problems of industrial waste disposal. The Water Pollution Control Act of 1977 provided regulatory control over industrial discharges to drainage canals and other surface water bodies. However, the act has not been effectively enforced and a large number of industries in Dhaka city discharge liquid wastes directly to open sewer, canals and other surface water bodies. The areas where Hazaribagh and Tejgaon and to some lesser extent Motijheel and Mirpur.

In Hazaribagh, 160 closely located tanneries (See Figure 3) use chromate and various volatile hydrocarbon compounds in the curing of animal hides and wastes from these operations are routinely discharged into the roadside drains which connect with the Rayer Bazar Khal (canal). Prior to construction of the western embankment as part of the Dhaka flood protection project, these Khals carrying tannery wastes discharged freely to the Buriganga River. After construction of the embankment, however, the outlets have

been blocked, resulting in the retention of accumulated wastes. It may be mentioned here that the liquid wastes from these tannery wastes containing heavy metals such chromium and other toxic chemicals do not have any provision for any kind of treatment prior to disposal into the open water bodies.

Tejgaon industrial area (see Figure 4) and Motijheel contain several large industries including pesticides, insecticides, pharmaceutical, textile and other chemical industries. The Dept. of Environment reports that the waste streams contains various toxic and hazardous chemicals. Most of these industries do not have any type of treatment facilities and they routinely discharge their raw wastes through the local storm drainage system to Begunbari Khal which ultimately discharges into the Balu river on the east of Dhaka.

3.2 Water quality Monitoring

In order to assess the impact of Dhaka flood protection project on the quality of receiving water bodies with respect to industrial waste discharges, an attempt has been made to collect sufficient water quality data both during pre-embankment and post embankment period. Significant amount of data were collected from the Department of Environment and other relevant organizations on water quality of the river Buriganga at different locations. Water quality data for the receiving water bodies within the embankment area was, however, not available as no regular monitoring of such water quality exists. The data for Buriganga river which was monitored at a distant place, was subsequently analyzed (Karim and Rahman, 1992) and was found to be of little relevance to the primary objective of assessing the impact of the embankment on water quality and is therefore not presented here.

From field visits at some early stage of the study (Karim and Rahman, 1992), it was clearly established that industrial discharges particularly at Hazaribagh area were getting accumulated in water bodies within the city as a result of the construction of the embankment and thereby blocking the free discharge paths to river Buriganga. Although it was understood that a direct comparison of water quality between pre-embankment and post-embankment periods was not possible as there was no data available for pre-embankment period, yet a laboratory test program was undertaken to monitor the water quality of the receiving water bodies within the embankment area in an effort to assess possible impact of flood protection embankment on water quality particularly due to industrial discharges. Similar test program was also undertaken to assess the water quality of Begunbari canal receiving industrial discharges from Tejgaon industrial area

although this canal has not yet been affected by embankment construction which would take place during, the implementation of the 2nd phase of the flood protection works. The intention has been to provide data for future assessment of the impact of flood protection embankment on surface water quality.

A total of 10 sampling stations were selected in Hazaribagh area, as indicated in Figure 3, located both inside and outside the embankment. Among these stations (S2)_i, (S3)_i, and (S4)_i located just inside the embankment, have corresponding stations just outside the embankment namely (S2)_o, (S3)_o, and (S4)_o. This was done to assess variation in surface water quality inside and outside the embankment. Without the embankment the corresponding inside and outside stations would have almost similar water quality.

As already mentioned earlier, there are about 156 different kinds of polluting industries concentrated in Tejgaon industrial area and most of their untreated liquid wastes are being discharged into Begunbari canal through the existing storm drainage system of the area, which ultimately discharges into the Balu river on the east of Dhaka city. Two sampling stations were selected for this area, one located in close vicinity of the outlet of the storm drainage system the other being located in the canal about 200 m downstream. The intention of monitoring water quality in this area was not to assess the impact of embankment as this canal is not yet directly affected by embankment construction but to see how untreated industrial discharges continually deteriorating the quality of inland water bodies.

For the purpose of the present study water quality parameters monitored were pH, colour, turbidity, chloride, solids content, Dissolved Oxygen, BOD, COD and chromium. Other trace metal concentrations representative of various industrial discharges particularly mercury, lead, arsenic, zinc and copper could not be monitored within the scope of the present study.

3.3 Water Quality Variation at Hazaribagh Area

Various water quality parameters tested in the laboratory for water bodies both inside and outside embankment are presented in Figure 5. The figure clearly demonstrates variation in water quality due to construction of the flood protection embankment. As mentioned earlier, the distance between corresponding inside and outside monitoring stations is only of the order of the width of the base of embankment. The water quality between inside and outside stations would vary only slightly due to dilution, had there been no embankment. Figure 5 shows large variation in measured water quality

parameters establishing the impact of embankment on surface water quality within the city. Important water quality parameters such as BOD₅, COD, colour, turbidity, chloride, total solids and chromium, all show very high values indicating accumulation of these pollution loads inside the embankment area. It is also seen from Figure 5 that the water bodies within the embankment area are completely devoid of dissolved oxygen. The range of values of various parameters inside and outside the embankment for both wet and dry weather period are presented in Table 2 indicating even worse condition during dry weather period.

Standard values for industrial discharges into various courses, as recommended by the Department of Environment (1991) are given in Table 3. The discharges from tannery industries at Hazaribagh area however, do not comply with these standards as there is no provision of treatment for these tannery discharges prior to disposal. This was indicated by Rahman (1994) through his monitoring program of tannery discharges at Hazaribagh. Table 4 shows the water quality standards for various water use e.g., for recreation, laundry, bathing and survival of aquatic life. Comparing values of various water quality parameters presented in Figure 5 and in Table 2 with those of Table 4, one can easily realize that the quality of water bodies impounded by the embankment is completely unsuitable for any intended use.

Apart from water quality deterioration of impounded water bodies at Hazaribagh area, the other major impact of flood protection embankment is the submergence of the vast adjoining area. It was estimated, from field observation, that the area submerged by continual discharge of liquid tannery wastes is approximately 8 to 10 times greater in post-embankment period, as indicated in Figure 6. Also indicated in this figure is the extent of area affected by obnoxious odour resulting from disposal of untreated tannery liquid wastes as well as solid wastes. This problem is particularly acute during summer when the rate of decomposition of organic matter is high. Prior to the construction of the flood protection embankments this odour problem was limited within the Hazaribagh area itself and part of Dhanmondi residential area. After construction of the embankment this unpleasant odour now spreads out all over Hazaribagh area, part of Dhanmondi, Mohammadpur and Shymoli residential area. The extent of area affected by bad odors from Hazaribagh tanneries was approximately identified through field observation and interviewing local people and is indicated in the map of Figure 6.

3.4 Water Quality of Begunbari Canal

The Begunbari canal, as mentioned earlier, receives mainly discharges from Tejgaon industrial area where more than 150 polluting industries of varying degree are

located. This canal flowing across the middle of Dhaka city carries enormous amounts of pollution load from various point and non-point sources and ultimately discharges in the Balu river on the east. This canal is not obstructed as yet, by the construction of embankment which is planned in the second phase of Dhaka city flood protection project. The purpose of monitoring the Begunbari canal water was to assess the present water quality. This would help assess the impact of construction of second phase of embankment across the canal.

Similar parameters were considered and monitoring was done for both wet and dry period. The results of which are presented in figure 7. The first monitoring location was very close to the industrial discharges outlet and therefore the values of this location reflect mainly industrial wastes characteristics.

The second location, about 200 m downstream reflects the canal water quality receiving both industrial discharges as well as pollution loads from other sources e.g., domestic sewage from nearby slums. As can be seen from Figure 7, all parameters show very high values indicating that the canal water is grossly polluted both during wet and dry periods, values for wet period being slightly lower than the dry period values as might be expected. The values are also far beyond the standard water quality criteria laid down for fish and other aquatic life as well as other uses (see Table 4). The canal water has been found to be completely devoid of dissolved oxygen, a condition for complete absence of all aerobic flora and fauna in the stream. The Dissolved Oxygen (DO) measured at different sections of Begunbari canal and computed from the DO sag model developed for the canal (Karim and Rahman, 1992) give zero values at all sections upto about 5 km downstream at all section indicating the canal to be under septic condition. The huge pollution load carried by this canal are being discharged into Balu river thereby affecting the biomass of that river also.

4. CONCLUDING REMARKS AND SOME RECOMMENDATIONS

The primary focus of the study has been to look at the impact of Dhaka city flood protection embankment on surface water quality with respect to industrial liquid waste discharges. Two areas namely Hazaribagh and Tejgaon were considered where most of the city's industries are located. In both cases, the industries are discharging their untreated wastes into nearby water bodies. The adjoining water bodies at Hazaribagh area is already affected by the construction of the first phase of the flood protection embankment whereas the Begunbari canal receiving industrial discharges from Tejgaon is not yet directly affected by embankment construction.

The study clearly demonstrates that the water quality of the depressions in the city side of the embankment at Hazaribagh area are being tremendously degraded and that pollutants from the tannery industries are getting accumulated within the city side of the embankment thereby making the impounded water body completely unsuitable for any intended use and furthermore, if this situation continues it would pose serious threat to the health and well being of the local population. The study however, does not claim that prior to construction of the embankment the situation was good. Previous studies (e.g., Rahman, 1988; Ahmed, 1997) had already indicated about the polluting effects of discharging untreated tannery wastes. These studies had also recommended either full treatment of tannery wastes prior to disposal or shifting of the whole industrial installations from Hazaribagh area to a distant place. None of these two recommendations, however, has so far been implemented.

The rapid degradation of the water quality at Hazaribagh area is therefore attributed to two major reasons.

- i) firstly, no consideration was given to such disposal of untreated tannery water into the water environment prior to construction of the embankment along this area; and
- ii) secondly, constructing the embankment without adequate pumping facilities along this part of the city. Provision for installation of large pumps however, is kept in the second phase of the project which is yet to be implemented in the future.

It is therefore, recommended that authorities take immediately appropriate action in order to improve this aggravating situation at Hazaribagh area. Construction of a complete treatment plant outside the embankment area for full treatment of the tannery wastes prior to disposal into the river Buriganga might be considered as an option for long term solution to the problem. Installing adequate pumping facilities in order to pumpout the grossly polluted impounded waters may be considered as an immediate action.

The present water quality status of Begunbari canal is alarming. Unless due attention is given to the indiscriminate discharge of untreated industrial wastes into the canal prior to construction of the second phase of the flood protection embankment along the eastern part of the city, the situation would deteriorate to an extreme extent. It appears at this stage that imposing strict control on the release of untreated wastes from the industries could improve the water quality of Begunbari canal significantly. Immediate studies may be undertaken in order to examine various alternatives and suggest effective control measures against pollution of the water environment

As a final remark, it can justifiably be stated that hasty planning and implementation of projects like the one of constructing flood protection embankment around a big city like Dhaka without prior environmental assessment could only lead to various adverse impacts which might be costly to repair.

ACKNOWLEDGEMENT

The paper is based on a study carried out in the Department of Civil Engineering of the Bangladesh University of Engineering and Technology, Dhaka, with financial assistance from the United Nations Centre for Regional Development, Nagoya, Japan.

REFERENCES

1. Ahmed, M.F. (1977), Polluting Effects of Tannery Waste at Hazaribagh and its Control, Journal of the institution of Engineers, Bangladesh, 5, 1-4; pp.6.
2. Bangladesh Bureau of Statistics (1991), Statistical Year Book of Bangladesh, Government of People's of Bangladesh, Twelfth edition, Dhaka, Bangladesh.
3. Department of Environment (DOE, 1990), progress Environmental Impact Assessment (PEIA) for Dhaka Flood Protection Project, Government of People's Republic of Bangladesh, July. Dhaka, Bangladesh.
4. Department of Environment (DOE, 1991), Environmental Quality Standards (EQS) for Bangladesh, Government of People's Republic of Bangladesh, July, Dhaka, Bangladesh.
5. Japan International Cooperation Agency (JICA, 1987), Study on Storm Water Drainage System Improvement Project in Dhaka City. Main Report and Supporting Report, October, Dhaka, Bangladesh.
6. Karim, M.A. and Rahman, M.M. (1992), Impact of Greater Dhaka City Flood Protection Embankment on the Disposal of Industrial Wastes and Environment, Final Report, A Joint Research Initiative of United Nations Center for Regional Development (UNCRD), Nagoya. Japan and Bangladesh University of Engineering and Technology (BUET), Dhaka, Bangladesh. August.
7. Louis Berger International (1991), Dhaka Integrated Flood Protection Project, Interim Report No. 1, FAP-8B. ADB, T.A. No. 1318-BAN, May. Dhaka, Bangladesh.
8. National Environmental Monitoring and Pollution Control Project (NEMPCP,

February, 1991), Trip Report of T.P. Washington, Seatec International Company Ltd., Dhaka, Bangladesh.

9. Rahman, M.H. (1994), A Study on Tannery Waste Treatment, M.Sc. Engineering Thesis. Department of Civil Engineering. BUET, Dhaka, Bangladesh.

10. Rahman, M.B. (1988), Hazaribagh Tanneries: A Comparative Study of Pollution Control Options, M. Engineering Thesis, Department of Civil Engineering, BUET. Dhaka, Bangladesh.

AN ASSESSMENT OF THE IMPACTS OF DHAKA CITY FLOOD CONTROL PROJECT

Jahir Uddin Chowdhury

Professor,

Institute of Flood Control and Drainage Research, BUET.

Muhammad Abdul Momin Khondaker

Research Assistant,

Institute of Flood Control and Drainage Research, BUET.

ABSTRACT

An assessment of the impacts of Dhaka City Flood Control project has been made through extensive field inspections and public opinion survey in the part of the project. There had been drainage congestion and waterlogging at several locations after the construction of the project. Most respondents in the survey consider that fear from flood related disaster has been removed, but the project does not provide economical opportunities and additional facility for communication. There would be significant hydraulic impacts in the proposed part after its implementation: during rainfall average flow rates in the channels would be increased to 114-143% and water levels in the water bodies would be depleted by 0.36 to 0.6 m.

1. INTRODUCTION

Dhaka, the capital of Bangladesh, is located in the flat region near the confluence of three major international rivers, the Ganges, the Brahmaputra and the Meghna. The city is surrounded by distributaries of these major rivers. Flood water from surrounding rivers inundates the low-lying area of the city. During the monsoon of 1988, Dhaka City was subjected to a catastrophic flood. Soon after this flood, the government took a project to protect the city from overbank spills of surrounding rivers by constructing embankments. The storm water drainage channels of the city discharges to the rivers. The embankment obstructs the hydraulic links between the drainage systems and the rivers. This paper discusses some important impacts upon surface water environment of the city.

2. DHAKA CITY FLOOD CONTROL PROJECT

The Dhaka City Flood Control Project covers an area of 265 km² and is divided into two phases as shown in Figure 1. Under the Phase-1 program, 68 km of embankments, 1 pump station and 7 regulators have been constructed in the existing urbanized part covering 147 km². In the Phase-2 program, construction of 65 km of embankments, 4 pump stations and 6 regulators has been proposed in the flood plain of the adjacent rivers covering 118 km² (JICAI 1992). Major part of the phase-2 area is not urbanized but the city is rapidly expanding into this area. The flood control and drainage schemes would be implemented in stages by dividing the area into 4 compartments.

3. SURFACE WATER SYSTEMS

The surface water systems of Dhaka City comprise several depression storages (ponds, lakes, submerged lowlying lands) and they are linked to the surrounding rivers as shown in Fig.1. The city rainfall runoff is accumulated into the depressions and discharges to the surrounding rivers through the channels. There are more than 40 channels having a catchment area varying from 6 to 40 km². In a normal flood, average depth of water in the depressions vary from 1 to 2.5 m during monsoon (Khondaker et al., 1992). Frequency analysis indicates that approximately 60% of the city area is under mean annual maximum flood level, and 75, 81, 87, and 90% of the area are subjected to flood at 10, 5, 2 and 1% exceedance probability respectively (Khondaker et al., 1992).

4.0 METHODOLOGY FOR IMPACT ASSESSMENT

The methodology has two parts. In part one, an assessment of the impacts of constructed part of the project has been made through field inspections and public opinion survey, In part two, predictions of possible hydraulic impacts of the proposed part of the project has been made through mathematical model study.

Extensive field inspections were made to four locations adjacent to the embankment during the period September 1990 to August 1992, the four locations were selected based on landuse pattern: one agricultural area, one residential area, one residential and agricultural area, and one residential and industrial area. Public opinion survey was made through questioning 325 inhabitants in these areas during November to December of 1991. The classification of respondents in terms of profession and age groups are given in Table 1.

Table 1. Number of respondents in the public opinion survey

Mathematical model consists of a rainfall-runoff submodel (McCue, 1986) for a drainage catchment and a flow routing submodel (Chowdhury, 1986) for the channel. The water levels at the outlet of the catchment during a rainfall were measured and the model was calibrated against these water levels. Then the model was verified against another set

of observations. The impact assessment has been made by running the model for the 'with project' (WP) and 'without project' (WOP) conditions.

5. IMPACTS DURING PROJECT CONSTRUCTION

The implementation period of the phase-1 of the project was from 1989 to 1991. The drainage regulators were constructed after the construction of embankment. One pumping station was constructed at the end of 1992. Field observation of the project during the period of September 1990 to August 1992 and results from public opinion survey during the period November to December of 1991 are briefly discussed below.

5.1 Field Observation

The embankment has caused drainage congestion and waterlogging at several locations. The consequences were severe that the people in one area cut the embankment in the first year of its construction. Temporary pumping was made to remove drainage congestion before the regulators have been even after construction of regulators, drainage congestion and waterlogging occurred in some areas. This is due to operational problems related to regulators' gate openings at the time of heavy storm and high water levels in the rivers.

5.2 Public Opinion Survey

Every respondent was asked a total of 20 questions as per printed proforma. A brief summary of results from important questions is given in Tables 2 and 3. Most of the respondents are of the opinion that the project has removed the fear from flood related disasters. However, there are significant concerns for the drainage congestion and waterlogging created by the embankment. A significant number of respondents do not consider that the project is helpful for economic activities. They also do not consider that the embankment has provided additional facility for communication. These aspects should be given due attention during the design stage at phase-2 part of the project.

Table 2. Public Opinion Regarding the Impacts of the Project

The employed persons and traders seem to be the happiest with the project as indicated by Table 3. This is perhaps due to the increase in employment opportunities

created by the project. As expected the fishermen are the worst sufferer. Among the four age groups, the youngest group is unhappy about the performance of the project. The youngest group is also seemed to be the most sensitive to environmental consequences of the project.

Table 3. Variation in Public Opinion Regarding the Project Performance

6. PREDICTION OF HYDRAULIC IMPACTS IN THE PROPOSED PART

6.1 Flow Characteristics During Rainfall

In the 'without project' condition the outlet of the channels fall into the surrounding rivers. So the design 100-yr flood water level in the rivers has been used as the outlet boundary condition of the channels, In the 'with project' condition the rainfall runoff would be disposed off by pumping. So the proposed pump discharges in the project are used as the outlet boundary conditions here. The predicted effect as shown in typical Figure 2-1 indicates that the flow rates in the channels would be reduced if the project is implemented. In the 'without project' condition the maximum and average flow rates in the channels during the rainfall (proposed for pump discharge estimation) are computed as 112 to 138 m³/s and 59 to 73 m³/s respectively. These would be reduced to 72 to 88 m³/s and 44 to 51 m³/s respectively. The rate of pumping is less than the rate of inflow in the retarding basins of pump stations which results in high water level at downstream with respect to upstream of the channels and thus causes less head difference to flow. Consequently, the water levels in the lakes and other water storage areas would rise as shown in typical Figure 2-2. This figure also shows that the water level would be reduced by 3.86 m with respect to 100-yr flood level if the project is implemented and thus the city would be protected from river flood.

6.2 Flow Characteristics During Receding Flow

In both 'without project' and 'with project' conditions, the outlet boundary of the channels in the model have been kept as the surrounding river water levels during post-monsoon period. In the 'without project' condition, the proposed water storage areas have been input in the model. The predicted effects as shown in the typical Figure 3-1 and

3-2 indicate that the channels would have higher flow rates which would result in quick depletion in water level in the water bodies. Due to reduction in water storage areas and flow of confined water through confined water ways after the project, such effects would result. The average flow rates in the channels in the 'without project' conditions are estimated as 0.72 to 1.0 m³/s. These would increase to 1.01 to 1.33 m³/s. The reduction in water level in the lakes and other water storage areas at the end of the post-monsoon are predicted as 0.36 to 0.60 m.

7.0 CONCLUSION

There had been severe drainage congestion and waterlogging at several locations after the construction of flood protection embankment. These undesirable consequences occurred because the regulators and link channels have been constructed long after the construction of embankment. Long implementation period of the project has caused increase in severity of consequences. However, most the people questioned during the survey consider that the project has removed the fear of hazards related to river floods.

Mathematical model studies in the proposed part of the project predict that during rainfall in the monsoon the average flow rates in the drainage channels would be smaller in comparison to the 'without project' condition. The recession of the flow in the water bodies and channels during post-monsoon period would be quicker in the 'with project' condition. Revision of the proposed flood control and drainage schemes to preserve more surface water storage areas to reduce hydraulic consequences should be considered.

ACKNOWLEDGEMENT

The authors thank the IFCDR for approving the research study and the United Nations Centre for Regional Development (UNCRD), Nagoya, Japan for financial assistance for this study.

REFERENCES

1. Khondaker, M.A.M. and Chowdhury, J.U. (1992), Effect of Dhaka City Flood Protection Embankment Upon Surface Water Drainage Systems and Environment, IFCDR, BUET, Dhaka.
2. JICA (1992), Feasibility Study on Greater Dhaka Protection Project of FAP-8A, Main Report, Flood Plan Coordination Organization, Dhaka.

3. McCuen, R.H. and Snyder, W.M. (1986), Hydrological Modelling Statistical Methods and Applications, Ch.8, Prentice-Hall, New Jersey.
4. Chowdhury, J.U. (1986), An Implicit Numerical Model of Unsteady Flow in River Network, Report No. R01/86, IFCDR, BUET.

EFFECTS OF GREATER DHAKA TOWN PROTECTION EMBANKMENT OF THE CHANGES IN THE TREND OF SETTLEMENT PATTERN AND LANDUSE IN THE FRINGE AREAS OF EMBANKMENT

Ms. Roxana Hafiz

Assistant Professor,
Department of Urban and Regional Planning, BUET.

Sarwar Jahan

Associate Professor,
Department of Urban and Regional Planning, BUET.

Zahid Hossain Khan

Former Graduate Student,
Department of Urban and Regional Planning, BUET.

1. INTRODUCTION

Dhaka, the capital city of Bangladesh, is located on the southern edge of the Madhupur jungle and is surrounded by rivers on all four sides- Tongi river on the north, Balu river on the east, Turag river on the west and Buriganga river on the south. A dominant feature of the greater Dhaka area is the limited availability of flood-free land. The fringe, low-lying areas are flooded 2.0m to 4.0m several months every year by overflowing of the surrounding rivers. Even the central part of Dhaka City is affected during major floods. During the last few decades, the flood stage of the Buriganga river at Mill Barrack, located near old Dhaka exceeded 6.0m GTS six times, damaging the central part of Dhaka city as well.

Flooding in the city results mainly from heavy rainfall, high surrounding water levels and an inadequate drainage system. Inadequate attention towards the operations and maintenance of the drainage system has compounded past flooding. Flooding problems are aggravated when heavy rainfalls are late and coincide with the flooding of river.

The greater Dhaka area was hit by the catastrophic floods during the period of August-September, 1988. The Buriganga river at Mill Barrack recorded the highest flood stage of 7.58m in its history on September 4, 1988. The flood frequency were estimated to be 100 years. The flood submerged almost all of Dhaka Metropolitan area, leaving only 58 km² of the high elevated land unsubmerged. Major flooding of Dhaka city continued for 18 days from 30th August to 16th September, 1988. Approximately 1.9 million people or 56 percent of the greater Dhaka area was affected (JICA, 1990). While no official

figures of flood damages in Dhaka are available, the Dhaka City Corporation estimated that some 400 kms. of roads were damaged and 60 percent of the 1900 kms. internal road system was submerged. From the estimates of JICA for an area of 137 km² which includes the major built-up part of greater Dhaka, flood damage was estimated in the order of Tk. 500 millions to Taka 1000 millions.

In the wake of the devastating flood of 1988, the Government of Bangladesh constituted a committee for flood control and drainage of greater Dhaka with minister for planning as the chairman. The committee was assigned with the task of preparing a flood control plan for greater Dhaka metropolitan area.

In March, 1989 the report for flood control and drainage of greater Dhaka prepared by the committee was officially approved by the Government. The committee proposed a phased programme of greater Dhaka flood control and drainage (GDFCD) project, after considering the existing conditions of the city, previous studies and projects, on-going projects and existing plans (Committee for Flood Control and Drainage of Greater Dhaka, 1989). As shown in Figure 1 the phase-1 programme is proposed for most of the existing urbanized areas and the western part of the greater Dhaka city that are surrounded by the Buriganga river, Turag river, Tongi Khal. National Railway, DIT road etc. The remaining eastern part of the greater Dhaka city will be protected by the phase-II programme.

This paper presents the results of a study on the effects of greater Dhaka flood protection embankment on the changes in the trend of settlement pattern and land use in the fringe areas of the embankment. Due to time and financial constraints, the study was limited to the areas where earth embankment had been constructed, starting from Tongi road bridge upto Kellar Morh in old Dhaka. Three typical areas representing low, medium and high density of development were selected. A total of 300 households were selected randomly from these areas for the purpose of questionnaire survey.

2. PHYSICAL DEVELOPMENT AND POPULATION GROWTH IN DHAKA

Dhaka in the very early period of its history developed in an informal way. This informally planned part of the city, what we call old Dhaka, developed before the introduction of mechanised vehicles. Palanquins, horses and horse-drawn carriages were the principal means of urban transport and the city developed with narrow winding streets as the then transportation system demanded. Old Dhaka developed as mixed-use area with commercial and business activities lined along the roads while residential areas extended just beyond them. Concentration of commerce, business, industries and residences has turned old Dhaka into a heavily populated area.

Dhaka actually began to develop in a planned way during the later stages of the British colonial period, Its strategic location and its importance as a centre of trade and commerce necessitated the provision of required administrative machinery and urban facilities. The city centre at that time was focused at Sadar Ghat.

Development of Dhaka as a city began after 1947 in the Pakistan period. The principal communication and transportation routes developed, and the new city developed from the old railway line onwards to the north. This railway demarcates old Dhaka from new Dhaka.

New Dhaka developed with the establishment of Dhaka Improvement Trust, now the Rajdhani Unnayan Kartipakkhya (Capital Development Authority). In the newer part of the city, activities were compartmentalised and developed according to the Master Plan prepared in 1958. The new commercial centre of Motijheel and high-income residential area of Dhanmondi were developed as per the recommendation of the Master Plan. The new Dhaka has well-developed roads and public facilities. The Government administrative centres and other related public agencies, residential quarters of government employees, universities and large-scale parks and gardens occupy a great part of Motijheel, Ramna and Lalbagh.

The areas further north were developed during 1960's. Large scale housing projects namely Mirpur Housing Estate and Mohammadpur Housing Estate were developed for low-income as well as middle-income families. Gulshan and Banani were developed as high-class residential areas. The Uttara Model Town and Baridhara were also developed by RAJUK as middle and upper-income residential areas. Tejgaon was developed as an industrial area, and to the west of Tejgaon, Sher-e-Bangla Nagar was developed for the purpose of locating the parliament building and housing facilities for high ranking government officials.

Dhaka also experienced the largest increase in population in the country during the last few decades. The city accounted for about 28.68 percent of the total urban population in the country in 1991. The rate of growth of population of the city during the last few decades has been quite spectacular Figure 2 presents the growth of population of Dhaka City between 1901 and 1991. The increase in Dhaka's population between 1961 and 1991 was much higher than the increase in population during the previous census periods.

In accounting for such high growth rate of the city population, the rate of net immigration deserves special consideration. Limited job opportunity, diminishing returns in agriculture, lack of social amenities, high population growth and other factors continuously push rural people to the urban areas. The expansion of the job market in

Dhaka city and consequent large-scale immigration of people from rural areas and smaller towns played a significant role in the growth of city population. This is evident from the spectacular increase in the administrative, commercial, industrial and service establishments during the last two decades.

Even after the creation of Bangladesh it has never been possible on the part of the Government to make provisions for adequate housing facilities and job opportunities for the city residents. As a result, large areas of unplanned housing and squatter settlements have emerged in the northern part of the city. Private housing developments are also covering the low, wet areas to the east and west. Houses are built by earth-filling without the minimum community facilities. In this way a large part of the low-lying areas, canals and water ways which act as natural drainage ways are disappearing due to unplanned housing and other development activities.

3. CHANGING LAND USE AND SETTLEMENT PATTERNS IN THE FRINGE AREAS AFTER THE CONSTRUCTION OF THE EMBANKMENT

The construction of the greater Dhaka flood protection embankment made large areas free from flood. Consequently, these areas have become suitable for non-agricultural uses. Due to scarcity of buildable land in Dhaka, people have started buying lands in these areas and converting these lands from non-urban to urban uses. Significant changes in housing, transportation and settlement patterns have already taken place after the construction of the embankment. In what follows, an attempt is made to describe some of these changes with reference to the selected study areas:

3.1 Uttara (Along Turag River)

This part of the study area is at the north-west side of Dhaka city. The area covers high lands used for agricultural purposes. Scattered settlements of purely rural nature are also noticed. The area is of very low density of population. Boat is mainly used for transportation through river and canal network over the area. Due to the construction of the embankment, bicycle, rickshaw and other light mechanised vehicles have started using the embankment as road linking the adjacent areas. Huge areas have been purchased by housing societies along the embankment for development into residential plots. There is every chance that this part of the fringe area would be merged with the planned residential zone of Uttara and urban facilities would be extended upto the embankment.

3.2 Mohammadpur (Along Buriganga River)

Before construction of the embankment this low-lying agricultural area remained under water for most part of the year. Since the area is very near the city, it has developed quickly after construction of the embankment. A medium density settlement is undergoing to be a very high density locality since the urban facilities are available within a short distance. Expansion of the city along this direction was not possible before the construction of the embankment due to flood water and as such the vast land area was used for one time cultivation over the year. After the construction of the embankment rapid development have taken place in the area attracting people due to short distance from city centre and good communication link. Within a short period the area is going to be a densely populated residential area.

3.3 Kellar Morh in Lalbagh (Along Buriganga River):

This area is located in old Dhaka having a very high density of settlements. Close to the river Buriganga, this part of the city have developed during the early period of Mughal regime. Density of population over this area was increasing day by day but the area could not expand due to the risk of flood. Because of the embankment, the area is now flood-free and the embankment has provided the opportunity to link the area with the city centre. People of the area have started constructing bamboo bridges upto the embankment to use it as road-link to city. Before construction of the embankment they used boat as the mode of transportation. Instead of Kutcha houses they are now constructing Pucca structures as the river water cannot inundate the area now. Within a short period of time the whole of the low-lying area and ditches are likely to be filled up and developed for residential and commercial purposes

4. THE EFFECTS OF THE EMBANKMENT: A QUANTITATIVE ANALYSIS

In this section a quantitative analysis of the effects of the embankment on land use, land ownership, housing and transportation is presented:

4.1 Land Use

Significant changes in land use have been observed. Conversion of land from non-urban to urban uses is evident from the decrease in agricultural lands and open fields and the increase in residential and commercial use (Figure 3). There is also a significant decrease in water bodies indicating that low-lying areas are being filled-up.

Land value has also increased significantly as the lands have become flood-free due to the embankment. Private developers are filling up low areas. These areas are being

developed as residential plots and sold to buyers at higher prices. That the people are moving to the area protected by the embankment from other parts of the city as well as from outside is evident from the study. About 78 percent of those who moved to the fringe areas of the embankment indicated that their former place of residence was within the city while the rest indicated that they came from outside. As regards the factors influencing the decision to move about 73 percent of the respondents mentioned protection of land from flood as well as improvement of transportation facilities.

About 51 percent of the respondents also indicated that activities of the housing societies also influenced their decision to move.

4.2 Housing

Housing development has gained momentum after the construction of the embankment. Total number of houses has increased by about 140 percent by the end of 1992. There has also been significant improvement in the use of construction materials. Proportion of Kutcha houses (houses built with bamboo and straw) has decreased while the proportion of Pucca houses (brick-built) has increased significantly (Figure 4).

The present owners are in most cases economically better off than the previous owners who were mostly farmers. Moreover, protection of land from flood has been encouraging people to construct permanent houses. The people are also living in their own houses in larger numbers. Thus, majority of the owners (75%) are presently living in their own houses while only 25% of the houses have been rented out.

4.3 Transportation

A change in the mode of transportation has also been observed. Number of people using boat has decreased significantly after the construction of the embankment. Thus, boat was being used by 43 percent of the people in the area before the construction of the embankment. This has decreased to about 12 percent after the embankment. The percentage of people using bicycle, rickshaw and motorcycle has also increased significantly due to the embankment (Figure 5).

In future the use of the greater Dhaka flood control embankment as a link road between Tongi with LalBagh via Mirpur will also have a positive effect on the transportation system of Dhaka city. Again the second phase of the embankment if completed may be used as a bypass connecting Demra with Tongi. Thus, a peripheral road system can be developed around Dhaka city easing traffic congestion in the central part of the city.

5. ADVERSE EFFECTS OF THE EMBANKMENT

In the past, Dhaka city was criss-crossed by numerous canals and waterways, which provided for an excellent means of communication as well as a very natural drainage system. Most of these canals and water bodies have disappeared due to high rate of development activities. These Khals and low-lying areas have been choked up by encroachment mostly without proper sanction. Filling, deposition of city garbage, construction of housing projects, roads etc. in low-lying areas have decreased the water retention capacity of the city.

Construction of the embankment has led to further deterioration of the drainage problem in the city due to the disturbance of the natural drainage system within the embanked area. Water logging during the rainy season has become a serious problem and many people now consider the embankment as a curse rather than a blessing. Another disturbing aspect is the risk of higher flooding on the other side of the embankment. Although the areas within the embankment have been protected from flood, the areas outside the embankment are likely to experience higher floods due to the obstruction of flood water by the embankment.

Another important consequence of the embankment is the unplanned and haphazard development of the low-lying areas along the embankment. Private developers are filling up those lands and selling them to prospective home builders. These future-seeking developers are not aware of the environmental hazards and hydraulic imbalance they are creating filling up these natural drainage systems. Moreover, these areas are being developed without consideration to land use planning principles.

The encroachment of a large number of people on to the embankment has created problems not only for the embankment itself but also for the city dwellers. The embankment offers a rent-free, flood-free opportunity close to the place of work. Squatter settlements on the embankment have led to construction cuts in to the embankment's profile and removal of vegetation cover. These together with associated development of footpaths have brought about erosion.

6.0 RECOMMENDATIONS

Although large areas have been protected, adverse consequences of the embankment in terms of drainage congestion, erosion, unplanned development, squatter settlements etc, need immediate attention. Following recommendations are, therefore, made in this respect:

1. During excessive rains internal flooding may occur due to the obstruction of water by the embankment. A planned drainage network is to be activated for smooth draining out of rain water. Re-excavation and restoration of natural drain ways, Khals, water beds within the city and control of water movement through sufficient number of pumping stations, sluice gates etc, are needed.

2. It has been observed that serious erosions have occurred at many places and rain cuts have developed along the whole length of the embankment. Also at many places compaction measures will be needed so that the embankment can withstand peak flooding pressures.

3. The absence of defined and well-regulated land and housing policies has contributed to the unplanned and scattered location of development activities. Laws relating to planning are not strictly enforced. There is an urgent and immediate need for a guided and comprehensive land policy which should outline the land use programme of the city. An alternative land use plan should be prepared immediately in order to make optimum utilization of land within Dhaka and to ensure preservation of valuable agricultural lands, the swampy areas, Khals and canals for protection against flood. Also RAJUK in coordination with other development agencies for Dhaka city should go for an integrated area development plan for the vast fringe areas of the city protected by the embankment.

4. Measures should be taken to prevent people from moving on to the embankment for the purpose of squatting. It is, however, difficult to remove people sheltering on the embankment immediately after flooding and also those who move on to the embankment as a result of being displaced by the construction of the embankment. Resettlement of the people affected by the embankment, therefore, should be given priority.

5. It may be noted that in the second phase of the project there is provision for a four lane road on the inside to a lower level from Demra to Tongi bridge along the embankment. Similarly on the north-western side of the city from Tongi bridge to Shirnir Tek a four lane road along the inside part of the embankment have been proposed. The concerned authority should go for a peripheral road system around Dhaka city by connecting Demra with Tongi and again from Tongi upto Buriganga bridge along the length of the embankment. A detailed survey in this regard should be carried out and its feasibility should be studied since this embankment-cum-road system will require additional land acquisition by the government.

7. CONCLUSIONS

In this paper an attempt has been made to analyze the effects of the greater Dhaka town protection embankment in the fringe areas in terms of changes in land use and settlement patterns. The study indicates that there was very little change in land use in the area before the construction of the embankment despite heavy demand for land in the city. The areas remained flooded for most part of the year and were not suitable for urban uses. With the construction of flood protection embankment the fringe areas have been saved from a annual flooding and rapid change in land use pattern has taken place. Large areas have been purchased by housing societies to develop them for residential purposes. Individual land owners are filling their lands to construct houses either for their own living or for renting them out. It is interesting to note that an internal road network is developing using the embankment as the main connecting road to different parts of the city. Gradual development of other urban facilities are also visible.

What is now clearly apparent is that the fringe areas are undergoing rapid change in terms of land use and will soon become a congested residential zone unless proper steps are taken immediately. Moreover, the way low-lying areas are being filled up may create serious drainage problems in future over the areas. There is, therefore, an urgent and immediate need for an integrated development plan for the vast fringe areas of the city protected by the embankment.

REFERENCES

1. Committee for Flood Control and Drainage of Greater Dhaka, 1989: "Report on Flood Control and Drainage of Greater Dhaka" Government of Bangladesh.
2. Japan International Cooperation Agency (JICA), 1990: "Updating Study on Storm Water Drainage System Improvement Project in Dhaka City".

MASTER PLAN OF FLOOD SHELTER /EVACUATION SITE FUNCTIONING AS COMMUNITY CENTRE FOR DISASTER MANAGEMENT AND RURAL DEVELOPMENT

MIR SHAHIDUL ISLAM

Professor,
Department of Urban and Regional Planning. BUET.

MD. NAZMUL ALAM

Department of Urban and Regional Planning, BUET.

1. INTRODUCTION

Natural disaster like flood, drought, cyclone etc. hit different parts of Bangladesh frequently. Among these, flood is almost an annual event. During the most recent devastating flood in 1988 about 62% of the country was flooded and more than 50 million were directly affected (France Engineering Consortium, 1989). The immediate effect of disastrous flood tend to create a situation where vast areas of land is inundated. As a result, standing crop is damaged, roads, highways and railway, shops, service centres, offices and market places are forced to shut down, almost all normal activities come to a standstill.

People find themselves stranded in their homes especially in the rural areas where about eighty percent of the people live. When evacuation becomes imperative many seek refuge in the houses of relatives, nearby highlands, public buildings, schools, embankments, roads etc. While others are found to be stranded on their rooftops waiting to be rescued.

Transportation poses a problem as most roads and transportation routes are submerged, moving pregnant women, sick persons and aged persons often becomes difficult and after the move they often require medical attention and care. Carrying of livestock is another problem as small boats are highly hazardous for this purpose. Further more, one not only has to take the animals to safe refuge but also has to feed and take care of time.

Another that the people encounter is finding a safe shelter. People normally wish to move to a place familiar to them and at close proximity. Those who are able to save and carry their stock of food often lack pure water, matches, and stove fuel. But these too fall short of supply and at this point they go hungry unless relief supplies and materials reach them.

Material and human assistance during and after a disaster come from various sources. However reaching these to the flood affected people become a difficult task. Shortage of water vessels, helicopters etc. delay relief operations to the remote areas. Relief operations are seen to be concentrated in certain areas like the outskirts of towns and cities while in other inaccessible areas relief supplies do not reach the flood affected people in time. Relief providing organizations, teams and personnel face problems in assessing the flood situation and in determining priority needs. Lack of overall CO-ordination and prompt action is also a problem.

Soon after flood water starts to recede the health and sanitation conditions begin to deteriorate sharply. Outbreak of epidemics such as cholera, diarrhea, and other water borne diseases are common.

Massive rehabilitation measures need to be launched in the post flood period. Transportation and communication has to be reestablished, electric power supply has to be restored, damaged infrastructures have to be repaired, and people have to be rehabilitated to their home and work places.

In the backdrop of such a scenario in rural Bangladesh, it is highly desirable that a flood preparedness programme be implemented at the local level that would ensure safe refuge to evacuees, food and drinking water and primary Medicare for people suffering from snake bite, diarrhea, fever and other ailments. It is also desirable that a coordinated action be taken to search and rescue such flood victims, evacuate them to shelters and salvage of household and other items and shelter for livestock and poultry is also necessary.

Damage and destruction caused by frequent floods in Bangladesh have an adverse effect on rural economy and impedes development efforts. Therefore, disaster management and rural development has to be integrated. The conception of study emerges out of the assumption that the preparation of a sound disaster management programme and its efficient implementation, may provide a reliable means of satisfactorily dealing with natural disasters.

1.1 Objectives of the Study

This study is aimed at looking into the problem of flood management with its principal operating base at the local field level and possibility of organizing flood disaster management through implementation of an integrated Master Plan for flood shelter, community welfare and rural development.

The specific objectives of the study are:

- a. Identification of evacuation needs and priorities;
- b. Suggest criteria of selection of flood shelter /evacuation site;
- c. Preparation of an evacuation plan including logistics during flood;
- d. Suggest management facilities at evacuation centre including organization setup;
- e. Suggest preliminary planning of flood shelter /evacuation site; and
- f. Suggest optimum and potential use of evacuation site/flood shelter as community centre also cultural and rural development purpose

1 .2 Methodology of the Study

The approach adopted in the study was that an in-depth evaluation of the requirements of typical shelter in a flood prone village would provide the subsequent basis for a Master Plan. Therefore the study had been limited to a single union with particular focus on a village within that union.

Principal components of the methodology adopted were as follows:

- a) Field survey and investigation for determination of the existing site characteristics and peculiarities and consisted of physical, socio-economic and flood characteristics.
- b) Formulation of a comprehensive strategy for preparation of Master Plan of Flood Shelter/Evacuation Site and Disaster Management with integration of operational programme for disaster management, community development and rural development
- c) Size estimation of necessary facilities for determination of capacities of physical facilities.
- d) Planning and design of Master Plan through process of site selection of the flood shelter, planning and design of various physical facilities , cost considerations and preparations of management plan including evacuation, shelter, and operational plan with necessary organizational set-up for integrated operation of the flood shelter functioning as community centre

2. MAJOR ACTIVITIES OF THE RESEARCH

The methodology provided the basis for a systematic investigation into the different aspects of the study. Subsequent paragraphs in this section include the details of the works one in the study and the output obtained.

2.1 Survey and Investigation

Prior to starting the work on survey and investigation, project site was selected on the basis of a predetermined site selection criteria and the study area was precisely defined.

Kanchanpur Union of Basail Thana under Tangail district has been selected as the study area and a site for establishment of the flood shelter/evacuation site has been selected at the Kazi para village in the Kanchanpur Union as shown in figure 1. Field survey and investigation were made in a number of stages:

- a. Physical and infra-structure characteristics;
- b. Population and household characteristics; and
- c. Economic characteristics.

Flood vulnerability assessment included the following : a) land elevation and flood assessment b) flood frequency and flood depth analysis c) assessment of flood response d) assessment of flood damage.

2.2 Data Analysis

Survey and investigations were carried out according to the pre-determined methodology and questionnaire survey and the following summary results were obtained.

Results of the Community Assessment

Community assessment provided a first hand knowledge on different aspects of the human settlements in the study area, their distribution in space, locational characteristics etc.; population characteristics, their life style, education, household characteristics, occupation, income distribution, and on the nature of housing stock, livestock and other possessions. Results of community assessment are as follows:

- a) Water transport especially country boats are the most important means of evacuation and delivery of relief supplies but are found to be in short supply during floods;
- b) National and regional roads built on embankments in many places with non-permanent surface. Therefore, there is a scope for raising the top level of embankment above design flood level;
- c) General lifestyle of people tend to encourage carrying of as much of domestic possessions as possible with the evacuees;
- d) Population and household characteristics reveal that there are high literacy rate among

- both sexes and higher proportion of active age group which indicate prospects for creation of gainful employment;
- e) Information on housing stock reveal predominance of temporary and weak structures requiring facilities for building flood resistant structures;
 - f) Data on livestock indicate that protection of livestock and other domestic animals is an important component of evacuation plan and opportunities for development of the sector for creation of rural employment exist.

Figure 1. Schematic Representation of the Integrated Strategy

Results of Flood Vulnerability Assessment

The average land level of Basail thana is 7.6 meters above the sea level. The homestead groups are generally situated on land at 8.5 to 9.1 meters elevation.

Kanchanpur union fall under the 25 percent flood frequency zone and flood depth range of 90 to 180 cm.

The notable observations regarding evacuation during the flood of 1988 are as follows:

- a) More than half of the inhabitants of Kazipara reported to have evacuated their homes during the flood of 1988 leaving all but portable valuables and food;
- b) The rapid rise of water gave the people very little time to save their possessions. In many cases farmers handed over their livestock to people who could carry them away in boats or sold them for token money. Household items and furniture were lost or damaged;
- c) The inhabitants of Kazipara received knowledge about rising flood waters around them from the radio and people at the bazaars and meeting places but failed to take adequate protective measures.
- d) People depended largely on neighbours and relatives during times of flood for advice and assistance;
- e) Majority of the dwelling units were flooded;
- f) 75% of the dwelling units required major repairs (due to mud and floor);
- g) About 60% respondents left their house during flood to take shelter elsewhere;
- h) Forty-six percent people went to near by high lands;
- i) Eleven percent people took shelter at their relatives houses;
- j) During evacuation in 1988, boats were the major mode of transport to carry people, possessions and cattle to places of safety;
- k) Quick on-rushing water during 1988 flood meant that evacuation had to be rapid;
- l) Most evacuees were forced to leave behind bedding, furniture, ovens and other household items;
- m) Many sold their cattle and properties to lessen burden during evacuation and in anticipation of great need of cash in the immediate future;

In the light of above the following needs have been identified:

1. The inhabitants of Kazipara need to be made aware of the measures that must be taken to prepare themselves for possible evacuation. They need to be made educated and motivated toward meeting such emergency needs. To fulfill this need, non-formal education and training need to be initiated and implemented all the year round;

2. Timely and effective warning is necessary for evacuation;
3. Since neighbours rely on each other for advice and assistance, neighbourhood cohesion must be strengthened. Concerted effort of a neighbourhood in meeting evacuation need to be formed.
4. Since more than half the population of Kazipara had to evacuate their homes in 1988, a flood shelter is vital to the safety and security of the inhabitants. Moreover, valuable properties and livestock and poultry need to be saved and stored within the premises of the flood shelter;
5. Searches and rescue operations together with salvation operations need to be organized and carried out in an efficient manner.

Rural Development Programs

The main objectives of rural development aims at achieving improvement in the quality of life of the rural people through increased production, income generation and improvement of standard of living and of rural environment.

Special emphasis was given on identifying the rural development projects which could be integrated into the flood shelter management strategy. The following projects were of particular significance:

- i) literacy programme;
- ii) human resources development through vocational training;
- iii) reduction of rate of population growth;
- iv) improvement of health and sanitation;
- v) increased fish and livestock production;
- vi) promoting of cottage industries and small farm production; and
- vii) women employment programmes.

3. FORMULATION OF AN INTEGRATED STRATEGY

The integrated strategy of disaster management is an expression of policy for addressing the problem in a satisfactory manner. The concept of adoption of a planning approach for solution of the flood disaster management problem integrated with other closely related programmes of community development and rural development, call for separately identifying the components of each programme and then integrating them into a package plan for optimum utilization of the available resources.

The package plan will consist of a complete programme based on an integrated strategy. Figure 2 is a schematic representation of the integrated strategy. Flood disaster management, community development and rural development are the three major components of the strategy. These components are supported by resource centres including the information centre. Each component is again sub-divided into detailed functional plans. The package plan is conceived of as a comprehensive Master Plan consisting of the structural and non-structural components. Structural components will include a physical land use master plan for the flood shelter /evacuation site functioning as a community centre with necessary physical facilities. The non-structural components will include the operational management plan with administrative and other support services.

The system of management of operation is the area where the functional activities of other major components of community development and rural development will be integrated in such a way that the physical facilities can be put to optimal utilization for mutually beneficial purposes. Closely linked with the integrated strategy are the concepts of multipurpose use of the facilities of the flood shelter/community centre and establishment of proper functional linkages among all the major components.

Another aspect of the strategy is the local level focus of the operational base. The location of the flood shelter /evacuation site at the Union level have the advantages of moving closer to the affected area and obtaining public participation in an effective manner.

These are the two most important elements which greatly influence the efficiency of disaster management and have been dealt with in the study.

The package plan or the Disaster Management Master Plan is a combination of numerous plans and programmes. It is central to the concept of integrated strategy. At broad macro level, disaster management plan deals with the following aspects (Nishat, 1990; Quarentelli,1990):

- a. Pre-disaster mitigation measures to reduce the impact of flood,
- b. Disaster preparedness plan to face disaster in a systematic way and prepared well in advance. The master plan of physical facilities is an important item under this component.
- c. Management of disaster with measures to provide emergency aid, evacuation, providing temporary shelter etc.
- d. Post flood assistance in reconstruction and rehabilitation.

Further details of above measures which are also included in the strategy can be enumerated as follows:

- a. Under the pre-disaster measures, structural changes such as construction of transportation, drainage and flood control infrastructures are important.
- b. Disaster preparedness plan consists of a large number of measures ranging from devising the early warning system to the creation of physical facilities at the flood shelter/evacuation site in the form of physical land use master plan.
- c. The principal features of disaster management plan are as follows:
 - i) Establishment of the flood shelter/evacuation site with necessary physical facilities and logistics at the Union level;
 - ii) Creation for a Union level disaster management centre with Management Committees, information centre and monitoring and feed system;
 - iii) Preparation of an integrated operational programme of disaster management, community development and rural development;
 - iv) Institutional development with trained manpower for managing the flood shelter/community centre.

Preparation of the individual component plans for realization of the policies contained in the strategy, is the major work of the study. Through the process of

integration of the individual plans, attempts have been made to test the original concepts of locating the disaster management at the local level and also possibilities of integration of other rural development programmes for maximum utilization of the available resources.

4. MASTER PLAN OF FLOOD SHELTER/EVACUATION SITE

The Master Plan of physical facilities of the flood shelter and evacuation site has been formulated in response to the spatial requirements of the centre. Land use planning process has been followed for the preparation of the physical plan. The process has its own sequential steps which includes formulation of objectives, projections and forecasts, site selection criteria, design criteria, identification of different uses and physical facilities, size and capacity determination, calculation of space requirements and allocation of distribution of space for different uses in the Master Plan. Preliminary design of space for shelter and other uses and cost considerations have been indicated. A number of critical factors were observed in the planning and designing exercises of this study as follows:

4.1 Flood Vulnerability Assessment

Frequency of occurrence of flood of disaster level, land elevation, flood depths and area of coverage, are some of the critical factors which determine the dimension of the problem, and the nature and size of protection measures necessary in a particular situation. It is observed (MPO, 1987) that every year about 18 percent area of the country is inundated. During more severe floods, the inundated area may go up to 36 percent whereas the flood vulnerable area which has been flooded in one year or the other, is approximately 59 percent of the total area of the country (France, Engineering Consortium, 1988). In 1988, about 62 percent of the country was flooded.

Depth of flood is important for assessment of probable disaster level due to flood. The 20-year flood depth map shown in Figure 3 indicates spatial distribution of flood depths in the country. It is observed that flood depths of 180 cm and above, are of special significance for disaster management purposes.

4.2 Population Characteristics and the Life Style of the People

The distribution of settlements, density nature of dwelling units, household characteristics and the life style of the people, greatly influence the disaster management scheme.

From the flood response assessment it has been observed that due to predominance of temporary building structures, there is a tendency of the affected people to carry household personal belongings, livestock etc. with them during evacuation. These indicators are useful for identification of evacuation needs and priorities and in determining the type of facilities required for evacuation and temporary shelter.

4.3 Site Selection Criteria

Site selection criteria for the flood shelter /evacuation site is one of the critical elements in the flood shelter planning and design process. Land use, particularly concentration of settlements, high land elevation and favourable lines of transport and communications are critical elements.

4.4 Department of Physical Facilities and Size Estimation

Determination of the physical facilities and logistics required in the flood shelter/evacuation site needs careful consideration because type and size of each facility will be such as can serve the purpose of different programmes adequately and at the same time ensure optimum capacity utilization. In the planning and design exercises of the Master Plan, all these have been given careful consideration.

The concluding stage of the planning and design exercise led to the preparation of the physical Master Plan shown in Figure 2. Individual plans have also been prepared such as given in figure 3 which shows the layout plan of the main flood shelter building with allocation of space for alternative uses for flood shelter and for community and rural projects.

5.0 FLOOD SHELTER MANAGEMENT PLAN

The flood shelter management plan is in essence an operational plan which envisages integrated functioning of the three major components of operation of the flood shelter during flood disaster situation, execution of the rural development projects and rendering community services through utilization of the facilities and other resources of the Centre in normal situation.

Among all the components of the management plan, flood disaster management received added emphasis in the study. Detailed analysis of the different aspects of disaster management has been made before preparing a comprehensive operational plan. Different components of the disaster management plan have been identified as follows:

- a. disaster preparedness plan

- b. early warning system
- c. information collection and dissemination system
- d. organizational development
- e. public participation
- f. pre-flood activities
- g. operation of the flood shelter/evacuation site

Under the disaster preparedness plan, necessary physical facilities have been created, required logistics have been assembled and the operational procedure has been established. Figure 4 shows the flood shelter operational plan. It contains the procedural methodology for a co-ordinated operation. Needs and priorities of evacuation include search and rescue of human evacuees, search and rescue of domestic animals, salvaging and protection of household materials, removal of evacuees to safe places, registration of evacuees, their medical checkup and their removal to temporary shelters.

6. CONCLUSIONS AND RECOMMENDATIONS

Enormous shortcomings in the delivery of shelter relief services in post-flood disaster situation can be ascribed to a large extent to the inability to formulate appropriate strategies which would allow full mobilization of available resources and elimination of constraints created by abnormal post flood conditions. A pre-planned and well thought out flood disaster management strategy supported by a suitable Master Plan with necessary physical facilities and operational methodology is likely to assist in effectively addressing the flood problem,

The Flood Shelter functioning as a community centre and also used for disaster management and rural development is an attractive option. The integrated operation may ensure higher efficiency and capacity utilization of existing facilities and facilities created for shelter.

One of the advantages of integrated functioning of the flood shelter is that the operation and maintenance cost is expected to be generated from productive activities of the flood Shelter /community Centre. Even surplus revenue income may assist in building up a capital fund for the centre.

Income level of people in general is expected to rise through implementation of various rural development projects and local resources are expected to be mobilized for disaster management and rural development.

A detailed analysis of flood disaster management for realization of the objectives set for the study in a decentralized framework reveal that the Union level operation of the flood management centre is a viable proposition. Decentralization of management activities has the prospect of achieving greater public participation and advantages of flood management at the field level. With the implementation of the Master Plan the following benefits are anticipated:

- a) Benefits through achievement of rural development objectives;
- b) Benefits through access to community services;
- c) Benefits through successful disaster management.

Thus it is also recommended that the Line Ministry should be the Ministry of LG&RD and Cooperatives to match with the existing system of Local Government. This will facilitate better public participation and co-ordination. However there is ample scope for further research into the institutional arrangement for integrated operation at an optimal level.

Involvement of women in development projects through cooperatives and their inclusion in the voluntary shelter/community centre management force to safe women interests and raise status of women in society.

More studies should be conducted on space standards such as minimum shelter space per person, minimum space for domestic animals etc. Detailed manuals should be prepared for each operational unit of disaster management for higher efficiency while component manpower need to be developed through appropriate training.

NOTE

Other uses provided in the upper floors are:

Dining, vocational training/shelter,
Library, training/shelter,
Tailoring/shelter,
Resting room/visitors, etc.
and Service areas

Similarly, implementation of the evacuation plan requires a large number of activities followed in sequence. These include flood monitoring, arranging meeting of the

Disaster Management Committee, declaration of danger zone, activating early warning system, mobilisation site, registration and shifting of the evacuees.

The disaster management package plan is a total plan which includes all the components in a logical order.

REFERENCES

1. Alam, N. (1992) "Master Plan of Flood Shelter/Evacuation Site Functioning as Community Centre for Disaster Management" An unpublished MURP thesis, submitted in the Department of Urban & Regional Planning under a Joint Research Project of the UNCRD and BUET.
2. French Engineering Consortium (1989) "Pre Feasibility Study for Flood Control In Bangladesh" Vol. I-VI
3. Nishat, A (1990) "Planning of Evacuation Sites and Clustered Village Protection Against Flood" Paper presented before UNCRD-CIRDAP Workshop on Integrated Approach to Disaster Management and Regional Development Planning with People's Participation, Dhaka. Bangladesh, 28 Jan- 1 February.
4. Quarantelli, E.L. (1990) "Safety Assessment for Regional Development Planning" On Integrated Approach to Disaster Management and Regional Development Planning with Peoples Participation. Dhaka, Bangladesh 28 January- 1 February.
5. MPO (1987). "Floods and Storms" Technical Report No.11.

INSTITUTIONAL DEVELOPMENT PROGRAMME FOR LOCAL LEVEL FLOOD DISASTER MANAGEMENT AND RURAL DEVELOPMENT IN BANGLADESH

Dr. Mohammad A. Mohit

Associate Professor,
Department of Urban and Regional Planning, BUET.

Md. Golam Mustafa

Assistant Professor,
Urban and Rural Planning Discipline, Khulna University.

1. INTRODUCTION

Flood disaster has become a regular phenomena and a pertinent issue for rural development in Bangladesh. About 20 per cent of the country's area are annually flooded with the exception of the 1987 and 1988 floods which inundated 52 per cent and 62 per cent area of the country and inflicted losses worth Taka 3, 260 (US\$ 994) millions¹ and Taka 40,000 (US\$ 1,040) millions of properties² respectively. The impacts of flood disasters are wide in rural areas where 80 per cent of the country's people live in than urban areas where relatively better flood protection measures have been developed. It is thus imperative that rural areas which are more vulnerable to flood require development policies to be integrated with flood disaster management (DM).

Recent flood studies consider flood DM from macro viewpoint and so local level considerations have not received adequate attention.³ The joint UNDP (United Nations Development Program) and GOB (Government of Bangladesh) flood study (1989) identified eleven principles as the possible policy measures for solutions of flood problems of Bangladesh.⁴ The institutional matrix for the implementation of policy measures envisaged two kinds of institutional supports - co-operation of concerned agencies and involvement of beneficiaries, for successful implementation of policies. The joint flood study between the Governments of France and Bangladesh (1989) recommended "systematic embankment of the major rivers, their tributaries and distributeries".⁵ The study also recommended supporting socio-economic and environmental studies but it failed to envisage massive structural interventions to the ecosystems without giving due consideration to the possibility of adverse impacts on environment. It also failed to identify appropriate institutions to deal with the flood problem at the grassroots level.

The US-AID study (1989) recommended for a combination of the elements of structural and non-structural measures in order to reduce flood vulnerability of the country.⁶ The study assessed the need for local/rural level supporting studies and envisaged that such studies would enable better understanding of the flood context of Bangladesh and ensure assimilation of successful strategies for flood DM. The JICA (Japan International Co-operation Agency) (1989) study has raised cautions against large construction, instead it has recommended for limited and selective physical works plan.⁷ The study envisaged the need for non-structural measures such as flood forecasting and warning systems and flood fighting as indispensable for flood DM in Bangladesh.

The broad aim of FAP (Flood Action Plan) which covered a study period of five years (1990-95) and consisted of 26 components, is an attempt to set the foundation of a long-term programme for achieving a permanent and comprehensive solution of the flood problem based on eleven guiding principles.⁸ Several inconsistencies and inadequacies of the FAP have been identified by many authors.⁹ It has been remarked that some of the guiding principles demonstrate pre-judgement about the outcome of supposedly investigative studies of the Action Plan. The Task Force Report (1991) observed several inconsistencies and recommended for reappraisal of the FAP regarding its environmental, technical, financial and institutional viability.¹⁰ Rahman and Ahmed (1990) studied the current natural hazards and their impacts, documented the perception of the Government and other organisations engaged in disaster relief/mitigation and development, evaluated the strength and weaknesses of current mitigation measures and finally provided recommendations for national and sectoral policies.¹¹ This study has, however, failed to identify and suggest the appropriate local level institutions to carry out its recommended policy measures.

The foregoing discussion reveals that most flood studies are mainly concerned about flood DM from macro perspective and hence local level initiatives, responses and institutions/ organisations which contribute to flood mitigation measures have been neglected. The experience of 1988 flood in terms of local responses to cope with the disaster has demonstrated the inherent strength and tradition of local people to unite for helping the distressed through the creation of voluntary organisations. One study has observed that 630 socio-civic, cultural, educational, religious and even commercial organisations involved themselves in relief and rehabilitation activities during September and October, 1988.¹² Such demonstration of mass participation is indicative of the fact that local level institutions based on popular participation have the potential towards making contribution to effective flood DM in rural areas of Bangladesh. One author has thus remarked that "there are spaces for judicious policy interventions which could be

directed at augmenting the organisational and co-ordinating capabilities of these popular institutions on a much larger scale".¹³

2. OBJECTIVES AND METHODOLOGY OF THE STUDY

The main purpose of the research/study was to investigate into the local institutional aspects of flood DM in rural Bangladesh and as such the following objectives were set for the study:

- a. To investigate into the nature of the problems of flood disaster in rural areas.
- b. To identify the existing rural institutions responding to different phases of flood DM.
- c. To assess the efficiencies of these institutions in terms of their contribution to DM&RD.
- d. To find out the existing and potential areas of participation of the people in DM&RD.
- e. To identify the problems of institutionalising the potential areas of people's participation and to formulate alternative strategies for future courses of action.
- f. To suggest appropriate institutions for DM&RD with peoples participation.

In order to obtain the above objectives the methodology adopted for the present study consists of three main aspects-selection of the study area, field survey and investigation of official documents.

2.1 Selection of the Study Area

To understand the flood vulnerability context and the traditional means of responses of the people towards flood DM, a part of Kanchanpur Union under the jurisdiction of Basail Thana of Tangail District was selected for study purpose.¹⁴ The criteria adopted for the selection include-(a) Kanchanpur is one of the low lying and regularly flooded regions of Bangladesh; and (b) Kanchanpur is one of the poor and backward rural regions of Bangladesh.

2.2 Field Survey

A thorough reconnaissance survey was conducted during the regular flood period of 1990. A pre-coded household questionnaire was administered for investigation of local situation and it covered 200 households. The questionnaire consisted of questions regarding the socio-economic condition of the people, flood vulnerability of the region and people's response to it, people's perception regarding the possible measures and institutions for community based flood DM&RD. Two sets of questions were asked for

impact assessment of flood disaster - one for regular/normal flood condition and the other one for severe flood condition.

Five severely affected localities - Haluapara, Chankapara, Adajan, Dakhainpara and Saknaichar of the Union, were purposively selected for household questionnaire survey (Figure 3). A systematic sampling method was applied to the selection of 1st, 3rd, 5th and so on houses for household questionnaire survey in the five selected localities of Kanchanpur. In addition, a sample of 50 persons were randomly selected for interview for the evaluation of local institutions with respect to disaster management actions/ efficiencies.

Direct discussion with the local level institution heads and investigation into their nature and functions from recorded documents regarding disaster and development was also carried on. Discussions were also held with the concerned people of the area regarding the services that were reported to have been provided by the different local institutions.

2.3 Investigation of Official Documents

An in-depth investigation of the recorded documents of local institutions engaged in DM and rural development activities was conducted to understand their nature, functions, roles and responses in DM&RD of the area. These institutions include - (a) Thana Administration, (b) Union Parishad, (c) Local NGOs, (d) Local Clubs, Societies, and (e) Local School, Masjid, Maktab committees. Discussions were also held with the executive members of these institutions in order to gather more information which were deemed useful for the research.

3. THE STUDY AREA AND ITS VULNERABILITY TO FLOOD DISASTER

Kanchanpur Union is under the administrative jurisdiction of Basail Thana of Tangail District. It is located between 90 degrees -30' to 90 degrees -35' N latitude and 24 degrees -10' to 24 degrees 15' E longitude (Figure 1). There is no metalled road in the region. Three narrow earthen roads connect the area with Basail Thana Hq which is about 4 kilometres far from the study area in the northerly direction (Figure 2). Another earthen road which connects the area to the Dhaka-Tangail highway at Nataipara, is located 4 kilometres away from the study area. The Tangail District Hq. is the main urban centre of the region. The study area is located 15 kilometres far from it. Karatia and Mirzapur are two medium-sized urban centres of the region and the study area is located 10 kilometres and 13 kilometres far from these urban centres. Besides the Basail Thana Hq., the people of the study area has major interactions with Nataipara which is basically a market place and Karatia which is a market-cum-educational centre.

Ecologically, the study area consists of low lying plain land subjected to annual inundation ranging from 1.0 to 3.5 metres for about 4 months during the wet seasons. Most of the communication lines, ie., the earthen roads, are inundated by flood water every year. As such country boats remain the only mode of transport available for several months during the wet seasons.

Table 1. Height and Duration of Flood in the Study Area.

From Table 1 it can be seen that while average annual depth and duration of inundation of agricultural land is around 2.25 metres and 4 months, respectively, average annual depth and duration of inundation over the communication lines are 0.5 metres and 1 month, respectively. Both the depth of inundation and period of duration increase with severe flood in the area.¹⁵

Because of flood vulnerability general economic condition of the people of Kanchanpur is poor. Agriculture is the primary occupation of the people but landholding is unequally distributed what stand to indicate the poor resource base of majority of the people. Dry season IRRI-Boro¹⁶ cultivation is the main agricultural crop of the area. Aus¹⁷ and Aman¹⁸ cultivation are not practised because of their high risk to flood and low yields. So, agricultural employment is limited in the area. Social condition of the people is weak. 62 per cent people of the area are illiterate.

Table 2. Distribution of Land Ownership and Income.

Table 2 shows that landless and minifundist farmers are numerous in the study area with only 19 per cent farm households who are better-off. While 34 per cent landless farmers own only 1.38 per cent land and 47 per cent small farmers own 43.32 per cent land, 19 per cent farm families (medium and rich together) own 55.30 per cent land and that annual average household income has a positive relation with landholding. Table 2 also shows that 20 per cent and 54 per cent household incomes are lost during regular and severe floods, respectively. Both land and income condition of the people of the area indicate that it is the poor and landless who are more vulnerable to flood disaster because they have small resource base and limited alternative opportunities.

The flood vulnerability of the area is also reflected by the fact that 99 per cent homesteads were affected and 69 per cent houses were vacated during the 1988 flood. Such flood-proneness of the area generates severe impacts on the community both during and after the flood disaster.

Table 3 presents the impacts of regular and severe floods of the area and its population by landholding groups. The table shows that for the entire population during regular as well as severe floods, standing crop is the major area where damages usually occur. In case of severe flood, homestead, livestock /poultry and income from day labour /individual occupation appear as the principal areas where flood damages are widespread. However, it is important to note that in case of landless group, incomes from day labour /individual occupation are as the major areas of damage in both regular and severe floods. Severe flood also inflict significant damages to homestead, livestock /poultry cultivation and standing crops of the area.

The inherent strength of the society and the traditional means of response of the people to withstand the vulnerability of flood were investigated and it was found that people usually take a number of precautionary measures. For flood forecasting, people mostly depend on radio followed by personal communication. People also take flood preparedness measures by early husking of paddy, constructing raised platforms and even transporting

Table 4. Assistance Received by the Farm Families During and After 1988 Flood.

goods to safer places. When disaster comes many have to vacate their houses depending upon severity and find shelter either within the Thana or adjoining Thana; the later is a common practice in the study area.

Table 4 which documents the types of assistance received by the farm families during and after the 1988 flood from the local organisations shows that most of the flood-affected families received assistance from their relatives followed by NGOs and Union Parishad. It appears from Table 4 that the main items of during flood assistance were shelter followed by transport, firewood, storage and counseling whereas cash loan, free food and FFW (Food For Works) were of minor importance. Table 4 also shows that a major portion of farm families received post-flood rehabilitation help from relatives followed by Union Parishad and NGOs. Major type of assistance consisted of building materials followed by FFW and agricultural loans whereas cash help and loans, non-agricultural loan played a minor role in the assistance programme.

Kanchanpur Union is vulnerable to both regular and severe floods and socio-economic condition of the people being dominantly poor adds to the social vulnerability of the area to natural disasters. Nevertheless, a number of local organisations extended to the people a variety of help both during and after flood. Such DM capabilities of local organisations need appraisal and their potentials require proper investigation and analysis in order to develop effective local level flood mitigation policies.

4.0 INSTITUTIONAL ARRANGEMENTS FOR FLOOD DISASTER MANAGEMENT

In order to understand the institutional matrix of different local level organisations involved in flood DM and rural development in the study area, our inquiry led to the identification of two types of institutions - formal and informal. While formal institutions include both government and non-government organisations, informal institutions cover a host of educational, religious, socio-civic, socio-cultural and socio-economic organisations.

Table 5. Formal and Informal Institutions of Kanchanpur Union.

Table 5 shows that there are 2 (two) government formal, 27 formal non-government and 31 informal institutions involved in flood disaster management of Kanchanpur.

Table 6 presents the roles of formal and informal institutions in different phases of flood disaster management of Kanchanpur. While in the pre-flood and crisis phases NGOS except CBT and LIIs including KUP were very active, both government and NGOS made positive contributions to the reconstruction and rehabilitation phase of flood disaster management.

Table 6. Role of Formal and Informal Institutions in Flood Disaster Management of Kanchanpur

The following observations appear important about the roles of formal and informal institutions in the flood disaster management of Kanchanpur:

- a. Formal institutions like KUP and BTA are responsible to carry out overall development of the area. However, except flood time relief operations, post-disaster IFFW (Intensive Food For Works), VGDP (Vulnerable Group Development Programme) or RMP (Road Maintenance Programme) works, these organisations have failed to design appropriate strategies to address the need of the poor who are highly vulnerable to natural disaster like flood.
- b. NGOS (Non-government organisations) like PKB and GBB, on the other hand, have demonstrated a successful mechanism for providing a comprehensive package of financial, technical and motivational support to the target group population (the poor) for qualitative development of their living conditions and thus reducing their vulnerability to flood disaster.
- c. There was a gap between the services provided by the government organisations to the target group population during flood disaster of 1988, and the services actually received by the concerned population. However, in case of NGOs, this gap was nominal what stand to indicate that the NGOS have responded more effectively to flood disaster management.
- d. The Union Parishad (UP) is the lowest local government unit and it is largely represented by the rural elite. Henceforth, it could not guarantee mass people's participation. On the other hand, the NGOS have evolved a participatory type of

development strategy for the rural poor.

- e. Provision for plan-making at the Union level is ensured by law. But the actual authority of approval of those plans lies with the Thana resulting in bureaucracy, mismanagement and underhand dealings, even during the emergency situation like flood of 1988. On the contrary, the NGOS like GBB and PKB, prepare development plans and implement those by the local people under the supportive guidance of these organisations.
- f. The UP depends on national government grants for development funds and it has little capability to mobilise local resources and meet emergency situations like flood disasters. On the contrary, the NGOS like GBB and PKB through creation of group funds have successfully enhanced the capabilities of the target group to withstand the emergency situation like floods.

5. INSTITUTIONAL DEVELOPMENT PROCESS - POTENTIALS AND PROSPECTS

Based on the physical and social vulnerability of the area to flood disaster, nature of response of the people as well as people's choice on potential measures needed for flood DM of the area, 18 actions/interventions were identified. 8 specific institutional inputs were also identified to overcome the observed deficiency of the local institutions in order to make these institutions efficient to ensure the said 18 actions/interventions. Each of the local institution's present capacity/strength to ensure the said 18 actions and corresponding major necessary inputs was investigated. The result has been presented in an efficiency scale - potentials and limitations. The potentials were measured in ordinal scale and the limitations were measured in category scale. A potentials /limitations matrix of local level institutions has been developed to show strength of the major institutions.¹⁹ Table 7 provides a summarised version of the potentials and limitations of local level institutions of Kanchanpur to withstand flood disaster.

Table7. Potentials /Limitations of Local Institutions to Ensure Disaster Management Actions.

Note: Low and moderate potentialities are those where people's response in receiving such inputs were found to be approximately below 25% and 50%, respectively. Structural limitations indicate the limitation of the nature of representation that has been conceived to conduct the function of the institution. Legal limitations are the constitutionally approved jurisdiction of the institution to conduct the specific function.

It can be seen from Table 7 that government institutions like KUP and BTA have low potentials for DM. Only KUP stands to possess moderate potential in this respect. While NGOS like PKB and GBB have both high and moderate levels of potentials, local informal institutions have low potentialities for flood DM of the area. Table 7 also shows that government institutions such as KUP and BTA have managerial problems. Legal and structural problems in case of KUP and structural problems in case of BTA appear significant as well. While NGOS like Proshika (PKB) and Grameen Bank (GBB) have high legal limitations, their motivational limitations also appear significant. CBT has very high level of legal limitations with considerable structural limitations as well. Local informal institutions (LIIs) appear to have no structural limitations but they have considerable managerial limitations.

From the existing organisational structure, nature of operation and functional boundary of the local institutions, the range of potentials and the nature of limitations of these institutions to accommodate the choice of the people on different necessary institutional aspects has been developed (Mustafa²⁰) and Table 8 provides a summary of it.

Table 8. Potentials /Limitations of the Local Institutions to Ensure People's Choice.

The potentials of local institutions for disaster management based on popular choice criteria as presented in Table 8 indicates that whereas formal government institutions such as KUP and BTA have significantly low potentials. NGOS like GBB and PKB appear to have high potentials followed by LIIs which tend to have moderate

potentials. Table 8 also shows that whereas institutions like KUP and BTA including CBT have high structural limitations, other NGOS and LIIs appear to have high legal limitations for flood disaster management programmes.

Table 9. Generalised Evaluation of Potentials/ Limitations of Local Institutions for DM.

The evaluation of the local institutions of Kanchanpur for disaster management may be combined to produce a generalised scenario of the potentials and limitations of these institutions and is presented in Table 9. It appears from Table 9 that the DM potentials of KUP and BTA can be upgraded by enhancing their legal, structural and managerial capabilities. There are needs to improve legal status of NGOs in order to maintain their high potentials for DM. Similarly, there is a need to enhance legal and managerial capabilities of LIIs to increase their disaster management potentials.

Based on the potentials and limitations of local institutions of Kanchanpur, the following three mutually exclusive policies for disaster management and rural development have been formulated:

- a. Reorganisation of BTA to make it an apex organisation for co-ordination and evaluation of technical/financial support provided to UPs and other development agencies for DM&RD.
- b. Reorganisation of Union Parishad (Council) to make it an effective local organisation for DM&RD.
- c. Expansion of the functional boundaries of NGOS like PKB and GBB and internalisation of LIIs for disaster management and rural development.

In the light of present government's reorganisation policy²¹ which places strong emphasis upon the key role of local government for development, it appears appropriate to accord UPs the central position in the whole task of DM&RD at the local level. The suggested policy recommendation is presented in the following manner:

Develop Union Council as a lead local agency for DM&RD as well as institutionalise and integrate the disaster management and rural development activities of NGOs and LIIs through reorganising Thana Administration as a co-ordinating and monitoring agency for DM&RD of the area.

6. SUMMARY AND CONCLUSIONS

This research has investigated into the flood disaster vulnerability of a rural area, ie., Kanchanpur Union of Bangladesh, the responses of the people to this disaster and above all, the institutions involved in disaster management of the area. The study has observed that 2 government formal, 27 non-government formal and 31 informal local institutions are involved in different phases of disaster management of Kanchanpur. Nevertheless, an evaluation of efficiencies - potentials and limitations of these institutions was necessary in order to determine effective disaster management integrated with rural development of the area. Our analysis of local institutional efficiencies indicates that there are needs for legal, structural and managerial reorganisation of Thana administration and Union Councils to make them effective agencies for DM&RD.

Similarly, it has appeared that there is a need to augment legal status of NGOs and legal and managerial capabilities of LIIs in order to enhance the disaster management potentials of these institutions. Based on these possibilities, three mutually exclusive institutional development policies have been formulated for local level disaster management and rural development. Finally, it is recommended that Union Council should be strengthened and developed as a lead agency for local level disaster management and rural development along with the internalisation of NGO and LII disaster management activities as well as reorganisation of Thana administration as a co-ordinating and monitoring unit for disaster management and rural development in Bangladesh.

NOTES AND REFERENCES

1. BARC, 1987 Flood of 1987 and Agricultural Rehabilitation Research Programmes, Dhaka: BARC, p.141.
2. Elahi, K.M., 1989 "Socio-Economic Impacts of Flood and Possibilities of Co-existence with Flood" seminar paper presented at Fifth Bangladesh National Geographical Association Conference, Rajshahi, 2-4 March.
3. After the devastation of 1988 flood international awareness about flood disaster management and control was directed towards a number of flood studies in Bangladesh.

4. For details see, UNDP, 1989. Bangladesh Flood Policy Study. Final Report, Dhaka: Ministry of Irrigation, Water Development and Flood Control.
5. Governments of France and Bangladesh, 1989 Prefeasibility Study for Flood Control in Bangladesh, Dhaka: FEC/BWDB.
6. Rogers, P. and others, 1989 Eastern Water Study: Strategies to Manage Flood and Draught in the Ganges -Brahmaputra Basin, Dhaka: US-AID.
7. JICA, 1989 Report of Survey of Flood Control Planning in Bangladesh, Dhaka: JICA.
8. For details, see Task Force Report, 1991 TFR on Bangladesh Development Strategies-Developing Infrastructures. Vol.3. Dhaka: UPL, pp.379-388.
9. For details see, Adnan, S., 1991 "Floods, People and the Environment", Grassroots, Vol.1, No. 1, July-Sept., pp.27-48.
10. Task Force Report, Vol.3, 1991, op. cit., pp.389-90.
11. Rahman, A. and Ahmed, G.C., 1990 Disaster and Development: A Study in Institution Building, Dhaka: BIDS.
12. Rahman and Ahmed, 1990, op. cit., p.10.
13. Adnan, 1991, op. cit., p.38.
14. For the purpose of administration, the country is divided into six Divisions. Each division is further subdivided into Zilas (Districts). Each Zila consists of several Thanas, Several Unions constitute a Thana.
15. The return period estimated for severe flood in Bangladesh is about 9 years.
16. A high yield variety of paddy shown in mid-October and harvested in mid-May.
17. A variety of paddy shown in March-April and harvested in August
18. A variety of paddy shown in mid-June and harvested in December.
19. For details of the matrix, see Mustafa. G., 1993, Institutional Development Program for Flood Disaster Management and Rural Development in Bangladesh, unpublished M.U.R.P. thesis, Dept of Urban and Regional Planning, BUET, Dhaka, pp.x-29-x-32.
20. For details of the table, see Mustafa, 1993, op. cit, px-33.
21. The present government has commitment to reorganize local government through reintroducing the erstwhile Upazila (Subdistrict) system which will provide a scope to revitalize the grass root institution in the task of disaster management and rural development in Bangladesh.