

SUPPORTING REPORT E: FLOOD AND FLOOD DAMAGE

1. Flood Condition

1.1 General

Flood caused by overflow of river water is called external flood, while that caused due to lack of drainage facilities is called internal flood.

Most of floodings within the study area boundaries derive from the surrounding rivers. However, some built-up areas are susceptible to internal flood on account of insufficient storm water drainage.

Major external floods of the study area were recorded in 1954, 1955, 1958, 1970, 1974, 1980, 1987 and 1988 since water level observation was initiated at Mill Barack in Dhaka in 1945.

During the 1988 flood, a large part of the urban area, which is usually free from floods, was submerged by flooding from the surrounding rivers. Also most parts of Greater Dhaka were submerged during the flood with average depth of 0.94 m and average duration of 22.83 days.

The built-up areas in Greater Dhaka experience the annual internal flood with average depth of 0.38 m and average duration of 0.48 days.

1.2 Flood Survey

The JICA Study Team carried out a sampling questionnaire survey to know the extent and locations of external and internal flooding. The survey covered the entire study area and the number of samples reached 2,700.

People in the Study Area experienced severe floods consecutively in 1987 and 1988. 1987 flood was a mid-size flood with a 10-year return period, while the 1988 was the severest one experienced in the past, the return period of which is estimated to be 70-years. These two floods of different return periods are vivid in the memories of the people. While, a flooding that is likely to occur annually in the study area is termed as "annual flood".

So the JICA study team surveyed the extent and locations of three external floods, namely, annual, 1987 and 1988 flood as well as two internal floods, the annual and worst ones, accounting a total of five (5) cases.

The flood condition is expressed as depth and duration of flooding of a typical residence.

The team interviewed residents to ask the flooded depth and duration of their houses in the above mentioned five (5) floods. If the residences are elevated to avoid floods above normal ground level, then the team measured the difference in elevation between the ground level and house basement level.

For the sake of convenience the study area was divided into 122 Zones based on administrative divisions mostly represented by wards and unions (Refer to Fig. E.1). The study area itself was divided into five (5) Sub-Areas.

The name of those Zones for each of the five (5) Sub-Areas are shown hereunder.

Dhaka Sub-Area (69 Zones) :

1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31 Dhaka, 32 Dhaka, 33 Dhaka, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, Gulshan 57, Cantonment Ward-1, Cantonment Ward-2, Cantonment Ward-3, Sultanganj, Harirampur, Dakshin Khan Cantonment, Uttar Khan, Dakshin Khan Gulshan, Beraid Gulshan, Beraid Demra, Demra and Matuail Dhaka.

Narayanganj Sub-Area (27 Zones) :

31 Nara., 32 Nara., 33 Nara., Matuail Nara., Shyampur, N1, N2, N3, N4, N5, N6, N7, N8, N9, N10, N11, N12, Tarabo, Kachpur, Siddhirganj, Simulpara, Godnail, Kutubpur, Fatullah, Enayetnagar, Kashipur and NO1.

Keraniganj Sub-Area (11 Zone) :

Konda, Teguria, Subhadya, Zinjira, Kalindi, Basta, Sakta, Rohitpur, Taranagar, Kalatia and KO1.

Savar Sub-Area (13 Zones) :

Amin Bazar, Kaundia, Hazratpur, Bhakurta, Tetuljhora, Banagram, Biralia, Savar, Ashulia, Pathalia, Dhamsona, Yearpur and Kasimpur.

Tongi Sub-Area (2 Zone) :

Tongi and Gachha.

Concerning internal flood condition of Zone No. 1 to 60 at Dhaka Sub-Area the survey result of 1987 JICA Study was adopted. The depth and duration of inundation are measured with respect to the ground level.

The internal flood of Zone No. 115 at Tongi Sub-Area was not identified when the Study Team interviewed the flood depth and duration with concerned residences. However, internal flood is recognized at site. Accordingly, the Study Team resurveyed the flood depth and duration in Zone No. 115.

1.3 External Flood

1.3.1 Annual Flood

1) Area

As a result of annual external flood survey, the hectareage of the total flood areas in the annual external flood was found to reach 39,737.1 ha, corresponding to 48.0% of that of the study area.

Out of 122 Zones within the study area, zones that are flood free number 44, accounting for 36.1%.

Those Zones where less than 50% of area was inundated number 42, accounting for 34.4%.

It follows that in 36 Zones (29.5%) the majority of area is inundated during the annual external flood.

Sub-Area wise, the hectareage of flood areas in Dhaka is calculated at 11,802.7 ha, accounting for 42.9% of that of the total area. Similarly, the

hectareage of flood areas in Narayanganj, Keraniganj, Savar and Tongi is calculated at 1,635.2 ha (16.2%), 14,415.8 ha (84.6%), 10,641.0 ha (43.8%) and 1,242.5 ha (33.0%), respectively (Refer to Table E.1 and Fig. E.5).

The flood areas are illustrated in Fig. E.2. Most parts of Keraniganj, south parts of Savar and west parts of Greater Dhaka are inundated in the flood season but villages or residential areas are mostly free from the flood.

2) Depth and Duration

It was found out that there are only few cases of inundation due to annual external floods within the entire boundaries of the study area. However, it does not mean that the study area is virtually free from annual external floods. The depth and duration of inundation under consideration are for residences, which are mostly located in elevated places that are protected from and unaffected by annual external floods (Refer to Table E.2 and Fig. E.5).

1.3.2 1987 Flood

1) Area

The total hectareage of flood areas in the 1987 external flood is calculated at 49,202.6 ha, accounting for 59.5% of that of the study area. The flood area expanded 24% more than that of annual flood.

Those Zones which were not flooded count 35, having a 28.7% share.

Those Zones less than 50% of whose area was flooded count 36, having a 29.5% share.

It follows that in 51 Zones or 41.4%, the majority of their area was flooded in 1987.

Sub-Area wise, the hectareage of flood areas in Dhaka adds up to 16,917.7 ha, accounting for 61.5% of that of the total area. Similarly, the hectareage of flood areas in Narayanganj, Keraniganj, Savar and Tongi is calculated at 2,458.7 ha (24.4%), 16,685.1 ha (97.9%), 11,714.5 ha (48.2%) and 1,426.6 ha (37.9%), respectively (Refer to Table E.1, Fig.E.3 and Fig.E.5).

2) Depth and Duration

In the 1987 external flood the maximum depth and duration of inundation over the entire study area were 1.65 m and 32 days, respectively. Likewise, the corresponding average depth and duration were 0.42 m and 10.53 days, respectively.

The external flood map, Fig.E.3, shows also flooded depth/duration of residences and the depth around residences at nine sections. Villages and residences that are located even in elevated places are affected by the flood as mentioned above. Flooded depth around residences is from 0.5 m to 4 m.

Zones where the average depth of inundation in the 1987 flood exceeded 0.50 m are identified and listed below.

1, 10, 34, 41, 48, 54, 55, 56, Cantonment Ward-1, Cantonment Ward-2, Sultanganj, Dakshin Khan Cantonment, Kashipur and Banagram.

Similarly, Zones where the duration of inundation in the said flood was greater than 14 days are shown below.

1, 10, 41, 54, 56, Cantonment Ward-1, Cantonment Ward-2 and Sultanganj.

Sub-Area wise, the average depth of inundation in Dhaka works out at 0.51 m. Similarly, the average depth of inundation in Narayanganj, Keraniganj, Savar and Tongi works out at 0.30 m, 0.40 m, 0.43 m and 0.43 m, respectively.

The average duration of inundation in Dhaka works out at 12.42 days. Similarly, the average duration of inundation in Narayanganj, Keraniganj, Savar and Tongi works out at 8.26 days, 10.33 days, 10.39 days and 6.70 days respectively (Refer to Table E.2 and Fig. E.5).

1.3.3 1988 Flood

1) Area

In 1988 the most severe external flood in the history of Bangladesh hit the study area with the return period estimated at 70 years. The hectareage of the flood areas

reached 62,046.0 ha, corresponding to 75.0% of that of the study area. The flood area expanded 26% more than that of 1987 flood.

Those Zones that were spared of flooding number 19, corresponding to 15.6%.

Those Zones where less than 50% of their area was flooded number 28, corresponding to 23.0%.

It follows from the above that in 75 Zones or 61.5% the majority of area was inundated in the 1988 flood.

Sub-Area wise, the hectareage of flood areas in Dhaka is calculated at 21,456.0 ha, accounting for 77.9% of that of the total area. Likewise, the hectareage of flood areas in Narayanganj, Keraniganj, Savar and Tongi is calculated at 3,830.1 ha (38.7%), 16,385.1 ha (100.0%), 16,070.5 ha (66.1%) and 3,454.3 ha (91.7%), respectively (Refer to Table E.1, Fig. E.4 and Fig. E.5).

2) Depth and Duration

The historic external flood of 1988 recorded the maximum inundation depth and duration of 3.20 m and 65 days, respectively inside the boundaries of the study area. The average inundation depth and duration in the same flood within the same area reached 1.03 m and 22.07 days, respectively.

The external flood map, Fig. E.4, shows also flooded depth and duration like that of Fig. E.3. Villages and residences are affected by the flood as mentioned above. Flooded depth around residences is from 1 m to 5 m.

Those Zones where an average depth of inundation was witnessed in 1988 with more than 1.30 m are as listed below.

1, Cantonment Ward - 1, Cantonment Ward - 2, Sultanganj, Zinjira, Kalindi, Taranagar, Kaundia, Bhakurta and Ashulia.

Similarly, those Zones where an average duration of inundation was experienced in the same year with more than 27 days are as follows.

1, 10, 35, 38, 39, 54, Cantonment Ward - 1, Cantonment Ward - 2, Sultanganj, Matuail Dhaka and N2.

Sub-Area wise, the average depth of inundation in Dhaka is calculated at 0.94 m. Likewise, the average depth of inundation in Narayanganj, Keraniganj, Savar and Tongi is calculated at 0.79 m, 1.24 m, 1.11 m and 0.80 m, respectively.

The average duration of inundation in Dhaka is calculated at 22.83 days. Likewise, the average duration of inundation in Narayanganj, Keraniganj, Savar and Tongi is calculated at 21.53 days, 23.92 days, 20.15 days and 16.77 days, respectively (Refer to Table E.2 and Fig. E.5).

It is evident from the above that in the following Zones the flood conditions are severer than others in terms of both depth and duration of inundation as well as in terms of susceptibility to flood.

1, 10, 54, Cantonment Ward - 1, Cantonment Ward - 2 and Sultanganj.

1.4 Internal Flood

1.4.1 Annual Flood

1) Area

The total hectareage of internal flood areas is calculated at 1,977.3 ha, occupying 2.4% of the study area.

Zones that are inundated due to internal floods number 69, accounting for 57.5%.

It is noted that internal inundation areas are located mostly in the highly built-up areas in Dhaka, Narayanganj and Tongi.

Sub-Area wise, the hectareage of flood areas in Dhaka works out to 1,013.5 ha, accounting for 3.7% of that of the total area. In the same way, the hectareage of flood areas in Narayanganj and Tongi works out to 514.2 ha (5.1%) and 449.6 ha (11.9%), respectively. Keraniganj and Savar have no internal flood areas (Refer to Table E.1, Fig. E.6 and Fig. E.7).

2) Depth and Duration

It was found out as a result of the sampling questionnaire survey that the maximum depth and duration of inundation within the boundaries of the study area in the annual internal flood are 0.61 m and 4 days, respectively. Also, the average depth and duration of inundation in the same flood in the said area are calculated at 0.38 m and 0.48 days, respectively.

Following Zones were found to be affected by annual internal flood.

10, 11, 12, 13, 15, 19, 56, Cantonment Ward - 1, N3, N4 and Siddhirganj.

Sub-Area wise, the average depth of inundation in Dhaka is calculated at 0.38 m. Likewise, the average inundation depth in Narayanganj and Tongi is calculated at 0.07 m and 0.19 m respectively.

The average duration of inundation in Dhaka is calculated at 0.48 day. Likewise, the average duration of inundation in Narayanganj and Tongi is calculated at 0.41 day and 0.44 day, respectively. Both the depth and duration of inundation were reported to be zero for the two (2) Areas of Keraniganj and Savar (Refer to Table E.3 and Fig. E.7).

1.4.2 Worst Flood

1) Area

The total hectareage of internal flood areas is calculated at 2,014.8 ha, occupying 2.4% of the study area.

Zones that are inundated due to worst floods number 69, accounting for 57.5%.

It is noticed that internal inundation areas are located mostly in the highly built-up areas of Dhaka, Narayanganj and Tongi.

Sub-Area wise, the hectareage of flood areas in Dhaka works out to 1,051.0 ha, accounting for 3.8% of that of the total area. In the same way, the hectareage of flood areas in Narayanganj and Tongi works out to 514.2 ha (5.1%) and 449.6 ha (11.9%), respectively. Keraniganj and Savar have no internal flood areas (Refer to Table E.1, Fig. E.6 and Fig. E.7).

2) Depth and Duration

The maximum depth and duration of inundation within the study area in the worst internal flood in the past years were revealed to reach 0.91 m and 7 days, respectively based on survey results. On the other hand, the average depth and duration of inundation in the same area by same flood are calculated at 0.55 m and 1.53 days, respectively.

Those Zones with an average depth of inundation more than 0.7 m are as follows.

6, 22, 29, 37, 42, 43 and 48.

Also, those Zones having greater average durations of inundation with more than 2.5 days are listed below.

19, 38, 55, Cantonment Ward-1, Siddhirganj, Simulpara, Godnail and Kutubpur.

Sub-Area wise, the average depth of inundation in Dhaka works out at 0.58 m. Similarly, the average inundation depth in Narayanganj and Tongi works out at 0.25 m and 0.41 m, respectively.

The average duration of inundation in Dhaka works out at 1.38 day. Similarly, the average inundation duration in Narayanganj and Tongi works out at 3.08 days and 1.89 days, respectively. Both the depth and duration of inundation were reported to be zero for the two (2) Areas of Keraniganj and Savar (Refer to Table E.3 and Fig. E.7).

2. Flood Damage

2.1 General

Two kinds of flood damage surveys were conducted. One was intended to know the extent of flood damages over the study area in the most recent consecutive big floods of 1987 and 1988 by means of relevant data and information collection from the administrative and other organs concerned. The other was the sampling questionnaire

survey conducted over the entire study area and was intended to establish the relationships between the depths/durations of inundation and flood damages.

More specifically, the second survey was aimed to establish the relationships between the depths/durations of inundation and flood damage ratios for houses, shops, factories and institutions, to establish the relationships between the depths/durations of inundation and income/profit losses for houses, shops and factories, and also to establish the relationships between the depths/durations of inundation and flood damages to agricultural crops. Those relationships were determined for 1987 and 1988 external floods. The relationships for annual external flood as well as for annual and worst internal floods could not be formulated due to virtual non-existence of flood damages in time of those floods.

Those relationships were eventually combined with the actual flood conditions, i.e. depths/durations of inundation over the study area, unit values of properties and the number of properties in the flood areas to arrive at flood damage estimates.

Flood damage surveys were conducted for the ultimate purpose of the estimation of benefits to be realized in case the project is implemented.

2.2 Flood Damage Surveys

2.2.1 Flood Damage Records of 1987 and 1988 Floods

Data and information of flood damages to various properties over the study area in 1987 and 1988 floods were collected by visiting the Deputy Commissioner, Dhaka Region and Upazila offices of Narayanganj, Keraniganj, Savar and Tongi.

Based on the official data gathered in this way, the results of the analysis on the dimension and amount of flood damage by the two floods have been produced (Refer to Table E.4 and E.5).

In the 1987 flood the number of affected people reached 946,651, of which 68 people died of direct causes. The number of damaged homesteads and the area of damaged crops came to 95,009 and 19,740 ha, respectively. The number of damaged educational facilities and the length of damaged roads were 690 and 1,261 km, respectively. Livestock deaths counted 2,968.

In terms of the amount of flood damages houses topped others with Tk 135.5 million, followed by crops with Tk 125.0 million. They are further followed by roads/bridges/culverts with Tk 58.2 million, educational facilities with Tk 16.3 million and livestock with Tk 12.2 million. The damages to infrastructures such as power supply, water supply, gas supply and telecommunication facilities were reported to be not very substantial. Thus, so far as the amount of reported flood damages is concerned it adds up to Tk 347.2 million.

As much as 2,233,418 people were reported to have been affected by the 1988 flood. Out of them 149 people died of direct causes. The number of damaged homesteads and the area of damaged crops totaled 268,042 and 29,377 ha, respectively. The number of damaged educational facilities and the length of damaged roads reached 878 and 2,106 km, respectively. 2,356 livestock died. Moreover, substantial damages were inflicted on such infrastructures as power supply, water supply, gas supply, telecommunication and transportation facilities.

In terms of the amount of flood damages houses led others with Tk 385.7 million, followed by crops with Tk 178.3 million. They are further followed by roads/bridges/culverts with Tk 97.1 million, educational facilities with Tk 20.7 million and livestock with Tk 9.8 million. The rehabilitation cost of above-mentioned infrastructures summed up to Tk 89.5 million. Thus, the total amount of the reported flood damages of 1988 flood comes to Tk 781.2 million.

2.2.2 Sampling Questionnaire Survey

The sampling questionnaire survey on flood damages was carried out in order to formulate the relationships between inundation depths/durations and flood damages.

The study area was divided into five (5) areas, i.e. the Area of Dhaka, Narayanganj, Keraniganj, Savar and Tongi. To each area 500 samples were allotted. Thus, the total number of samples comes to 2,500. Five hundred samples consist of 300 samples for houses, 100 samples for shops/factories and 100 samples for farm houses. Three hundred samples for houses are further broken down to 100 samples each for higher, medium and lower income houses. One hundred samples for shops/factories are further broken down to 50 samples each for shops and factories.

The questionnaire for houses contains questions concerning the depth/duration of inundation, the values of building(s) and household effects, damage amount of building(s) and household effects, the number of households, the number of household

members, household income, income losses due to flood, etc. The questionnaire for shops/factories contains questions concerning depth/duration of inundation, the values of building(s), equipment & machinery and inventory, damage amount of building(s), equipment & machinery and inventory, profit, the number of work days, the loss of work days due to flood, etc. The questionnaire for farm houses contains questions concerning inundation depth/duration of the farm house, the values of building(s) and household effects, damage amount of building(s) and household effects, inundation depth/duration of farm land, agricultural income, cropped area and damage amount by type of crops, etc. Questions related to inundation depth/duration, damages to properties and income losses were asked in connection with each of annual, 1987 and 1988 external floods as well as in connection with each of annual and worst internal floods.

Using the data collected as a result of the flood damage survey for houses, the JICA Study Team formulated the relationships between inundation depth/duration and damage ratios of building(s) and household effects as well as the relationships between inundation depth/duration and income loss ratio due to flood. Also, by using the data of the flood damage survey for shops/factories the Team formulated the relationships between inundation depth/duration and damage ratios of building(s), equipment & machinery and inventory as well as the relationships between inundation depth/duration and income loss ratio due to flood. Further, by using the data of the flood damage survey for farm houses the Team formulated the relationships between inundation depth/duration of the farm house and damage ratios of building(s) and household effects as well as the relationships between inundation depth/duration of farm land and agricultural income loss ratio due to flood. All the above-mentioned relationships were formulated in connection with each of 1987 and 1988 external floods.

2.3 Methodology for Flood Damage Estimation

The methodology adopted for the estimation of flood damages is explained hereunder (Refer to Fig. E.8 and E.9).

2.3.1 Preparation of Flood Conditions Data

Data on the flood area by zone for each of annual, 1987 and 1988 external floods as well as for each of annual and worst internal floods were prepared (Refer to Table E.1).

Also, data on the average depth/duration of inundation by zone for each of annual, 1987 and 1988 external floods as well as for each of annual and worst internal floods

were prepared. (Refer to Table E.2 and E.3.) Both data are primary prerequisites for the estimation of flood damages.

2.3.2 Formulation of Relations between Flood Conditions and Flood Damage Ratios

Based on the results of the sampling flood damage survey, the JICA Study Team established the regressional relationships between depth/duration of inundation and flood damage ratios of properties along with the regressional relationships between depth/duration of inundation and income loss ratio due to flood.

Those relationships were separately established for houses, shops, factories and farms. Those relationships were also separately established for 1987-scale and 1988-scale external floods (Refer to Table E.10 and E.11).

The relationships for farm houses were eventually not used firstly because the correlations between inundation depths/durations of farm houses and damage ratios were not good enough, and secondly because farm houses could not be properly separated from income class-wise ordinary houses. Also, the relationships for annual external flood as well as for internal floods could not be formulated due to virtual no reporting by respondents of direct damages by those floods.

2.3.3 Unit Prices and Number of Properties

In addition to the above-mentioned data, data on average unit prices of houses and their household effects by income class, and on average unit prices of shops, factories and their equipment, machinery and inventories under the present circumstances are required. The average unit price of institutions is estimated at 4.2 times that of shops. At the same time, estimated average unit prices of the above properties in the target year of 2010 are required. Also, data on average income/profit of households by income class, shops and factories, and on average productivity per cropped area, average cropped area per farm house in 1990 and 2010 are needed.

The above-mentioned data for 1990 are presented in Table E.12. In 2010 the values are estimated to increase by 29% based on the estimated growth of per capita GDP.

Besides, the number of houses by income class, shops, factories, institutions and farm houses for each flood area in 120 zones in both 1990 and 2010 are provided. The number is different for 1987-scale and 1988-scale external floods (Refer to Table E.7 to Table E.9).

2.3.4 Calculation of Flood Damages by Return Period

Combining inundation depths/durations, relationships between inundation depths/durations and flood damage ratios, unit prices of properties and the number of properties, combining inundation depths/durations, relationships between inundation depths/durations and income loss ratios, average income/profit of properties and the number of properties, and also combining inundation depths/durations of farms, relationships between inundation depths/durations of farms and damage ratios to agricultural crops, productivity per cropped area, the number of farm houses and average cropped area per farm house, one can work out direct flood damages to properties, income losses due to flood and direct flood damages to agricultural crops.

Eventually, those damages and losses are summed up for the entire study area for each of 1987-scale and 1988-scale external floods, and for each of the year 1990 and 2010.

The properties treated so far were houses, shops, factories, institutions and agricultural crops. There are infrastructures that are damageable in floods such as roads, bridges, power supply, water supply, gas supply, telecommunication and transport facilities. Also, there are damages to traffic in the form of extra hours needed to reach destinations and extra consumption of oil due to slower operating speed in time of flood. Such damages are assumed to combinedly reach 20% of the entire damages to the already treated properties.

Regarding internal floods, regressional relationships between depth/duration of inundation and flood damage ratios of properties as well as between depth/duration of inundation and income loss ratio could not be established. Because in the questionnaire survey the interviewers virtually could not elicit specific amount of damages inflicted upon their properties by the past internal floods. It seems that this happened partly due to the structuring of the related questions.

Fortunately, JICA conducted the "Study on Storm Water Drainage System Improvement Project in Dhaka City" in 1987. In this study internal flood damages in the Dhaka Area were estimated. Based on it the JICA Study Team worked out an updated estimation geared to its needs as shown in Table E.18. We do not have internal flood damage data for the Areas other than Dhaka.

2.3.5 Estimation of Average Annual Flood Damage

The return period of 1987-scale and 1988-scale floods is estimated at 10 and 70 years, respectively. The return period of the worst internal flood is estimated at 10 years. In order to estimate average annual flood damages one formulates equations in which the return period is an independent variable and flood damages is a dependent variable. That is to say, flood damages is assumed to be the function of the return period. If the return period is between one year and ten years, it is assumed that the function will take a convex logarithmic curve based on the similar relationships between the return period and rainfall intensity. If the return period is equal to or beyond ten years, the function is assumed to take a straight line.

Based on the data worked out in 2.3.4, equations expressing the relationships between the return period and flood damages for 1990 and 2010 are created. Those equations are eventually converted into probability density functions and the latter are integrated between one and a hundred year return periods. In this way, the average annual flood damages over the study area for the present (1990) and the target year (2010) are determined (Refer to Table E.19 and Fig.E.10).

2.4 Affected Population

The total population within the study area is estimated at 6,534,316 as of 1990. Supposing a 1987 size external flood had hit the study area in 1990, affected population would have reached 2,403,055, accounting for 36.8% of the total population. This estimation is based on the outcomes of the sampling questionnaire survey on flood damages coupled with population estimates.

Likewise, if a 1988 size external flood had hit the study area in 1990, as much as 3,751,456 people would have been affected. They correspond to 57.4% of the entire population. Also, an internal flood would have affected 664,736 people, accounting for 10.2%.

Area wise, a 1987 size external flood would have affected 1,459,061 people or 32.6% in Dhaka. Similarly, the flood would have affected 277,144 people (25.0%), 430,943 people (97.5%), 182,597 people (49.9%) and 53,310 people (37.3%) in Narayanganj, Keraniganj, Savar and Tongi, respectively.

A 1988 size external flood would have affected 2,432,305 people or 54.4% in Dhaka. Similarly, the flood would have affected 484,934 people (43.7%), 441,788 people

(100.0%), 261,427 people (71.4%) and 131,002 people (91.6%) in Narayanganj, Keraniganj, Savar and Tongi, respectively.

Further, an internal flood would have affected 595,482 people or 13.3% in Dhaka. Similarly, the flood would have affected 52,020 people (4.7%) and 17,234 people (12.1%) in Narayanganj and Tongi, respectively. The two (2) areas of Keraniganj and Savar would not have been affected.

It is estimated that 5,700,984 people out of the population of 13,431,147 would be affected if a 1987 size external flood hit the study area in 2010 in the event the flood protection and drainage project were not implemented up to the same year. They account for 42.4 % of the total population and 2.37 times greater than those in 1990.

Likewise, 8,532,717 people or 63.5 % would be affected if a 1988 size external flood hit the study area in 2010. They are 2.27 times greater than those in 1990.

It is to be noted that the ratio of affected population is estimated to rise from 36.8 % in 1990 to 42.4 % in 2010 under a 1987 size external flood, and from 57.4 % in 1990 to 63.5 % in 2010 under a 1988 size external flood.

Also, 1,066,390 people or 7.9 % would be affected if an internal flood hit the study area in 2010. They are 1.60 times greater than those in 1990.

Area wise, a 1987 size external flood would affect 3,668,674 people or 42.7 % in Dhaka. Similarly, the flood would affect 665,528 people (26.0 %), 791,452 people (97.4%), 333,105 people (41.0 %), and 242,226 people (36.8 %) in Narayanganj, Keraniganj, Savar and Tongi, respectively.

A 1988 size external flood would affect 5,483,959 people or 63.8 % in Dhaka. Similarly, the flood would affect 1,083,529 people (42.4 %), 813,191 people (100 %), 549,059 people (67.6 %) and 602,978 people (91.5 %) in Narayanganj, Keraniganj, Savar and Tongi, respectively.

Further, an internal flood would affect 856,965 people or 10.0 % in Dhaka. Similarly, the flood would affect 129,402 people (5.1 %) and 80,022 people (12.1 %) in Narayanganj and Tongi, respectively. The two areas of Keraniganj and Savar would not be affected (refer to Table E.6).

2.5 Estimated Flood Damages

In accordance with the procedures described in the preceding sections flood damages were estimated for the base year of 1990 and the target year of 2010. Finally, using the probability density functions average annual flood damages for 1990 and 2010 were estimated so that they may be used for the estimation of project benefits.

2.5.1 1987-Scale and 1988-Scale Flood Damages in 1990

Supposing a 1987-scale flood had hit the study area in 1990, residential buildings would have suffered flood damages amounting to Tk 2,392.5 million. Flood damages to household effects would have reached Tk 137.3 million. Income losses due to inability to work because of flooding would have come to Tk 531.1 million. Commercial establishments would have lost profit amounting to Tk 6.7 million. Further, flood damages to crops would have reached Tk 816.8 million. In estimating crop damages, value added ratio was assumed to be 86.5% (Refer to Table E.13).

Thus, the combined flood damages to properties mentioned above would have reached 3,884.4 million, of which flood damages to residential buildings account for 61.6%. Likewise, crop damages and income losses account for 21.0% and 13.7%, respectively.

Area wise, total flood damages in the Area of Dhaka would have been Tk 2,388.7 million accounting for 61.5%. Similarly, total flood damages in the Areas of Narayanganj, Keraniganj, Savar and Tongi would have been Tk 354.4 million (9.1%), Tk 685.8 million (17.7%), Tk 354.2 million (9.1%) and Tk 101.3 million (2.6%), respectively.

(If one adds flood damages to infrastructures and traffic, the total flood damages over the study area would have summed up to Tk 4,661.3 million.)

Supposing a 1988-scale flood had hit the study area in 1990, damages to residential buildings and household effects would have reached Tk 6,836.0 million and Tk 2,928.7 million, respectively. Income losses would have amounted to Tk 868.2 million. As regards commercial establishments, damages to buildings and equipment & inventories would have reached Tk 150.7 million and Tk 352.1 million, respectively. Profit losses would have amounted to Tk 31.4 million. Likewise, for industrial establishments damages to buildings and equipment & inventories would have reached Tk 189.5 million and Tk 629.6 million, respectively. Profit losses would have

amounted to Tk 99.8 million. Institutions would have suffered damages valued at Tk 603.4 million. Crop damages would have added up to Tk 966.4 million (Refer to Table E.14).

The combined damages and losses mentioned above come to Tk 13,655.8 million, of which damages to residential buildings account for 50.1%, damages to household effects 21.4% and crop damages 7.1%.

Area wise, the Area of Dhaka would have sustained the damages amounting to Tk 8,210.9 million accounting for 60.1%. Similarly, the Areas of Narayanganj, Keraniganj, Savar and Tongi would have sustained the damages amounting to Tk 1,811.4 million (13.3%), Tk 1,910.9 million (14.0%), Tk 1,011.6 million (7.4%) and Tk 711.0 million (5.2%), respectively.

(If one adds the damages to infrastructures and traffic, damages would have summed up to Tk 16,387.0 million.)

The relationships between return periods and flood damages are visualized in Fig.E.11.

2.5.2 1987-Scale and 1988-Scale Flood Damages in 2010

Number of properties in a zone is assumed to increase in proportion to the growth of population in the same zone. At the same time, the average values and income/profit of properties are assumed to increase in proportion to the growth of per capita GDP. Because of these two factors, flood damage potential in a zone will rise in the future.

The following flood damages would be brought on to the study area if flood protection and storm water drainage projects were not implemented up to 2010.

Supposing a 1987-scale flood hit the study area in 2010, residential buildings would suffer the damages amounting to Tk 8,041.4 million. Likewise, damages to household effects and income losses would reach Tk 426.6 million and Tk 1,738.2 million, respectively. Commercial establishments would lose profit totaling Tk 19.2 million. Damages to crops would add up to Tk 339.9 million (Refer to Table E.15).

Thus, the combined flood damages mentioned above work out at Tk 10,563.3 million. Out of them, damages to residential buildings account for 76.1%. Also, income losses and damages to household effects account for 4.0% and 16.5%, respectively.

Area wise, damages in the Area of Dhaka would reach Tk 7,008.7 million accounting for 66.3%. Similarly, damages in the Areas of Narayanganj, Keraniganj, Savar and Tongi would reach Tk 909.9 million (8.6%), Tk 1,497.5 million (14.2%), Tk 678.2 million (6.4%) and Tk 471.0 million (4.5%), respectively.

(If damages to infrastructures and traffic are taken into consideration and added together, the damages will sum up to Tk 12,676.0 million.)

Supposing a 1988-scale flood hit the study area in 2010, damages to residential buildings would reach Tk 20,838.1 million. Likewise, damages to household effects and income losses would reach Tk 8,914.7 million and Tk 2,652.7 million, respectively. As regards commercial establishments, damages to buildings and equipment & inventories would amount to Tk 411.3 million and Tk 958.5 million, respectively. Also, losses of profit would amount to Tk 85.6 million. Regarding industrial establishments, damages to buildings, damages to equipment & inventories and profit losses would come to Tk 712.1 million, Tk 2,373.0 million and Tk 377.8 million, respectively. Damages to institutional buildings would be valued at Tk 1,935.2 million. Crops would suffer damages corresponding to Tk 401.7 million (Refer to Table E.16).

The combined above damages work out at Tk 39,660.7 million. Damages to residential buildings account for 52.5%. Similarly, damages to household effects and income losses account for 22.5% and 6.7%, respectively.

Area wise, damages in the Area of Dhaka would reach Tk 23,613.1 million accounting for 59.5%. In the same way, damages in the Areas of Narayanganj, Keraniganj, Savar and Tongi would reach Tk 4,948.8 million (12.5%), Tk 4,400.8 million (11.1%), Tk 2,519.9 million (6.4%) and Tk 4,178.0 million (10.5%), respectively.

(When damages to infrastructures and traffic are taken into account and added together, total damages will eventually reach Tk 47,592.8 million.)

The relationships between return periods and flood damages are visualized in Fig.E.11.

2.5.3 Internal Flood Damages

Total damages due to annual internal floods over the Dhaka Area are estimated at Tk 312.4 million in 1990. They are broken down to Tk 165.0 million for houses accounting for 52.8%, Tk 75.9 million (24.3%) for public properties, Tk 44.6 million

(14.3%) for income losses, Tk 24.7 million (7.9%) for traffic damages and Tk 2.2 million (0.7%) for household articles. Tk 226.4 million or 72.5% belongs to Greater Dhaka East and the balance of Tk 86.0 million or 27.5% to Greater Dhaka West.

Similarly, total damages due to the worst internal floods over the Dhaka Area are estimated at Tk 663.9 million in 1990. They are broken down to Tk 345.6 million for houses accounting for 52.1%, Tk 187.1 million (28.2%) for public properties, Tk 87.1 million (13.1%) for income losses, Tk 24.3 million (3.7%) for traffic damages and Tk 19.8 million (3.0%) for household articles. Tk 468.4 million or 70.6% belongs to Greater Dhaka East and the balance of Tk 195.5 million or 29.4% to Greater Dhaka West.

In the target year of 2010 total annual internal flood damages over the Dhaka Area are projected to increase 1.92 times to Tk 600.1 million. Of them, houses will account for 41.1% with Tk 246.7 million, public properties 28.3% with Tk 170.0 million, income losses 20.8% with Tk 124.7 million, traffic damages 8.9% with Tk 53.6 million and household articles 0.8% with Tk 4.8 million. Greater Dhaka East will have the major share of 74.1% with Tk 444.6 million, while Greater Dhaka West will have the remaining share of 25.9% with Tk 155.5 million.

Likewise, in 2010 total worst internal flood damages over the Dhaka Area are projected to increase 1.87 times to Tk 1,239.4 million. Of them, houses will account for 38.9% with Tk 482.5 million, public properties 34.0% with Tk 420.9 million, income losses 19.2% with Tk 238.2 million, traffic damages 4.3% with Tk 53.2 million and household articles 3.6% with Tk 44.6 million. Greater Dhaka East will have the major share of 74.4% with Tk 922.4 million, while Greater Dhaka West will have the remaining share of 25.6% with Tk 317.0 million.

Internal flood damages for the Areas other than Dhaka are not immediately available.

The relationships between return periods and flood damages are graphically presented in Fig.E.11.

2.5.4 Average Annual Flood Damages

1) External Floods

The return period of 1987 and 1988 external floods is estimated at ten and 70 years, respectively. Flood damages in annual external flood were found out to be not very substantial.

Based on the results of the preceding sections average annual flood damage potentials as of 1990 work out at Tk 1,707.8 million (Refer to Table E.17).

Area wise, average annual flood damage potentials in the Area of Dhaka are calculated at Tk 1,045.9 million corresponding to 61.2% of the total potentials. Similarly, average annual flood damage potentials in the Areas of Narayanganj, Keraniganj, Savar and Tongi are calculated at Tk 169.0 million (9.9%), Tk 289.8 million (17.0%), Tk 150.3 million (8.8%) and Tk 52.8 million (3.1%), respectively.

If no countermeasures were taken to protect the study area from external floods and internal floods by lack of drainage up to the year 2010, then average annual flood damage potentials would grow 2.75 times to Tk 4,704.1 million in the same year.

Area wise, average annual flood damage potentials in the Area of Dhaka would be Tk 3,057.5 million accounting for 65.0%. Likewise, average annual flood damage potentials in the Areas of Narayanganj, Keraniganj, Savar and Tongi would be Tk 441.0 million (9.4%), Tk 638.2 million (13.6%), Tk 301.4 million (6.4%) and Tk 266.0 million (5.7%), respectively.

If damages to infrastructures and traffic are considered and added together, average annual flood damage potentials over the study area will sum up to Tk 2,049.4 million in 1990 and Tk 5,644.9 million in 2010.

2) Internal Floods

The return period of the worst internal floods is estimated at 10 years.

Average annual flood damage potentials in the Dhaka Area as of 1990 work out at Tk 383.3 million. Out of them, Greater Dhaka East accounts for 71.5% with

Tk 274.1 million and Greater Dhaka West covers the remaining 28.5% with Tk 109.2 million.

Average annual flood damage potentials in the Dhaka Area are projected to increase 1.89 times to Tk 726.1 million in the target year of 2010. They are broken down to Tk 539.2 million (74.3%) for Greater Dhaka East and Tk 186.9 million (25.7%) for Greater Dhaka West.

Flood damages for the Areas other than Dhaka are not immediately available.

Table E.1 (1) Flood Area

Zone No.	Name of Zone	Area (Ha.)	Flood Area (Unit : Ha.)						Ratio of Flood Area to Zone Area (%)					
			External Flood			Internal Flood			External Flood			Internal Flood		
			Annual Flood	1987 Flood	1988 Flood	Annual Flood	1987 Flood	Worst Flood	Annual Flood	1987 Flood	1988 Flood	Annual Flood	1987 Flood	Worst Flood
1		398.2	68.1	103.4	126.9	1.5	1.5	17.1	26.0	31.9	0.4	0.4		
2		319.2	226.7	278.3	291.6	15.0	15.0	71.0	87.2	91.4	4.7	4.7		
3		151.5	92.6	112.0	118.5	10.0	10.0	61.1	73.9	78.2	6.6	6.6		
4		168.9	29.9	35.9	41.9	15.0	15.0	17.7	21.3	24.8	8.9	8.9		
5		336.1	208.8	290.4	311.4	32.5	32.5	62.1	86.4	92.6	9.7	9.7		
6		183.4	39.4	71.0	118.3	35.0	35.0	21.5	38.7	64.5	19.1	19.1		
7		239.4	0.0	0.0	2.7	12.5	12.5	0.0	0.0	1.1	5.2	5.2		
8		82.6	0.0	0.0	0.0	27.3	27.3	0.0	0.0	0.0	33.1	33.1		
9		108.8	0.0	0.0	0.0	15.0	15.0	0.0	0.0	0.0	13.8	13.8		
10		195.5	60.0	111.5	135.5	12.5	12.5	30.7	57.1	69.3	6.4	6.4		
11		71.3	14.3	20.4	27.5	7.5	7.5	20.0	28.6	38.6	10.5	10.5		
12		68.5	19.8	44.1	51.8	2.5	2.5	28.9	64.4	75.6	3.6	3.6		
13		61.3	0.0	0.0	2.2	32.5	32.5	0.0	0.0	3.6	53.0	53.0		
14		66.1	0.0	0.0	0.0	25.0	25.0	0.0	0.0	0.0	37.8	37.8		
15		29.0	0.0	0.0	0.0	10.0	10.0	0.0	0.0	0.0	34.5	34.5		
16		45.5	5.3	14.0	22.8	0.0	0.0	11.5	30.8	50.0	0.0	0.0		
17		27.0	1.9	23.1	19.3	0.0	0.0	7.1	85.7	71.4	0.0	0.0		
18		32.2	0.0	0.0	0.0	5.0	5.0	0.0	0.0	0.0	15.5	15.5		
19		41.5	0.0	0.0	5.8	15.0	15.0	0.0	0.0	13.9	36.1	36.1		
20		46.7	0.0	0.0	0.0	27.5	27.5	0.0	0.0	0.0	58.9	58.9		
21		32.6	0.0	0.0	0.0	17.5	17.5	0.0	0.0	0.0	53.7	53.7		
22		16.9	0.0	0.0	0.0	2.5	2.5	0.0	0.0	0.0	14.8	14.8		
23		22.2	0.0	0.0	0.0	2.5	2.5	0.0	0.0	0.0	11.3	11.3		
24		25.4	0.0	0.0	7.8	0.5	0.5	0.0	0.0	30.8	2.0	2.0		
25		53.2	0.0	0.0	16.9	2.5	2.5	0.0	0.0	31.8	4.7	4.7		
26		43.1	0.0	0.0	0.0	12.5	12.5	0.0	0.0	0.0	29.0	29.0		
27		23.0	0.0	0.0	0.0	12.5	12.5	0.0	0.0	0.0	54.3	54.3		
28		62.9	0.0	0.0	0.0	45.0	45.0	0.0	0.0	0.0	71.5	71.5		
29		87.9	0.0	0.0	29.3	32.5	32.5	0.0	0.0	33.3	37.0	37.0		
30		73.3	0.0	0.0	45.9	55.0	55.0	0.0	0.0	62.7	75.0	75.0		
Dha31	31 Dhaka	120.0	0.0	0.0	120.0	27.5	27.5	0.0	0.0	100.0	22.9	22.9		
Dha32	32 Dhaka	19.0	0.0	0.0	19.0	1.0	1.0	0.0	0.0	100.0	5.3	5.3		
Dha33	33 Dhaka	83.4	0.0	0.0	81.7	2.5	2.5	0.0	0.0	98.0	3.0	3.0		
34		201.1	73.5	123.8	180.5	1.0	1.0	36.5	61.5	89.7	0.5	0.5		
35		102.8	0.0	0.0	42.8	20.0	20.0	0.0	0.0	41.7	19.5	19.5		
36		190.2	27.3	41.0	172.0	0.0	0.0	14.4	21.6	90.4	0.0	0.0		
37		76.2	0.0	0.0	64.3	15.0	15.0	0.0	0.0	84.4	19.7	19.7		
38		105.2	6.4	15.9	105.2	0.0	0.0	6.1	15.2	100.0	0.0	0.0		
39		185.4	124.1	129.5	185.4	0.0	0.0	66.9	69.9	100.0	0.0	0.0		
40		438.5	148.8	229.7	325.0	12.5	12.5	38.9	52.4	74.1	2.9	2.9		
41		95.5	0.0	0.0	71.1	37.5	37.5	0.0	0.0	74.5	39.3	39.3		

Table E.1 (2) Flood Area

Zone No.	Name of Zone	Area (Ha.)	Flood Area (Unit : Ha.)						Ratio of Flood Area to Zone Area (%)					
			External Flood			Internal Flood			External Flood			Internal Flood		
			Annual Flood	1987 Flood	1988 Flood	Annual Flood	1987 Flood	1988 Flood	Annual Flood	1987 Flood	1988 Flood	Annual Flood	1987 Flood	1988 Flood
42		80.2	0.0	0.0	31.7	17.5	17.5	0.0	0.0	39.5	21.8	21.8	21.8	
43		127.8	0.0	0.0	30.1	47.5	47.5	0.0	0.0	23.6	37.2	37.2	37.2	
44		229.7	0.0	0.0	0.0	17.3	37.3	0.0	0.0	0.0	7.5	7.5	16.2	
45		193.8	0.0	0.0	0.0	55.0	55.0	0.0	0.0	0.0	28.4	28.4	28.4	
46		161.2	0.0	0.0	0.0	7.5	7.5	0.0	0.0	0.0	4.7	4.7	4.7	
47		156.0	11.2	26.9	48.3	15.0	15.0	15.0	15.0	7.2	17.3	17.3	9.6	
48		326.4	77.8	99.5	140.3	0.0	0.0	0.0	0.0	23.8	30.5	30.5	0.0	
49		131.4	9.6	9.6	19.2	7.5	7.5	7.5	7.5	7.3	5.7	5.7	5.7	
50		92.7	0.0	1.5	4.4	17.5	20.0	20.0	20.0	0.0	1.6	1.6	21.6	
51		671.8	114.1	210.4	480.4	0.0	0.0	0.0	0.0	17.0	31.3	31.3	0.0	
52		186.2	67.5	128.2	186.2	0.0	0.0	0.0	0.0	36.2	68.8	68.8	0.0	
53		193.4	57.0	95.5	121.5	0.0	0.0	0.0	0.0	29.5	49.4	49.4	0.0	
54		1,630.0	747.1	1,048.4	1,194.1	5.0	5.0	5.0	5.0	45.8	64.3	73.3	0.3	
55		825.0	305.6	490.5	533.5	32.5	32.5	32.5	32.5	37.0	59.5	67.1	3.9	
56		1,180.8	377.9	798.9	1,181.0	52.5	52.5	52.5	52.5	32.0	67.7	95.8	4.4	
57	Gulshan 57	2,145.0	1,510.8	1,959.3	2,145.0	0.0	0.0	0.0	0.0	70.4	91.3	100.0	0.0	
58	Cantonment Ward-1	1,492.5	153.2	466.9	1,030.4	7.5	7.5	7.5	7.5	10.3	31.2	69.0	0.5	
59	Cantonment Ward-2	565.0	284.4	481.0	565.0	0.0	0.0	0.0	0.0	50.3	76.3	100.0	0.0	
60	Cantonment Ward-3	1,117.5	228.9	568.2	1,015.9	0.0	0.0	0.0	0.0	38.4	50.8	90.9	0.0	
61	Sultanganj	402.6	224.0	359.9	402.6	0.0	0.0	0.0	0.0	55.6	89.4	100.0	0.0	
62	Hairampur	2,017.5	1,470.7	1,814.1	2,007.6	0.0	0.0	0.0	0.0	72.9	89.9	99.5	0.0	
63	Dakshin Khan Cantonment	775.0	93.8	290.0	496.3	115.0	115.0	115.0	115.0	12.1	37.4	64.0	14.8	
64	Uttar Khan	1,737.5	849.8	1,460.3	1,561.7	0.0	0.0	0.0	0.0	48.9	84.0	89.9	0.0	
65	Dakshin Khan Gulshan	1,447.5	877.8	1,245.4	1,352.8	0.0	0.0	0.0	0.0	60.6	86.0	93.5	0.0	
66	Beraid Gulshan	2,023.5	1,777.0	1,990.4	2,023.5	0.0	0.0	0.0	0.0	87.8	98.4	100.0	0.0	
67	Beraid Demra	610.0	551.9	610.0	609.9	3.8	3.8	3.8	3.8	90.5	100.0	100.0	0.6	
68	Demra	1,362.5	1,110.2	1,294.9	1,362.5	11.1	11.1	11.1	11.1	81.5	95.0	100.0	0.8	
Dha69	Matuail Dhaka	914.0	667.2	758.6	868.3	0.0	0.0	0.0	0.0	73.0	83.0	95.0	0.0	
Nar31	31 Nara.	13.0	0.0	0.0	10.4	0.0	0.0	0.0	0.0	0.0	0.0	80.0	0.0	
Nar32	32 Nara.	171.0	0.0	0.0	0.0	10.0	10.0	10.0	10.0	0.0	0.0	0.0	5.8	
Nar33	33 Nara.	55.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Nar69	Matuail Nar.	1,698.0	0.0	0.0	0.0	7.5	7.5	7.5	7.5	0.0	0.0	0.0	0.4	
70	Shyampur	485.0	38.7	38.7	85.1	11.1	11.1	11.1	11.1	8.0	8.0	17.6	2.3	
71	N1	120.0	0.0	0.0	38.0	33.1	33.1	33.1	33.1	0.0	29.6	31.6	27.6	
72	N2	127.5	11.0	46.6	102.8	4.6	4.6	4.6	4.6	8.6	36.6	80.6	3.6	
73	N3	232.5	0.0	0.0	119.7	22.8	22.8	22.8	22.8	0.0	4.3	48.9	9.8	
74	N4	160.0	52.5	103.7	160.0	6.5	6.5	6.5	6.5	32.8	64.8	100.0	4.0	
75	N5	87.5	10.3	23.2	87.5	23.3	23.3	23.3	23.3	11.8	26.5	100.0	26.6	
76	N6	47.5	0.0	17.6	47.5	0.0	0.0	0.0	0.0	0.0	37.1	100.0	0.0	
77	N7	107.5	41.0	75.5	107.5	2.6	2.6	2.6	2.6	38.1	70.2	100.0	2.4	
78	N8	145.0	97.5	109.4	145.0	11.9	11.9	11.9	11.9	67.3	75.5	100.0	8.2	

Table E.1 (3) Flood Area

Zone No.	Name of Zone	Area (Ha.)	Flood Area (Unit : Ha.)						Ratio of Flood Area to Zone Area (%)					
			External Flood			Internal Flood			External Flood			Internal Flood		
			Annual Flood	1987 Flood	1988 Flood	Annual Flood	Worst Flood	Annual Flood	1987 Flood	1988 Flood	Annual Flood	Worst Flood	Annual Flood	1987 Flood
79	N9	340.0	118.6	185.9	340.0	4.9	4.9	34.9	54.7	100.0	100.0	1.4	1.4	1.4
80	N10	263.0	9.4	69.3	263.0	13.0	13.0	3.6	26.3	100.0	100.0	4.9	4.9	4.9
81	N11	305.0	75.6	302.3	305.0	0.0	0.0	24.8	99.1	100.0	100.0	0.0	0.0	0.0
82	N12	56.0	49.4	56.0	56.0	0.0	0.0	88.2	100.0	100.0	100.0	0.0	0.0	0.0
83	Tarabo	138.0	121.5	138.0	138.0	0.0	0.0	88.1	100.0	100.0	100.0	0.0	0.0	0.0
84	Kachpur	173.0	48.7	79.2	173.0	0.0	0.0	28.2	45.8	100.0	100.0	0.0	0.0	0.0
85	Siddhirganj	782.5	0.0	12.1	141.2	0.0	0.0	0.0	1.6	18.5	0.0	0.0	0.0	0.0
86	Simulpara	575.0	0.0	50.3	372.8	32.7	32.7	0.0	8.7	64.8	5.7	5.7	5.7	5.7
87	Godnail	1,015.0	0.0	8.9	135.2	162.0	162.0	0.0	0.9	13.3	16.0	16.0	16.0	16.0
88	Kutubpur	1,332.5	20.5	20.5	51.3	109.0	109.0	1.5	1.5	3.8	8.2	8.2	8.2	8.2
89	Fatullah	525.0	16.4	34.0	41.5	56.7	56.7	3.1	6.5	7.9	10.8	10.8	10.8	10.8
90	Enayethnagar	432.5	229.6	314.5	388.1	2.5	2.5	53.1	72.7	89.7	0.6	0.6	0.6	0.6
91	Kashipur	527.5	494.5	527.5	527.5	0.0	0.0	93.8	100.0	100.0	0.0	0.0	0.0	0.0
92	NO1	200.0	200.0	200.0	200.0	0.0	0.0	100.0	100.0	100.0	0.0	0.0	0.0	0.0
92	Konda	3,175.0	2,789.7	3,010.6	3,175.0	0.0	0.0	87.9	94.8	100.0	0.0	0.0	0.0	0.0
93	Teguria	1,442.5	1,070.5	1,384.0	1,442.6	0.0	0.0	74.2	95.9	100.0	0.0	0.0	0.0	0.0
94	Subhadya	1,157.5	997.1	1,152.2	1,157.5	0.0	0.0	86.1	99.5	100.0	0.0	0.0	0.0	0.0
95	Zinjira	390.0	113.3	368.2	390.0	0.0	0.0	29.0	94.4	100.0	0.0	0.0	0.0	0.0
96	Kalindi	722.5	602.3	705.2	722.6	0.0	0.0	83.4	97.6	100.0	0.0	0.0	0.0	0.0
97	Basta	1,972.5	1,756.0	1,944.6	1,972.5	0.0	0.0	89.0	98.6	100.0	0.0	0.0	0.0	0.0
98	Sakia	1,840.0	1,470.1	1,834.7	1,840.0	0.0	0.0	79.9	99.7	100.0	0.0	0.0	0.0	0.0
99	Rohitpur	1,935.0	1,765.3	1,909.1	1,935.0	0.0	0.0	91.2	96.7	100.0	0.0	0.0	0.0	0.0
100	Taranagar	1,950.0	1,689.8	1,950.0	1,950.0	0.0	0.0	86.7	100.0	100.0	0.0	0.0	0.0	0.0
101	Kalatia	1,800.0	1,511.8	1,776.5	1,800.0	0.0	0.0	84.0	98.7	100.0	0.0	0.0	0.0	0.0
102	KOI	650.0	650.0	650.0	650.0	0.0	0.0	100.0	100.0	100.0	0.0	0.0	0.0	0.0
102	Amin Bazar	655.0	607.6	641.7	655.0	0.0	0.0	92.8	98.0	100.0	0.0	0.0	0.0	0.0
103	Kaundia	1,045.0	941.8	1,019.9	1,045.0	0.0	0.0	90.1	97.6	100.0	0.0	0.0	0.0	0.0
104	Hazratpur	1,080.0	1,044.8	1,059.7	1,080.0	0.0	0.0	96.7	98.1	100.0	0.0	0.0	0.0	0.0
105	Bhakurta	2,265.0	2,070.3	2,237.8	2,265.0	0.0	0.0	91.4	98.8	100.0	0.0	0.0	0.0	0.0
106	Tetujhora	1,772.5	1,390.1	1,570.9	1,772.5	0.0	0.0	78.4	88.6	100.0	0.0	0.0	0.0	0.0
107	Banagram	1,422.5	993.7	921.4	1,349.5	0.0	0.0	49.8	64.8	94.9	0.0	0.0	0.0	0.0
108	Biralia	2,857.5	993.7	993.7	1,419.1	0.0	0.0	34.8	34.8	49.7	0.0	0.0	0.0	0.0
109	Savar	2,960.0	134.8	336.9	1,846.2	0.0	0.0	4.6	11.4	62.4	0.0	0.0	0.0	0.0
110	Ashulia	3,265.0	897.3	897.3	1,150.4	0.0	0.0	27.5	27.5	35.2	0.0	0.0	0.0	0.0
111	Pathalia	2,393.0	267.0	326.3	1,543.7	0.0	0.0	11.2	13.6	64.5	0.0	0.0	0.0	0.0
112	Dhamsona	980.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
113	Yearpur	1,872.5	1,028.3	1,044.7	1,140.3	0.0	0.0	54.9	55.8	60.9	0.0	0.0	0.0	0.0
114	Kashimpur	1,750.0	556.8	664.3	803.8	0.0	0.0	31.8	38.0	45.9	0.0	0.0	0.0	0.0
115	Tongi	3,687.5	1,183.3	1,346.6	3,374.3	449.6	449.6	32.1	36.5	91.5	12.2	12.2	12.2	12.2
116	Gachha	80.0	59.2	80.0	80.0	0.0	0.0	74.0	100.0	100.0	0.0	0.0	0.0	0.0

Table E.1 (4) Flood Area

Summary

Name of Sub-Area	Area (Ha.)	Flood Area (Unit : Ha.)						Ratio of Flood Area to Sub-Area (%)						
		External Flood			Internal Flood			External Flood			Internal Flood			
		Annual Flood	1987 Flood	1988 Flood	Annual Flood	Worst Flood	Annual Flood	1987 Flood	1988 Flood	Annual Flood	Worst Flood	Annual Flood	1987 Flood	1988 Flood
Dhaka	27,527.0	12,914.5	17,801.4	22,125.3	1,013.5	1,051.0	46.9	64.7	80.4	3.7	3.8			
Narayanganj	10,094.5	1,635.2	2,458.7	4,030.1	514.2	514.2	16.2	24.4	39.9	5.1	5.1			
Keraniganj	17,035.0	14,415.8	16,685.1	17,035.1	0.0	0.0	84.6	97.9	100.0	0.0	0.0			
Savar	24,318.0	10,641.0	11,714.5	16,070.5	0.0	0.0	43.8	48.2	66.1	0.0	0.0			
Tongi	3,767.5	1,242.5	1,426.6	3,454.3	449.6	449.6	33.0	37.9	91.7	11.9	11.9			
Study Area	82,742.0	40,848.9	50,086.3	62,715.3	1,977.3	2,014.8	49.4	60.5	75.8	2.4	2.4			

Table E.2 (1) External Flood Condition

Zone No.	Name of Zone	Annual Flood						1987 Flood						1988 Flood					
		Depth (meter)		Duration (day)		Depth (meter)		Duration (day)		Depth (meter)		Duration (day)		Depth (meter)		Duration (day)			
		Max.	Ave.	Min.	Max.	Ave.	Min.	Max.	Ave.	Min.	Max.	Ave.	Min.	Max.	Ave.	Min.	Max.	Ave.	Min.
1		0.00	0.00	0.00	0.00	0.00	0.00	0.81	1.30	0.00	32.00	18.09	0.00	2.51	1.64	0.00	59.00	31.33	0.00
2		0.00	0.00	0.00	0.00	0.00	0.00	0.28	0.41	0.00	13.00	8.50	0.00	1.91	1.08	0.27	45.00	21.75	5.00
3		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.52	0.52	0.00	15.00	15.00	0.00
4		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.91	0.56	0.00	20.00	12.50	0.00
6		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.64	0.46	0.00	15.00	9.50	0.00
7		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.85	0.67	0.00	18.00	14.75	0.00
8		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.85	0.73	0.00	18.00	17.00	0.00
9		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10		0.00	0.00	0.00	0.00	0.00	0.00	1.37	1.37	0.00	30.00	30.00	0.00	3.05	1.29	0.00	45.00	27.50	0.00
11		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.46	0.42	0.00	15.00	15.00	0.00
12		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.30	0.00	20.00	20.00	0.00
13		0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.15	0.00	4.00	4.00	0.00	0.76	0.76	0.00	20.00	20.00	0.00
14		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.15	0.00	7.00	7.00	0.00
16		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.40	0.40	0.00	15.00	15.00	0.00
17		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
18		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.76	0.76	0.00	15.00	15.00	0.00
19		0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.15	0.15	4.00	4.00	4.00	0.94	0.94	0.94	23.00	23.00	23.00
20		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
21		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
22		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
23		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.14	1.14	0.00	20.00	20.00	0.00
24		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
25		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.61	0.61	0.00	10.00	10.00	0.00
26		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.07	1.07	0.00	23.00	23.00	0.00
27		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
28		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
29		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.72	0.53	0.00	26.00	16.75	0.00
30		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.91	0.69	0.00	20.00	14.00	0.00
Dha31	31Dhaka	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.13	0.83	0.00	18.00	13.86	0.00
Dha32	32Dhaka	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.22	0.80	0.27	20.00	15.33	8.00
Dha33	33Dhaka	0.00	0.00	0.00	0.00	0.00	0.00	0.46	0.46	0.00	10.00	10.00	0.00	1.28	0.82	0.00	25.00	16.00	0.00
34		0.00	0.00	0.00	0.00	0.00	0.00	0.56	0.61	0.00	16.00	13.00	0.00	1.22	0.88	0.46	34.00	23.27	12.00
35		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.84	0.84	0.84	29.00	29.00	29.00
36		0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.08	0.00	2.00	2.00	0.00	1.19	0.76	0.00	35.00	23.33	0.00
37		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.46	0.29	0.15	14.00	10.29	6.00
38		0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.17	0.00	6.00	6.00	0.00	1.19	1.08	1.01	36.00	30.00	20.00
39		0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.12	0.00	5.00	5.00	0.00	1.10	0.88	0.40	34.00	27.29	12.00
40		0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.12	0.00	5.00	5.00	0.00	1.13	0.60	0.00	36.00	18.42	0.00
41		0.00	0.00	0.00	0.00	0.00	0.00	0.53	0.53	0.00	18.00	18.00	0.00	1.52	0.57	0.00	45.00	17.60	0.00

Table E.2 (2) External Flood Condition

Zone No.	Name of Zone	Annual Flood						1987 Flood						1988 Flood					
		Depth (meter)		Duration (day)		Depth (meter)		Duration (day)		Depth (meter)		Duration (day)		Depth (meter)		Duration (day)			
		Max.	Ave.	Min.	Max.	Min.	Ave.	Max.	Ave.	Min.	Max.	Min.	Ave.	Max.	Ave.	Min.	Max.	Ave.	Min.
42		0.00	0.00	0.00	0.00	0.00	0.08	0.08	0.00	1.00	0.00	0.64	0.44	0.00	15.00	10.67	0.00	0.00	
43		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.76	0.61	0.00	27.00	21.00	0.00	0.00	
44		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
45		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
46		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.61	0.61	0.00	15.00	15.00	0.00	0.00	
47		0.00	0.00	0.00	0.00	0.00	0.08	0.08	0.00	2.00	0.00	0.94	0.85	0.00	18.00	16.50	0.00	0.00	
48		0.00	0.00	0.00	0.00	0.00	0.91	0.54	0.00	15.00	11.17	1.80	0.83	0.00	32.00	18.91	0.00	0.00	
49		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.76	0.62	0.00	17.00	14.00	0.00	0.00	
50		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.82	0.81	0.00	20.00	20.00	0.00	0.00	
51		0.00	0.00	0.00	0.00	0.00	0.46	0.46	0.00	10.00	10.00	0.99	0.58	0.00	30.00	19.00	0.00	0.00	
52		0.00	0.00	0.00	0.00	0.00	0.15	0.15	0.00	4.00	4.00	0.76	0.60	0.00	25.00	17.25	0.00	0.00	
53		0.00	0.00	0.00	0.00	0.00	1.14	0.58	0.00	5.00	5.00	0.90	0.37	0.00	22.00	10.00	0.00	0.00	
54		0.00	0.00	0.00	0.00	0.00	1.04	0.63	0.00	30.00	15.67	1.98	1.18	0.00	48.00	27.71	0.00	0.00	
55		0.00	0.00	0.00	0.00	0.00	1.10	0.64	0.00	20.00	12.63	1.83	1.23	0.00	36.00	25.09	0.00	0.00	
56		0.00	0.00	0.00	0.00	0.00	0.38	0.24	0.00	26.00	15.20	2.19	1.25	0.00	48.00	26.47	0.00	0.00	
57	Gulshan 57	0.00	0.00	0.00	0.00	0.00	1.37	1.00	0.00	12.00	7.77	1.19	0.78	0.00	38.00	21.97	0.00	0.00	
58	Cantonment Ward-1	0.00	0.00	0.00	0.00	0.00	1.55	0.73	0.00	32.00	14.05	3.20	1.39	0.00	63.00	27.39	0.00	0.00	
59	Cantonment Ward-2	0.00	0.00	0.00	0.00	0.00	1.48	0.80	0.00	28.00	15.57	2.80	1.71	0.00	54.00	33.78	19.00	0.00	
60	Cantonment Ward-3	0.00	0.00	0.00	0.00	0.00	0.43	0.28	0.00	15.00	9.00	1.40	0.81	0.00	65.00	24.39	0.00	0.00	
61	Sultanganj	0.00	0.00	0.00	0.00	0.00	1.37	1.00	0.00	30.00	25.67	3.05	2.02	1.30	50.00	35.50	25.00	0.00	
62	Harrampur	0.00	0.00	0.00	0.00	0.00	0.91	0.42	0.00	20.00	10.33	1.91	1.01	0.00	45.00	24.47	0.00	0.00	
63	Dakshin Khan Cantonment	0.00	0.00	0.00	0.00	0.00	1.14	0.66	0.00	25.00	13.67	2.06	0.85	0.00	45.00	21.21	0.00	0.00	
64	Uttar Khan	0.00	0.00	0.00	0.00	0.00	0.66	0.41	0.00	18.00	11.94	1.93	1.04	0.00	35.00	22.88	0.00	0.00	
65	Dakshin Khan Gulshan	0.00	0.00	0.00	0.00	0.00	0.69	0.34	0.00	22.00	9.90	1.74	0.66	0.00	40.00	19.82	0.00	0.00	
66	Beraid Gulshan	0.00	0.00	0.00	0.00	0.00	0.20	0.20	0.00	7.00	7.00	1.25	0.70	0.00	39.00	19.71	0.00	0.00	
67	Beraid Demra	0.00	0.00	0.00	0.00	0.00	0.24	0.24	0.00	7.00	7.00	0.99	0.74	0.30	23.00	16.57	8.00	0.00	
68	Demra	0.00	0.00	0.00	0.00	0.00	0.38	0.29	0.00	13.00	9.75	1.52	0.92	0.29	42.00	26.84	12.00	0.00	
Dha69	Matuail Dhaka	0.00	0.00	0.00	0.00	0.00	0.76	0.41	0.00	12.00	9.67	2.13	0.86	0.00	36.00	27.22	0.00	0.00	
NAR31	31 Nara.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
NAR32	32 Nara.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
NAR33	33 Nara.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.88	0.68	0.00	23.00	17.44	0.00	0.00	
NAR69	Matuail Nara.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.61	0.61	0.00	15.00	15.00	0.00	0.00	
70	Snyampur	0.00	0.00	0.00	0.00	0.00	0.15	0.11	0.00	5.00	5.00	0.99	0.78	0.00	30.00	24.00	0.00	0.00	
71	N1	0.00	0.00	0.00	0.00	0.00	0.20	0.20	0.00	7.00	7.00	1.07	1.07	0.00	30.00	30.00	0.00	0.00	
72	N2	0.00	0.00	0.00	0.00	0.00	0.20	0.23	0.00	15.00	7.50	1.07	0.74	0.00	35.00	22.50	0.00	0.00	
73	N3	0.00	0.00	0.00	0.00	0.00	0.46	0.23	0.00	8.00	6.33	1.14	0.67	0.00	40.00	19.57	0.00	0.00	
74	N4	0.00	0.00	0.00	0.00	0.00	0.23	0.21	0.00	8.00	7.25	1.14	0.88	0.00	35.00	22.43	15.00	0.00	
75	N5	0.00	0.00	0.00	0.00	0.00	0.38	0.25	0.00	12.00	7.25	1.14	0.88	0.00	35.00	22.43	15.00	0.00	
76	N6	0.00	0.00	0.00	0.00	0.00	0.61	0.34	0.00	14.00	8.67	1.60	1.14	0.91	30.00	25.75	21.00	0.00	
77	N7	0.00	0.00	0.00	0.00	0.00	0.61	0.24	0.00	14.00	6.33	1.58	1.01	0.46	35.00	23.71	16.00	0.00	
78	N8	0.00	0.00	0.00	0.00	0.00	0.34	0.20	0.00	8.00	4.80	1.14	0.67	0.00	30.00	24.44	0.00	0.00	

Table E.2 (3) External Flood Condition

Zone No.	Name of Zone	Annual Flood						1987 Flood						1988 Flood							
		Depth (meter)		Duration (day)		Duration (day)		Depth (meter)		Duration (day)		Duration (day)		Depth (meter)		Duration (day)		Depth (meter)		Duration (day)	
		Max.	Ave.	Min.	Ave.	Max.	Ave.	Min.	Ave.	Max.	Ave.	Min.	Ave.	Max.	Ave.	Min.	Ave.	Max.	Ave.	Min.	Ave.
79	N9	0.00	0.00	0.00	0.00	0.00	0.00	0.46	0.20	0.00	15.00	6.70	0.00	1.17	0.65	0.00	33.00	22.27	0.00	0.00	
80	N10	0.00	0.00	0.00	0.00	0.20	0.11	0.00	0.11	0.00	7.00	4.33	0.00	1.25	0.72	0.00	30.00	20.65	0.00	0.00	
81	N11	0.00	0.00	0.00	0.00	0.53	0.28	0.00	0.28	0.00	15.00	8.42	0.00	1.37	0.89	0.00	38.00	26.62	0.00	0.00	
82	N12	0.00	0.00	0.00	0.00	0.38	0.23	0.00	0.23	0.00	7.00	3.40	0.00	1.19	0.96	0.64	30.00	23.88	17.00	0.00	
83	Tarabo	0.00	0.00	0.00	0.00	0.49	0.42	0.00	0.42	0.00	13.00	11.00	0.00	0.85	0.68	0.46	18.00	15.88	13.00	0.00	
84	Kachpur	0.00	0.00	0.00	0.00	0.34	0.17	0.00	0.17	0.00	17.00	8.50	0.00	0.99	0.66	0.34	32.00	24.00	15.00	0.00	
85	Siddhirganj	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.94	0.81	0.00	23.00	19.25	0.00	0.00	
86	Simulpara	0.00	0.00	0.00	0.00	0.46	0.19	0.00	0.19	0.00	15.00	8.71	0.00	1.22	0.72	0.00	31.00	20.15	0.00	0.00	
87	Godnail	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.14	0.67	0.00	20.00	13.75	0.00	0.00	
88	Kutubpur	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.30	0.00	8.00	8.00	0.00	0.00	
89	Fatullah	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
90	Enayetrnagar	0.00	0.00	0.00	0.00	0.61	0.29	0.00	0.29	0.00	18.00	9.17	0.00	1.31	0.88	0.00	36.00	21.43	0.00	0.00	
91	Kashipur	0.00	0.00	0.00	0.00	1.04	0.54	0.00	0.54	0.00	22.00	12.44	0.00	1.89	1.02	0.15	35.00	21.79	3.00	0.00	
92	Konda	0.00	0.00	0.00	0.00	0.69	0.29	0.00	0.29	0.00	20.00	8.80	0.00	1.68	1.10	0.00	32.00	20.75	0.00	0.00	
93	Tegurua	0.00	0.00	0.00	0.00	0.82	0.46	0.00	0.46	0.00	20.00	11.22	0.00	1.75	1.28	0.61	35.00	24.41	13.00	0.00	
94	Subhadya	0.00	0.00	0.00	0.00	0.87	0.35	0.00	0.35	0.00	20.00	9.39	0.00	1.78	1.23	0.69	40.00	23.08	14.00	0.00	
95	Zinjira	0.00	0.00	0.00	0.00	1.13	0.49	0.00	0.49	0.00	20.00	11.74	0.00	2.65	1.36	0.64	45.00	25.24	13.00	0.00	
96	Kalindi	0.00	0.00	0.00	0.00	1.13	0.38	0.00	0.38	0.00	18.00	9.19	0.00	2.82	1.31	0.82	37.00	26.37	18.00	0.00	
97	Basta	0.00	0.00	0.00	0.00	0.87	0.41	0.00	0.41	0.00	20.00	9.76	0.00	2.06	1.18	0.11	45.00	25.27	4.00	0.00	
98	Sakta	0.00	0.00	0.00	0.00	0.87	0.37	0.00	0.37	0.00	20.00	10.23	0.00	1.78	1.24	0.52	45.00	25.95	10.00	0.00	
99	Rohitpur	0.00	0.00	0.00	0.00	0.73	0.34	0.00	0.34	0.00	18.00	9.64	0.00	1.68	1.22	1.02	35.00	23.50	15.00	0.00	
100	Taranagar	0.00	0.00	0.00	0.00	0.94	0.44	0.00	0.44	0.00	21.00	11.07	0.00	2.04	1.34	0.69	42.00	25.21	14.00	0.00	
101	Kalatia	0.00	0.00	0.00	0.00	0.87	0.43	0.00	0.43	0.00	20.00	11.15	0.00	1.86	1.21	0.46	40.00	23.24	10.00	0.00	
102	Amin Bazar	0.00	0.00	0.00	0.00	0.69	0.38	0.00	0.38	0.00	15.00	11.75	0.00	1.85	1.21	0.69	35.00	23.95	12.00	0.00	
103	Kaundia	0.00	0.00	0.00	0.00	0.95	0.45	0.00	0.45	0.00	17.00	9.39	0.00	2.21	1.39	0.64	40.00	26.15	10.00	0.00	
104	Hazratpur	0.00	0.00	0.00	0.00	0.84	0.50	0.00	0.50	0.00	20.00	12.33	0.00	1.68	1.13	0.53	30.00	21.00	12.00	0.00	
105	Bhakuria	0.00	0.00	0.00	0.00	1.07	0.46	0.00	0.46	0.00	20.00	11.33	0.00	2.06	1.43	0.61	36.00	25.04	12.00	0.00	
106	Tetuljhora	0.00	0.00	0.00	0.00	0.76	0.46	0.00	0.46	0.00	18.00	9.75	0.00	1.85	1.23	0.15	40.00	21.33	3.00	0.00	
107	Banagram	0.00	0.00	0.00	0.00	1.07	0.62	0.00	0.62	0.00	17.00	13.25	0.00	1.91	0.84	0.00	40.00	15.67	0.00	0.00	
108	Biralia	0.00	0.00	0.00	0.00	0.97	0.39	0.00	0.39	0.00	18.00	9.59	0.00	1.98	0.93	0.00	22.00	14.67	0.00	0.00	
109	Savar	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.52	1.36	0.00	30.00	25.11	0.00	0.00	
110	Ashulia	0.00	0.00	0.00	0.00	0.36	0.27	0.00	0.27	0.00	10.00	7.43	0.00	1.55	0.98	0.00	27.00	16.93	0.00	0.00	
111	Pathalia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.51	0.51	0.00	10.00	10.00	0.00	0.00	
112	Dhamsona	0.00	0.00	0.00	0.00	0.48	0.28	0.00	0.28	0.00	8.00	5.00	0.00	1.58	0.84	0.00	28.00	14.50	0.00	0.00	
113	Yearpur	0.00	0.00	0.00	0.00	0.61	0.44	0.00	0.44	0.00	18.00	13.63	0.00	1.58	0.86	0.00	34.00	19.40	0.00	0.00	
114	Kashipur	0.00	0.00	0.00	0.00	0.74	0.43	0.00	0.43	0.00	15.00	10.31	0.00	1.91	0.80	0.00	40.00	16.69	0.00	0.00	
115	Tongi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.97	0.77	0.66	25.00	18.00	0.00	0.00	
116	Gachha	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table E.2 (4) External Flood Condition

Summary

Name of Sub-Area	Annual Flood						1987 Flood						1988 Flood					
	Depth (meter)			Duration (day)			Depth (meter)			Duration (day)			Depth (meter)			Duration (day)		
	Max.	Ave.	Min.	Max.	Ave.	Min.	Max.	Ave.	Min.	Max.	Ave.	Min.	Max.	Ave.	Min.	Max.	Ave.	Min.
Dhaka	0.00	0.00	0.00	0.00	0.00	0.00	1.65	0.51	0.00	32.00	12.42	0.00	0.00	0.94	0.00	65.00	22.83	0.00
Narayanganj	0.00	0.00	0.00	0.00	0.00	0.00	1.04	0.30	0.00	22.00	8.26	0.00	0.00	0.79	0.00	40.00	21.53	0.00
Keraniganj	0.00	0.00	0.00	0.00	0.00	0.00	1.13	0.40	0.00	21.00	10.33	0.00	0.00	1.24	0.00	45.00	23.92	0.00
Savar	0.00	0.00	0.00	0.00	0.00	0.00	1.07	0.43	0.00	20.00	10.99	0.00	0.00	1.11	0.00	40.00	20.15	0.00
Tongi	0.00	0.00	0.00	0.00	0.00	0.00	0.74	0.49	0.00	15.00	6.70	0.00	0.00	0.80	0.00	40.00	16.77	0.00
Study Area	0.00	0.00	0.00	0.00	0.00	0.00	1.65	0.42	0.00	32.00	10.53	0.00	0.00	1.03	0.00	65.00	22.07	0.00

Table E.3 (1) Internal Flood Condition

Zone No.	Name of Zone	Annual Flood						Worst Flood					
		Depth (meter)			Duration (day)			Depth (meter)			Duration (day)		
		Max.	Ave.	Min.	Max.	Ave.	Min.	Max.	Ave.	Min.	Max.	Ave.	Min.
1		0.61	0.41	0.00	3.00	0.98	0.00	0.91	0.57	0.00	6.00	2.32	0.00
2		0.61	0.32	0.00	0.50	0.21	0.00	0.91	0.59	0.00	3.00	0.89	0.00
3		0.30	0.30	0.00	0.25	0.16	0.00	0.91	0.53	0.00	3.00	0.88	0.00
4		0.61	0.35	0.00	1.00	0.34	0.00	0.91	0.47	0.00	4.00	0.90	0.00
5		0.61	0.37	0.00	0.63	0.30	0.00	0.91	0.61	0.00	2.00	1.17	0.00
6		0.61	0.34	0.00	2.00	0.44	0.00	0.91	0.70	0.00	4.00	1.97	0.00
7		0.61	0.38	0.00	3.00	0.25	0.00	0.91	0.44	0.00	4.00	0.48	0.00
8		0.61	0.37	0.00	4.00	0.62	0.00	0.91	0.52	0.00	4.00	0.77	0.00
9		0.61	0.35	0.00	2.00	0.42	0.00	0.91	0.57	0.00	2.00	0.88	0.00
10		0.61	0.39	0.30	2.00	0.29	0.04	0.91	0.56	0.30	5.00	0.97	0.04
11		0.30	0.30	0.30	2.00	0.41	0.00	0.91	0.52	0.30	2.00	0.46	0.04
12		0.61	0.41	0.30	0.25	0.18	0.13	0.91	0.61	0.30	1.00	0.53	0.25
13		0.61	0.38	0.00	2.25	0.55	0.00	0.91	0.61	0.00	4.00	1.36	0.00
14		0.61	0.43	0.00	3.00	1.04	0.00	0.91	0.61	0.00	6.00	2.39	0.00
15		0.61	0.46	0.00	0.42	0.25	0.00	0.61	0.61	0.00	1.25	1.13	0.00
16		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
18		0.61	0.34	0.00	1.00	0.41	0.00	0.91	0.55	0.00	3.00	1.17	0.00
19		0.61	0.51	0.00	3.00	1.57	0.00	0.91	0.69	0.00	5.00	2.55	0.00
20		0.61	0.44	0.00	4.00	1.46	0.00	0.91	0.55	0.00	6.00	2.41	0.00
21		0.61	0.39	0.00	0.50	0.35	0.00	0.91	0.58	0.00	2.00	1.10	0.00
22		0.61	0.61	0.00	2.00	1.25	0.00	0.91	0.71	0.30	5.00	2.42	0.25
23		0.30	0.30	0.00	0.21	0.15	0.00	0.61	0.44	0.00	0.50	0.42	0.00
24		0.30	0.30	0.00	0.25	0.19	0.00	0.91	0.46	0.00	1.00	0.44	0.00
25		0.61	0.42	0.00	0.63	0.25	0.00	0.91	0.53	0.00	2.00	0.74	0.00
26		0.61	0.34	0.30	1.00	0.29	0.08	0.91	0.47	0.30	2.00	0.77	0.08
27		0.61	0.43	0.00	2.00	0.29	0.00	0.91	0.69	0.00	5.00	0.93	0.00
28		0.30	0.30	0.30	0.21	0.05	0.01	0.61	0.51	0.30	5.00	1.81	0.04
29		0.61	0.49	0.00	0.50	0.26	0.00	0.91	0.71	0.00	5.00	1.57	0.00
30		0.61	0.34	0.30	1.00	0.63	0.01	0.91	0.55	0.30	5.00	1.98	0.04
Dha31	31Dhaka	0.30	0.30	0.00	0.29	0.13	0.00	0.91	0.51	0.00	5.00	1.79	0.00
Dha32	32Dhaka	0.61	0.43	0.00	0.33	0.13	0.00	0.91	0.61	0.00	5.00	0.67	0.00
Dha33	33Dhaka	0.61	0.46	0.00	1.00	0.48	0.00	0.91	0.53	0.00	2.00	0.94	0.00
34		0.61	0.39	0.00	2.00	0.70	0.00	0.91	0.46	0.00	6.00	2.34	0.00
35		0.61	0.37	0.00	3.00	0.37	0.00	0.91	0.47	0.00	5.00	1.03	0.00
36		0.61	0.33	0.00	0.50	0.15	0.00	0.91	0.48	0.00	2.00	0.55	0.00
37		0.61	0.56	0.30	0.50	0.32	0.21	0.91	0.76	0.61	6.00	2.50	0.50
38		0.30	0.30	0.30	2.00	0.72	0.13	0.61	0.49	0.30	6.00	2.60	1.00
39		0.30	0.30	0.30	2.00	0.58	0.08	0.91	0.51	0.30	5.00	2.08	0.42
40		0.61	0.36	0.00	3.00	0.40	0.00	0.91	0.57	0.00	4.00	0.96	0.00
41		0.61	0.37	0.00	1.00	0.37	0.00	0.91	0.61	0.00	3.00	1.03	0.00

Table E.3 (2) Internal Flood Condition

Zone No.	Name of Zone	Annual Flood						Worst Flood							
		Depth (meter)		Duration (day)		Min.	Max.	Depth (meter)		Duration (day)		Min.	Max.	Ave.	Min.
		Max.	Ave.	Min.	Max.			Min.	Max.	Min.	Max.				
42		0.61	0.44	0.30	0.63	0.38	0.21	0.91	0.70	0.30	2.00	1.02	0.50		
43		0.61	0.47	0.00	3.00	0.46	0.00	0.91	0.72	0.00	5.00	0.82	0.00		
44		0.61	0.45	0.00	3.00	0.54	0.00	0.91	0.67	0.00	6.00	1.44	0.00		
45		0.61	0.45	0.00	3.00	0.84	0.00	0.91	0.69	0.00	4.00	1.86	0.00		
46		0.61	0.44	0.30	0.50	0.30	0.17	0.91	0.61	0.30	2.00	0.69	0.25		
47		0.61	0.38	0.00	2.00	0.50	0.00	0.91	0.58	0.00	3.00	1.17	0.00		
48		0.61	0.46	0.30	0.63	0.52	0.42	0.91	0.76	0.61	2.00	2.00	2.00		
49		0.61	0.37	0.00	0.63	0.37	0.00	0.91	0.53	0.00	4.00	1.27	0.00		
50		0.61	0.42	0.00	0.63	0.40	0.00	0.91	0.62	0.00	2.00	1.18	0.00		
51		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
52		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
53		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
54		0.61	0.36	0.00	1.00	0.37	0.00	0.91	0.58	0.00	4.00	1.44	0.00		
55		0.61	0.46	0.00	1.00	0.58	0.00	0.91	0.61	0.00	6.00	3.78	0.00		
56		0.61	0.37	0.00	3.00	0.57	0.00	0.91	0.60	0.00	6.00	1.83	0.00		
57	Gulshan 57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
58	Cantonment Ward-1	0.61	0.36	0.00	2.00	0.79	0.00	0.91	0.65	0.00	6.00	2.56	0.00		
59	Cantonment Ward-2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
60	Cantonment Ward-3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
61	Suitanganj	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
62	Harirampur	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
63	Dakshin Khan Cantonment	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.18	0.00	3.00	0.94	0.00		
64	Uttar Khan	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
65	Dakshin Khan Gulshan	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
66	Beraid Gulshan	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
67	Beraid Demra	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
68	Demra	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Dha69	Matuail Dhaka	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
NAR31	31 Nara.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
NAR32	32 Nara.	0.00	0.00	0.00	0.00	0.00	0.00	0.46	0.31	0.00	0.30	0.21	0.00		
NAR33	33 Nara.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
NAR69	Matuail Nara.	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.23	0.00	0.35	0.24	0.00		
70	Shyampur	0.00	0.00	0.00	0.00	0.00	0.00	0.43	0.43	0.00	0.30	0.30	0.00		
71	N1	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.15	0.00	1.00	1.00	0.00		
72	N2	0.00	0.00	0.00	0.00	0.00	0.00	0.24	0.13	0.00	1.00	0.61	0.00		
73	N3	0.15	0.14	0.00	0.08	0.08	0.00	0.76	0.40	0.00	1.00	0.67	0.00		
74	N4	0.12	0.12	0.00	0.08	0.08	0.00	0.62	0.45	0.00	0.83	0.47	0.00		
75	N5	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.30	0.00	0.50	0.50	0.00		
76	N6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
77	N7	0.00	0.00	0.00	0.00	0.00	0.00	0.61	0.61	0.00	2.00	2.00	0.00		
78	N8	0.00	0.00	0.00	0.00	0.00	0.00	0.38	0.21	0.00	0.50	0.28	0.00		

Table E.3 (3) Internal Flood Condition

Zone No.	Name of Zone	Annual Flood						Worst Flood					
		Depth (meter)		Duration (day)		Min.	Max.	Depth (meter)		Duration (day)		Min.	Max.
		Ave.	Max.	Ave.	Max.			Ave.	Max.	Ave.	Max.		
79	N9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
80	N10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
81	N11	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.27	0.00	0.50	0.45	0.00
82	N12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
83	Tarabo	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
84	Kachpur	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
85	Siddhigani	0.15	0.13	0.00	2.00	0.00	0.25	0.23	0.23	0.00	7.00	6.39	0.00
86	Simulpara	0.00	0.00	0.00	0.00	0.00	0.26	0.19	0.19	0.00	7.00	4.63	0.00
87	Godnail	0.00	0.00	0.00	0.00	0.00	0.26	0.23	0.23	0.00	7.00	6.67	0.00
88	Kuubpur	0.00	0.00	0.00	0.00	0.00	0.41	0.29	0.29	0.00	3.00	0.90	0.00
89	Fatullah	0.00	0.00	0.00	0.00	0.00	0.08	0.08	0.08	0.00	0.20	0.20	0.00
90	Enayetnagar	0.61	0.07	0.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
91	Kashipur	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
92	Konda	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
93	Teguria	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
94	Subhadya	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
95	Zinjira	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
96	Kalindi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
97	Basta	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
98	Sakta	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
99	Rohitpur	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
100	Taranagar	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
101	Kalatia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
102	Amin Bazar	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
103	Kaundia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
104	Hazratpur	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
105	Bhakuria	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
106	Tetujhora	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
107	Banagram	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
108	Biraila	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
109	Savar	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
110	Ashulia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
111	Pathalia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
112	Dhamsona	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
113	Yearpur	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
114	Kashimpur	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
115	Tongi	0.35	0.19	0.00	1.88	0.00	0.49	0.41	0.41	0.00	4.00	1.89	0.00
116	Gachha	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table E.3(4) Internal Flood Condition

Summary

Name of Sub-Area	Annual Flood						Worst Flood					
	Depth (meter)		Duration (day)		Depth (meter)		Duration (day)		Depth (meter)		Duration (day)	
	Max.	Ave.	Min.	Max.	Ave.	Min.	Max.	Ave.	Min.	Max.	Ave.	Min.
Dhaka	0.61	0.38	0.00	4.00	0.48	0.00	0.91	0.58	0.00	6.00	1.38	0.00
Narayanganj	0.61	0.07	0.00	2.00	0.41	0.00	0.82	0.25	0.00	7.00	3.08	0.00
Keraniganj	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Savar	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tongi	0.35	0.19	0.00	1.88	0.44	0.00	0.49	0.41	0.00	4.00	1.89	0.00
Study Area	0.61	0.38	0.00	4.00	0.48	0.00	0.91	0.55	0.00	7.00	1.53	0.00

Table E.4 Flood Damage Statement of Study Area - Based on Official Records

Area	No. of Affected People	No. of Damaged Homesteads		Area of Damaged Crops (Ha)		No. of Human Deaths	No. of Damaged Educational Facilities	Length of Damaged Road (km)	No. of Livestock Deaths
		Full	Partial	Full	Partial				
1. 1987 Flood									
Dhaka	497,000	19,200	24,535	13,820	-	38	298	241	2,282
Narayanganj	88,117	549	12,612	648	867	1	88	391	448
Keraniganj	157,350	8,569	11,332	947	-	4	150	341	110
Savar	210,000	10,000	6,000	3,245	-	25	104	257	128
Tongi	12,184	2,212	-	202	-	-	50	103	-
Total	964,651	40,530	54,479	18,862	867	68	690	1,333	2,968
2. 1988 Flood									
Dhaka	805,843	60,313	86,581	17,099	768	63	379	660	1,519
Narayanganj	730,000	3,145	21,300	1,119	2,875	30	112	407	153
Keraniganj	361,625	6,967	25,000	3,000	-	24	191	574	526
Savar	260,950	35,253	17,483	3,100	-	20	132	253	75
Tongi	75,000	12,000	-	1,416	-	12	64	212	83
Total	2,233,418	117,678	150,364	25,734	3,643	149	878	2,106	2,356

Sources: Deputy Commissioner, Dhaka Region and Upazila Offices of Narayanganj, Keraniganj, Savar and Tongi

Table E.5 Amount of Flood Damages in the Study Area - Based on Official Records

Area	Households	Crops	Educational Institutions	Roads/ Bridge/ Culverts	Livestock	Rehabilitation Costs				
						Power	Water Supply	Gas	Telecommunications	Bus Transport
1. 1987 Flood										
Dhaka	62.94	89.44	7.02	11.12	9.36	-	-	-	-	-
Narayanganj	13.71	7.00	2.06	14.71	1.88	-	-	-	-	-
Keraniganj	28.47	6.13	3.54	15.73	0.45	-	-	-	-	-
Savar	26.00	21.07	2.44	11.85	0.59	-	-	-	-	-
Tongi	4.42	1.31	1.19	4.75	-	-	-	-	-	-
Total	135.54	124.95	16.25	58.16	12.28	-	-	-	-	-
2. 1988 Flood										
Dhaka	207.20	113.15	8.94	30.44	6.23	31.50	10.27	2.45	6.25	7.46
Narayanganj	27.59	16.55	2.64	18.77	0.64	31.14	-	-	-	0.44
Keraniganj	38.93	19.42	4.50	26.48	2.16	-	-	-	-	-
Savar	87.99	20.06	3.11	11.67	0.35	-	-	-	-	-
Tongi	24.00	9.16	1.55	9.78	0.39	-	-	-	-	-
Total	385.71	178.34	20.70	97.14	9.77	62.64	10.27	2.45	6.25	7.90

Sources: Deputy Commissioner, Dhaka Region and Upazila Offices of Narayanganj, Keraniganj, Savar and Tongi

Table E.6 Affected Population by Area by Return Period

1. 1990

(Unit: Persons)

Area	External Flood		Internal Flood	Total Population
	1/10 Return Period	1/70 Return Period		
Dhaka	1,459,061 (32.6%)	2,432,305 (54.4%)	595,482 (13.3%)	4,472,633
Narayanganj	277,144 (25.0%)	484,934 (43.7%)	52,020 (4.7%)	1,110,616
Keraniganj	430,943 (97.5%)	441,788 (100.0%)	0 (0.0%)	441,788
Savar	182,597 (49.9%)	261,427 (71.4%)	0 (0.0%)	366,270
Tongi	53,310 (37.3%)	131,002 (91.6%)	17,234 (12.1%)	143,009
TOTAL	2,403,055 (36.8%)	3,751,456 (57.4%)	664,736 (10.2%)	6,534,316

2. 2010

(Unit: Persons)

Area	External Flood		Internal Flood	Total Population
	1/10 Return Period	1/70 Return Period		
Dhaka	3,668,674 (42.7%)	5,483,959 (63.8%)	856,965 (10.0%)	8,588,909
Narayanganj	665,528 (26.0%)	1,083,529 (42.4%)	129,402 (5.1%)	2,558,436
Keraniganj	791,452 (97.4%)	813,191 (100.0%)	0 (0.0%)	813,191
Savar	333,105 (41.0%)	549,059 (67.6%)	0 (0.0%)	811,880
Tongi	242,226 (36.8%)	602,978 (91.5%)	80,022 (12.1%)	658,731
TOTAL	5,700,984 (42.4%)	8,532,717 (63.5%)	1,066,390 (7.9%)	13,431,147

Notes : 1. 1987 size external flood : 1/10 return period
1988 size external flood : 1/70 return period
: 2. A percentage means the ratio to the total population.

Source : JICA

Table E.7 No. of Properties in Inundation Areas by Area by Type of Properties in 1980

Name of Areas	1987 - Scale Flood				1988 - Scale Flood			
	Houses	Shops	Factories	Institutions	Houses	Shops	Factories	Institutions
Dhaka	247,700	7,905	665	7,726	410,651	14,027	1,191	14,348
Narayanganj	48,055	1,153	727	1,093	84,680	2,611	1,930	2,117
Keraniganj	77,989	2,221	272	616	79,916	2,312	283	635
Savar	30,701	231	82	295	43,455	381	301	787
Tongi	9,848	542	571	777	24,237	1,352	1,430	1,947
TOTAL	414,304	12,051	2,316	10,507	642,938	20,683	4,585	19,834

(Unit: Number)

Note: No. is on household basis.

Source: JICA

Table E.8 No. of Properties in Inundation Areas by Area by Type of Properties in 2010

Name of Areas	1987 - Scale Flood				1988 - Scale Flood			
	Houses	Shops	Factories	Institutions	Houses	Shops	Factories	Institutions
Dhaka	630,735	16,509	1,092	18,637	933,373	27,171	1,997	30,424
Narayanganj	116,701	1,964	1,788	2,553	180,947	4,345	3,210	4,484
Keraniganj	141,241	3,482	538	1,130	144,983	3,622	561	1,167
Savar	55,824	423	198	671	90,407	822	840	2,281
Tongi	44,820	2,503	2,649	3,606	111,630	6,266	6,641	9,037
TOTAL	989,321	24,882	6,265	26,596	1,471,340	42,225	16,250	47,404

(Unit: Number)

Note: No. is on household basis.

Source: JICA

Table E.9 No. of Farm Houses by Area in 1990 and 2010

Name of Areas	No. of Farm Houses	
	1990	2010
Dhaka	89,497	21,227
Narayanganj	24,585	7,880
Keraniganj	17,690	15,555
Savar	230,055	19,301
Tongi	5,179	2,545
TOTAL	160,006	66,508

Source: Upazila Statistics of Bangladesh 1988 and JICA

Table E.10(1) Relationships between Inundation Depths/Durations and Damage Ratios for 1987 Flood

1. Regression Equation - 1

$$DM = a + b_1 * DP + b_2 * DR$$

where DM : Flood damage ratio (%)
 DP : Inundation depth (m)
 DR : Inundation duration (days)
 a, b₁, b₂ : Regression coefficients

R = Multiple correlation coefficient
 T = T value
 N = No. of samples

Item	a	b ₁	b ₂	R	T	N
1) House						
(1) Building(s)	-6.482	2.093	1.182	0.705	5.630	34
(2) Household Effects	-4.638	5.521	0.312	0.797	4.372	13
(3) Income	1.383	0.157	0.185	0.673	5.687	41
2) Shop						
(1) Building(s)	-	-	-	-	-	-
(2) Equipment & Inventories	-	-	-	-	-	-
(3) Profit	1.780	0.421	0.099	0.567	3.368	26
3) Factory						
(1) Building(s)	-	-	-	-	-	-
(2) Equipment & Inventories	-	-	-	-	-	-
(3) Profit	-	-	-	-	-	-

2. Regression Equation - 2

$$FP = a_p + b_p * DP$$

where FP : Inundation depth of a farm (m)
 DP : Inundation depth of a farm house (m)
 a_p, b_p : Regression coefficients for equation FP

R_p = Correlation coefficient for equation FP
 T_p = T value for equation FP
 N_p = No. of samples for equation FP

Table E.10(2) Relationships between Inundation Depths/Durations and Damage Ratios for 1987 Flood

$$FR = a_r + b_r * DR$$

where FR : Inundation duration of a farm (days)
 DR : Inundation duration of a farm house (days)
 a_r, b_r : Regression coefficients for equation FR

R_r = Correlation coefficient for equation FR

T_r = T value for equation FR

N_r = No. of samples for equation FR

a_p	b_p	R_p	T_p	N_p	a_r	b_r	R_r	T_r	N_r
2.864	0.851	0.372	5.531	192	110.078	1.249	0.316	2.425	55

3. Regression Equation - 3

$$FM = a + b_1 * FP + b_2 * FR$$

where FM : Ratio of flood damages to agricultural crops (%)
 FP : Inundation depth of a farm (m)
 FR : Inundation duration of a farm (days)
 a, b_1, b_2 : Regression coefficients

R = Multiple correlation coefficient

T = T value

N = No. of samples

Item	a	b_1	b_2	R	T	N
Agricultural Crops	57.539	0.064	0.203	0.289	5.220	302

Source: JICA

Table E.11(1) Relationships between Inundation Depths/Durations and Damage Ratios for 1988 Flood

1. Regression Equation - 1

$$DM = a + b_1 * DP + b_2 * DR$$

where DM : Flood damage ratio (%)
 DP : Inundation depth (m)
 DR : Inundation duration (days)
 a, b₁, b₂ : Regression coefficients

R = Multiple correlation coefficient

T = T value

N = No. of samples

Item	a	b ₁	b ₂	R	T	N
1) House						
(1) Building(s)	-2.341	10.368	0.179	0.277	10.342	1,287
(2) Household Effects	6.491	5.260	0.330	0.170	6.213	1,292
(3) Income	0.143	0.075	0.143	0.346	11.169	922
2) Shop						
(1) Building(s)	5.036	1.510	0.411	0.427	2.363	27
(2) Equipment & Inventories	8.510	2.920	0.074	0.214	2.010	86
(3) Profit	2.450	0.508	0.221	0.699	15.034	238
3) Factory						
(1) Building(s)	2.359	2.201	0.227	0.177	2.506	197
(2) Equipment & Inventories	12.377	0.188	0.609	0.221	3.209	202
(3) Profit	6.789	7.379	0.020	0.234	3.523	217

2. Regression Equation - 2

$$FP = a_p + b_p * DP$$

where FP : Inundation depth of a farm (m)
 DP : Inundation depth of a farm house (m)
 a_p, b_p : Regression coefficients for equation FP

R_p = Correlation coefficient for equation FP

T_p = T value for equation FP

N_p = No. of samples for equation FP

Table E.11(2) Relationships between Inundation Depths/Durations and Damage Ratios for 1988 Flood

$$FR = a_r + b_r * DR$$

where FR : Inundation duration of a farm (days)
 DR : Inundation duration of a farm house (days)
 a_r, b_r : Regression coefficients for equation FR

R_r = Correlation coefficient for equation FR

T_r = T value for equation FR

N_r = No. of samples for equation FR

a_p	b_p	R_p	T_p	N_p	a_r	b_r	R_r	T_r	N_r
2.695	0.936	0.258	5.915	491	92.515	1.100	0.276	6.241	474

3. Regression Equation - 3

$$FM = a + b_1 * FP + b_2 * FR$$

where FM : Ratio of flood damages to agricultural crops (%)
 FP : Inundation depth of a farm (m)
 FR : Inundation duration of a farm (days)
 a, b_1, b_2 : Regression coefficients

R = Multiple correlation coefficient

T = T value

N = No. of samples

Item	a	b_1	b_2	R	T	N
Agricultural Crops	92.255	0.237	0.032	0.161	3.050	351

Source: JICA

Table E.12(1) Average Values of Various Indices for Economic Analysis

1. Dimensions of Properties

Item	House				Shop	Factory
	Low Class	Middle Class	High Class	Total		
1) Height of Floor (m)	0.34	0.36	0.36	0.35	0.25	0.27
2) Elevated Ground Height (m)	0.16	0.10	0.60	0.15	0.10	0.02
3) Floor Area (m ²)	39.8	87.5	177.6	61.6	23.9	291.7
4) Present Value (Tk)						
(1) Building(s)	33,216	167,767	377,182	93,319	48,178	488,483
(2) Household Effects	9,429	37,802	158,998	24,416	-	-
(3) Equipment & Inventories	-	-	-	-	136,074	571,855
5) No. of Families in a House	1.21	1.42	1.76	1.30	-	-
6) No. of Members in a Family	5.53	6.76	7.83	6.05	-	-
7) No. of Workers in a Shop/Factory	-	-	-	-	2.49	15.20
8) Annual Income/ Profit (Tk)	21,754	56,703	217,810	40,567	19,940	163,053
9) No. of Samples	505	490	505	-	251	237

Note: Low Class : Families with a monthly income of less than Tk 2,500
Middle Class : Families with a monthly income Tk 2,500 to Tk 6,999
High Class : Families with a monthly income of not less than Tk 7,000

Table E.12(2) Average Values of Various Indices for Economic Analysis

2. Inundation Depths/Duration and Damage Ratios

Item	1987 Flood			1988 Flood		
	House	Shop	Factory	House	Shop	Factory
1) Inundation						
Depth (m)	0.72	0.67	-	1.10	1.02	1.06
Duration (days)	11.3	6.50	-	20.4	18.4	19.9
2) Flood Damage						
Ratio (%)						
(1) Building(s)	8.39	-	-	12.73	15.07	9.19
(2) Household	2.48	-	-	18.90	-	-
Effects						
(3) Equipment & Inventories	-	-	-	-	12.52	24.65
(4) Income/Profit	4.11	2.93	-	5.38	6.33	14.97

3. Indices on Farmers

1) Farm House

(1) Height of Floor (m)	: 0.48
(2) Elevated Ground Height (m)	: 1.39
(3) Floor Area (m ²)	: 54.8
(4) Present Value (Tk)	
i. Building(s)	: 59,644
ii. Household Effects	: 28,801
(5) No. of Members in a House	: 9.65

Table E.12(3) Average Values of Various Indices for Economic Analysis

2) Inundation Depths/Durations and Ratio of Damages to Crops

Item	1987 Flood	1988 Flood
(1) Inundation Depths (m)		
i. Farm House	0.37	1.00
ii. Farm	3.18	3.63
(2) Inundation Duration (days)		
i. Farm House	7.6	15.7
ii. Farm	120.2	109.8
(3) Ratio of Damages to Crops (%)	69.6	96.6

3) Agriculture in Flood Season

Crops	Cropped Area per Farmer (ha)	Ratio of Farmers with Cropped Area (%)	Average Yield (t/ha)	Gate Price (Tk/t)
Aus	0.555	17.8	1.038	4,934
Amon	0.593	12.0	1.601	5,685
Jute	0.342	40.9	0.607	6,310
Vegetables	0.187	40.1	8.471	5,171
Others	0.671	45.5	1.277	5,746

Source: JICA

Table E.13 1987-Scale Flood Damages by Area by Type of Properties in 1980

Bd=Building(s), H.E=Household Effects, Ic=Income, E&I=Equipment and Inventories, Pf=Profit, Cp=Crops

(Unit: Tk Million)

Name of Areas	Residential			Commercial			Industrial			Institutional			Agricultural						
	Bd	H.E	Ic	Bd	E&I	Pf	Bd	E&I	Pf	Bd	E&I	Pf	Bd	E&I	Pf	Bd	E&I	Pf	Cp
Dhaka	1,505.5	106.5	315.5	0.0	0.0	4.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	456.9
Narayanganj	168.8	4.8	55.8	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	124.4
Keraniganj	472.3	15.1	105.8	0.0	0.0	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	81.2
Savar	187.0	8.7	40.8	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	117.6
Tongi	58.9	2.2	13.2	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	26.7
TOTAL	2,392.5	137.3	531.1	0.0	0.0	6.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	816.8

Source: JICA

Table E.14 1988-Scale Flood Damages by Area by Type of Properties in 1980

Bd=Building(s), H.E=Household Effects, Ic=Income, E&I=Equipment and Inventories, Pf=Profit, Cp=Crops

(Unit: Tk Million)

Name of Areas	Residential			Commercial			Industrial			Institutional			Agricultural						
	Bd	H.E	Ic	Bd	E&I	Pf	Bd	E&I	Pf	Bd	E&I	Pf	Bd	E&I	Pf	Bd	E&I	Pf	Cp
Dhaka	4,221.1	1,853.9	556.5	100.9	235.5	21.0	48.2	163.0	26.0	443.1	163.0	26.0	443.1	163.0	26.0	443.1	163.0	26.0	540.7
Narayanganj	770.8	365.4	111.3	19.4	43.4	4.0	58.3	183.0	28.6	63.9	183.0	28.6	63.9	183.0	28.6	63.9	183.0	28.6	148.3
Keraniganj	1,120.0	411.1	119.6	19.2	44.3	4.0	14.0	42.6	7.5	21.6	42.6	7.5	21.6	42.6	7.5	21.6	42.6	7.5	107.0
Savar	521.9	202.4	55.3	2.7	6.8	0.6	12.7	40.4	7.2	22.4	40.4	7.2	22.4	40.4	7.2	22.4	40.4	7.2	139.2
Tongi	202.2	85.8	25.5	8.5	22.1	1.8	55.3	185.6	30.5	52.4	185.6	30.5	52.4	185.6	30.5	52.4	185.6	30.5	31.2
TOTAL	6,836.0	2,828.7	868.2	150.7	352.1	31.4	189.5	629.6	99.8	603.4	629.6	99.8	603.4	629.6	99.8	603.4	629.6	99.8	866.4

Source: JICA

Table E.15 1987-Scale Flood Damages by Area by Type of Properties in 2010

Bd=Building(s), H.E=Household Effects, Ic=Income, E&I=Equipment and Inventories, Pf=Profit, Cp=Crops

Name of Areas	Residential			Commercial			Industrial			Institutional			Agricultural	
	Bd	H.E	Ic	Bd	E&I	Pf	Bd	E&I	Pf	Bd	Pf	Bd	Pf	Cp
Dhaka	5,436.3	332.7	1,118.4	0.0	0.0	12.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	108.5
Narayanganj	658.5	23.3	187.1	0.0	0.0	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	39.7
Keraniganj	1,125.5	35.6	253.4	0.0	0.0	2.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	80.2
Savar	459.2	21.3	89.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	98.4
Tongi	361.9	13.7	80.3	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.1
TOTAL	8,041.4	426.6	1,738.2	0.0	0.0	19.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	339.9

(Unit: Tk Million)

Source: JICA

Table E.16 1988-Scale Flood Damages by Area by Type of Properties in 2010

Bd=Building(s), H.E=Household Effects, Ic=Income, E&I=Equipment and Inventories, Pf=Profit, Cp=Crops

Name of Areas	Residential			Commercial			Industrial			Institutional			Agricultural	
	Bd	H.E	Ic	Bd	E&I	Pf	Bd	E&I	Pf	Bd	Pf	Bd	Pf	Cp
Dhaka	13,261.5	5,714.2	1,735.0	269.4	618.3	56.1	111.2	365.5	58.6	1,297.1	128.2	1,297.1	128.2	128.2
Narayanganj	2,287.1	1,086.0	328.8	42.0	95.2	8.8	179.0	608.0	87.1	178.3	47.5	178.3	47.5	47.5
Keraniganj	2,677.4	984.8	286.2	39.8	91.8	8.3	36.2	110.8	19.3	52.1	94.1	52.1	94.1	94.1
Savar	1,378.7	544.7	147.3	7.6	19.3	1.6	45.8	147.4	26.0	84.8	116.6	84.8	116.6	116.6
Tongi	1,233.4	585.0	155.4	52.4	135.9	10.8	339.8	1,141.3	186.8	321.9	15.3	321.9	15.3	15.3
TOTAL	20,838.1	8,814.7	2,652.7	411.3	958.5	85.6	712.1	2,373.0	377.8	1,935.2	401.7	1,935.2	401.7	401.7

(Unit: Tk Million)

Source: JICA

Table E.17(1) Flood Damages by Zone by Scale of Floods

(Unit: Tk. Million)

Zone No.	Name of Zones	1990		2010		Average Annual	
		1987-Scale	1988-Scale	1987-Scale	1988-Scale	1990	2010
1	1	58.2	107.9	110.6	208.9	23.3	44.4
2	2	109.4	385.2	221.8	827.1	48.1	98.6
3	3	9.5	108.4	14.2	210.4	5.9	10.0
4	4	6.4	12.2	6.0	17.9	2.6	2.6
5	5	18.9	123.3	27.0	336.9	9.7	17.5
6	6	1.6	39.7	4.7	100.6	1.5	4.0
7	7	0.0	1.3	0.0	2.5	0.0	0.1
8	8	0.0	0.0	0.0	0.0	0.0	0.0
9	9	0.0	0.0	0.0	0.0	0.0	0.0
10	10	62.5	293.4	44.8	544.2	29.2	28.7
11	11	1.4	31.9	3.4	77.4	1.2	3.0
12	12	7.3	159.8	7.8	169.2	6.4	6.7
13	13	0.0	3.4	0.0	10.3	0.1	0.2
14	14	0.0	0.0	0.0	0.0	0.0	0.0
15	15	0.0	0.0	0.0	0.0	0.0	0.0
16	16	2.7	88.0	2.3	76.1	3.0	2.6
17	17	1.7	38.5	2.9	65.2	1.5	2.6
18	18	0.0	0.0	0.0	0.0	0.0	0.0
19	19	0.0	19.0	0.0	30.2	0.4	0.7
20	20	0.0	0.0	0.0	0.0	0.0	0.0
21	21	0.0	0.0	0.0	0.0	0.0	0.0
22	22	0.0	0.0	0.0	0.0	0.0	0.0
23	23	0.0	0.0	0.0	0.0	0.0	0.0
24	24	0.0	7.0	0.0	8.9	0.2	0.2
25	25	0.0	28.5	0.0	51.2	0.7	1.2
26	26	0.0	0.0	0.0	0.0	0.0	0.0
27	27	0.0	0.0	0.0	0.0	0.0	0.0
28	28	0.0	0.0	0.0	0.0	0.0	0.0
29	29	0.0	37.4	0.0	73.6	0.9	1.7
30	30	0.0	96.2	0.0	198.6	2.2	4.6
31	31 Dhaka	52.7	313.2	0.0	620.9	26.1	14.5
32	32 Dhaka	0.0	43.1	0.0	118.8	1.0	2.8
33	33 Dhaka	0.3	163.4	0.0	328.3	3.9	7.7
34	34	200.7	383.0	483.9	925.1	80.7	194.6
35	35	1.7	90.5	0.0	173.6	2.7	4.1
36	36	7.2	197.3	4.6	426.9	7.2	11.6
37	37	0.0	30.1	0.0	57.9	0.7	1.4
38	38	3.1	236.2	6.8	514.0	6.6	14.4
39	39	30.6	392.8	27.7	786.3	20.1	28.3
40	40	46.6	119.9	9.5	183.3	19.5	7.7
41	41	0.0	81.3	0.0	158.3	1.9	3.7
42	42	0.0	40.3	0.0	78.5	0.9	1.8
43	43	0.0	27.5	0.0	55.0	0.6	1.3
44	44	0.0	0.0	0.0	0.0	0.0	0.0
45	45	0.0	0.0	0.0	0.0	0.0	0.0
46	46	0.0	0.0	0.0	0.0	0.0	0.0
47	47	1.9	72.8	3.7	142.8	2.4	4.7
48	48	53.0	238.3	105.8	475.1	24.5	48.9
49	49	0.2	10.4	0.4	20.5	0.3	0.6
50	50	0.1	8.2	0.2	16.2	0.2	0.4

Note: Flood damages = Flood damages to houses, shops, factories, institutions and agricultural crops

Source: JICA

Table E.17(2) Flood Damages by Zone by Scale of Floods

(Unit: Tk. Million)

Zone No.	Name of Zones	1990		2010		Average Annual	
		1987-Scale	1988-Scale	1987-Scale	1988-Scale	1990	2010
51	51	27.8	126.5	55.1	250.7	12.9	25.6
52	52	7.7	160.0	15.3	317.2	6.5	12.9
53	53	4.7	56.2	9.3	111.1	3.0	5.9
54	54	149.9	351.5	399.2	993.0	61.8	165.9
55	55	99.3	347.6	245.5	872.7	43.6	108.2
56	56	403.3	821.1	1,046.8	2,420.8	165.7	431.5
57	Gulshan 57	56.4	165.0	281.7	1,088.1	24.0	126.1
58	Cantonment Ward-1	69.8	334.6	184.3	883.4	32.8	86.5
59	Cantonment Ward-2	97.0	248.0	312.6	799.6	40.5	130.5
60	Cantonment Ward-3	40.0	110.6	162.3	858.0	16.9	78.1
61	Sultanganj	336.7	453.1	1,213.1	1,632.6	131.0	471.8
62	Harirampur	88.7	155.5	351.1	873.7	35.3	148.3
63	Dakshin Khan Cantt.	65.7	176.7	202.9	552.6	27.6	85.5
64	Uttar Khan	52.7	88.3	527.6	1,037.2	20.9	212.8
65	Dakshin Khan Gulshan	54.5	119.0	333.8	843.2	22.3	139.1
66	Beraid Gulshan	36.5	81.6	79.4	296.9	14.9	35.3
67	Beraid Deara	19.4	35.1	11.9	41.3	7.8	5.2
68	Deara	89.8	217.0	159.7	505.4	37.2	68.9
69	Matuail Dhaka	10.9	34.5	327.0	1,044.9	4.7	141.3
31	31 Nara.	0.0	5.7	0.0	14.1	0.1	0.3
32	32 Nara.	0.0	0.0	0.0	0.0	0.0	0.0
33	33 Nara.	0.1	0.2	0.0	0.0	0.1	0.0
69	Matuail Nara.	28.0	33.7	18.9	22.8	10.8	7.3
70	Shyampur	5.1	61.8	3.5	162.0	3.3	5.0
71	N 1	5.9	32.9	3.6	73.5	2.9	3.0
72	N 2	4.9	68.3	7.6	142.0	3.3	6.0
73	N 3	12.6	49.8	2.2	100.8	5.7	3.1
74	N 4	13.0	146.6	23.2	282.0	8.1	14.9
75	N 5	5.0	113.3	9.6	218.6	4.4	8.5
76	N 6	14.4	155.7	28.0	303.2	8.8	17.1
77	N 7	8.6	67.3	11.4	124.7	4.6	7.0
78	N 8	5.2	76.1	7.4	144.3	3.6	6.0
79	N 9	10.7	92.4	29.9	409.0	6.0	20.2
80	N10	4.7	56.5	2.1	112.2	3.0	3.4
81	N11	27.9	103.7	46.4	207.4	12.4	21.4
82	N12	2.4	64.2	7.0	203.5	2.4	7.2
83	Tarabo	58.2	99.8	154.1	273.1	23.1	61.5
84	Kachpur	15.8	75.0	44.8	379.8	7.4	24.9
85	Siddhirganj	6.5	39.7	2.1	88.8	3.3	2.4
86	Simulpara	7.6	203.1	12.9	421.6	7.5	14.5
87	Godnail	8.0	17.8	1.0	94.6	3.3	2.6
88	Kutubpur	13.1	19.4	7.1	21.8	5.1	3.1
89	Fatullah	2.8	5.4	1.2	8.5	1.1	0.6
90	Enayetnagar	25.5	114.5	114.5	559.2	11.8	54.0
91	Kashipur	68.4	108.8	371.6	601.2	27.0	146.9
92	Konda	52.1	172.8	128.5	520.8	22.7	58.1
93	Tegurua	47.5	104.7	200.8	483.2	19.4	83.1
94	Subhadya	141.5	470.7	285.6	974.4	61.6	124.9
95	Zinjira	163.9	458.5	322.4	902.5	69.3	136.3
96	Kalindi	29.7	101.4	78.6	286.2	13.0	34.8

Note: Flood damages = Flood damages to houses, shops, factories, institutions and agricultural crops

Source: JICA

Table E.17(3) Flood Damages by Zone by Scale of Floods

(Unit: Tk. Million)

Zone No.	Name of Zones	1990		2010		Average Annual	
		1987-Scale	1988-Scale	1987-Scale	1988-Scale	1990	2010
97	Basta	42.1	107.6	79.7	219.8	17.6	33.6
98	Sakta	58.3	151.8	113.7	314.3	24.4	48.0
99	Rohitpur	35.8	92.5	65.6	186.6	15.0	27.8
100	Taranagar	55.1	123.1	105.3	250.4	22.6	43.5
101	Kalatia	59.6	127.5	117.3	262.6	24.3	48.1
102	Amin Bazar	43.2	94.7	81.3	181.3	17.7	33.3
103	Kaundia	33.1	106.5	60.3	203.3	14.3	26.3
104	Hazratpur	32.4	54.4	100.9	177.8	12.9	40.2
105	Bhakurta	67.0	153.6	131.2	316.6	27.5	54.3
106	Tetuljhora	36.9	98.0	71.5	207.5	15.5	30.4
107	Banagram	35.1	55.6	68.8	112.0	13.9	27.2
108	Biralia	16.5	42.4	16.0	68.1	6.9	7.3
109	Savar	22.1	187.7	52.3	826.4	12.3	38.0
110	Ashulia	18.8	62.1	17.4	106.5	8.2	8.7
111	Pathalia	13.7	86.8	13.5	177.1	6.9	8.9
112	Dhamsona	4.6	5.5	2.5	3.0	1.8	1.0
113	Yearpur	11.3	36.2	13.6	65.5	4.9	6.4
114	Kashimpur	19.3	28.1	49.1	74.7	7.6	19.3
115	Tongi	100.5	706.1	470.0	4,168.6	52.4	265.5
116	Gachha	0.8	4.9	0.9	9.5	0.4	0.6
	TOTAL	3,884.4	13,655.8	10,565.3	39,660.7	1,707.8	4,704.1

Summary

(Unit: Tk. Million)

Name of Areas	1990		2010		Average Annual	
	1987-Scale	1988-Scale	1987-Scale	1988-Scale	1990	2010
Dhaka	2,388.7	8,210.9	7,008.7	23,613.1	1,045.9	3,057.5
Narayanganj	354.4	1,811.4	909.9	4,948.8	169.0	441.0
Keraniganj	685.8	1,910.9	1,497.5	4,400.8	289.8	638.2
Savar	354.2	1,011.6	678.2	2,519.9	150.3	301.4
Tongi	101.3	711.0	471.0	4,178.0	52.8	266.0
TOTAL	3,884.4	13,655.8	10,565.3	39,660.7	1,707.8	4,704.1

Note: Flood damages = Flood damages to houses, shops, factories, institutions and agricultural crops

Source: JICA

Table E.18 Internal Flood Damages by Area by Scale of Floods

1. Annual and Worst Floods

(Unit: Tk Million)

Damageable Items	Annual Flood			Worst Flood		
	G. Dhaka West	G. Dhaka East	Total	G. Dhaka West	G. Dhaka East	Total
1) Year 1990						
Houses	45.2	119.8	165.0	101.3	244.3	345.6
Household Articles	1.0	1.2	2.2	6.8	13.0	19.8
Public Properties	20.8	55.1	75.9	54.8	132.3	187.1
Income Losses	12.2	32.4	44.6	25.5	61.6	87.1
Traffic Damages	6.8	17.0	24.7	7.1	17.2	24.3
Total	86.0	226.4	312.4	195.5	468.4	663.9
2) Year 2010						
Houses	63.6	183.4	247.0	121.7	360.8	482.5
Household Articles	2.3	2.5	4.8	15.5	29.1	44.6
Public Properties	43.8	126.2	170.0	106.2	314.7	420.9
Income Losses	32.0	92.7	124.7	60.1	178.1	238.2
Traffic Damages	13.8	39.8	53.6	13.5	39.7	53.2
Total	155.5	444.6	600.1	317.0	922.4	1,239.4

2. Average Annual Flood

(Unit: Tk Million)

Year	Greater Dhaka West	Greater Dhaka East	Total
1990	109.2	274.1	383.3
2010	186.9	539.2	726.1

Source: JICA

Table E.19 Example of Calculation of Average Annual Flood Damages

1. Year 1990

1) Damage - Return Period Curve

$$y = f(x) = (f(10)/\log 10) \log x = 1,686.9735 \log x \quad (1 \leq x \leq 10)$$

$$y = f(x) = (7f(10)-f(70))/6 + ((f(70)-f(10))/60) x \\ = 2,255.8333 + 162.8567 x \quad (10 \leq x)$$

where y: external flood damages in the study area (Tk million)

x: return period (years)

2) Average Annual Flood Damages

$$z = \int_1^{10} (1,686.9735 \log x / x^2) dx \\ + \int_{10}^{100} (2,255.8333 + 162.8567 x) / x^2 dx \\ = 1,707.8$$

where z: average annual flood damages in the study area (Tk million)

2. Year 2010

1) Damage - Return Period Curve

$$y = f(x) = (f(10)/\log 10) \log x = 4,588.4515 \log x \quad (1 \leq x \leq 10)$$

$$y = f(x) = (7f(10)-f(70))/6 + ((f(70)-f(10))/60) x \\ = 5,716.0667 + 484.9233 x \quad (10 \leq x)$$

2) Average Annual Flood Damages

$$z = \int_1^{10} (4,588.4515 \log x / x^2) dx \\ + \int_{10}^{100} (5,716.0667 + 484.9233 x) / x^2 dx \\ = 4,704.1$$

Note: Flood damages = Flood damages to houses, shops, factories, institutions and agricultural crops

Source: JICA

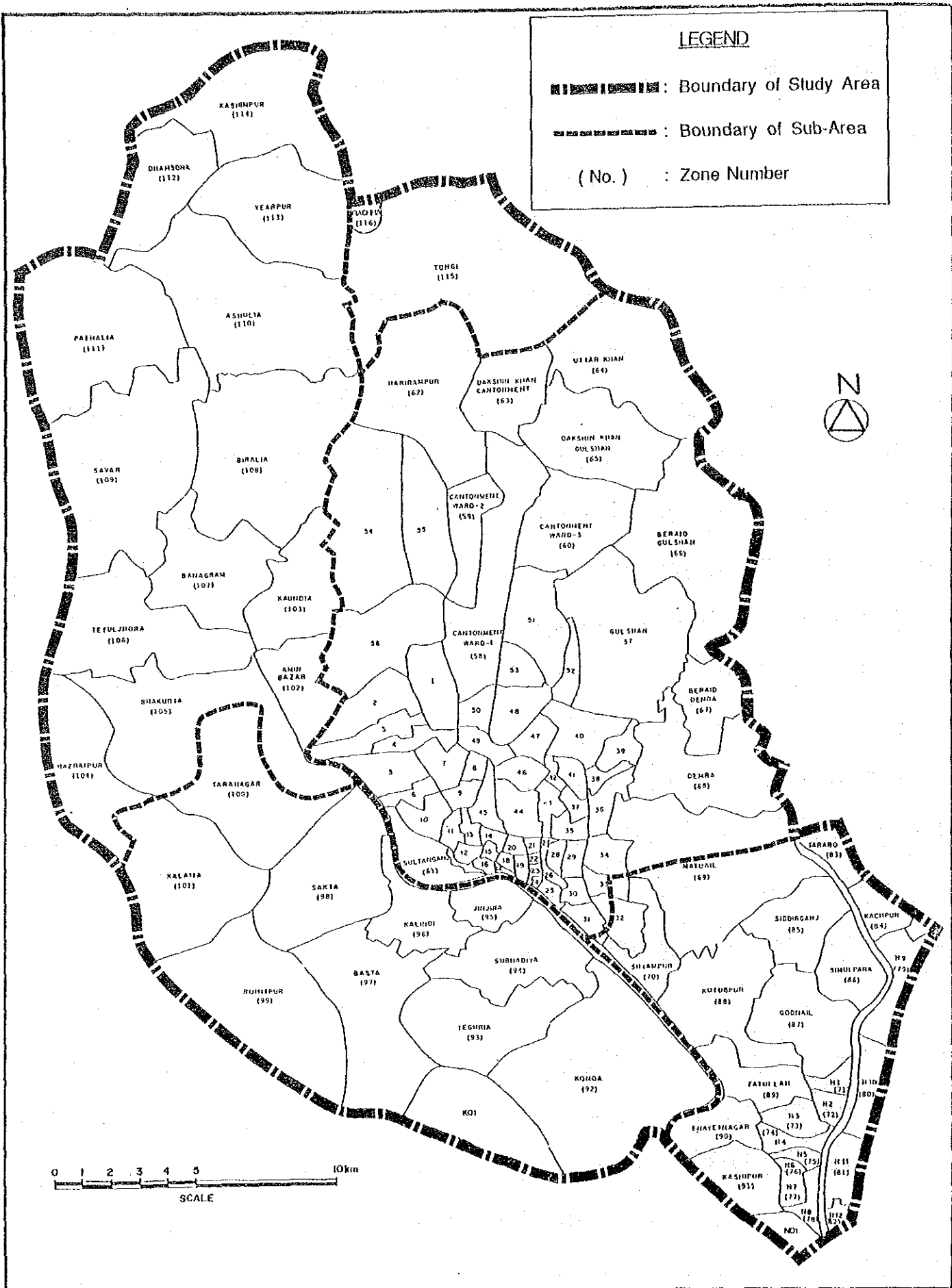


FIG. E.1

DIVISION OF STUDY AREA BY ZONE

GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLITAN AREA) OF BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH

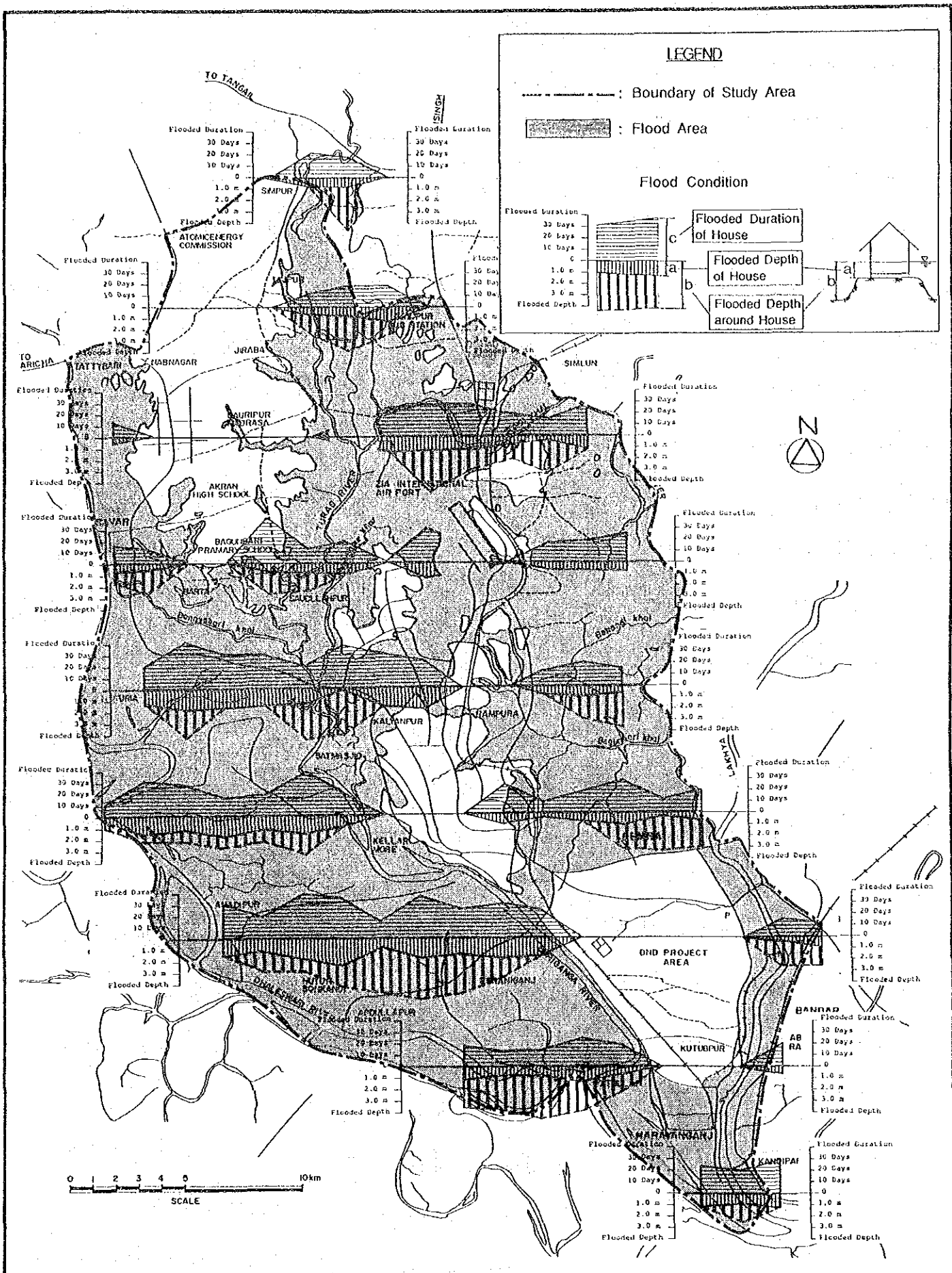


FIG. E.4

EXTERNAL FLOOD MAP - 1988 FLOOD

GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLITAN AREA) OF BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH

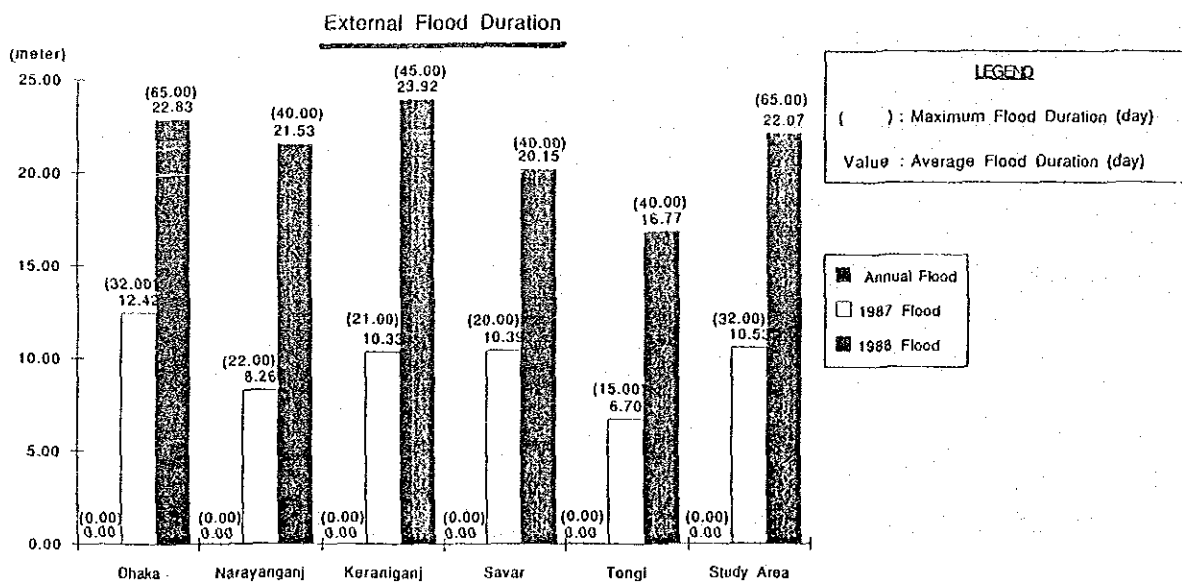
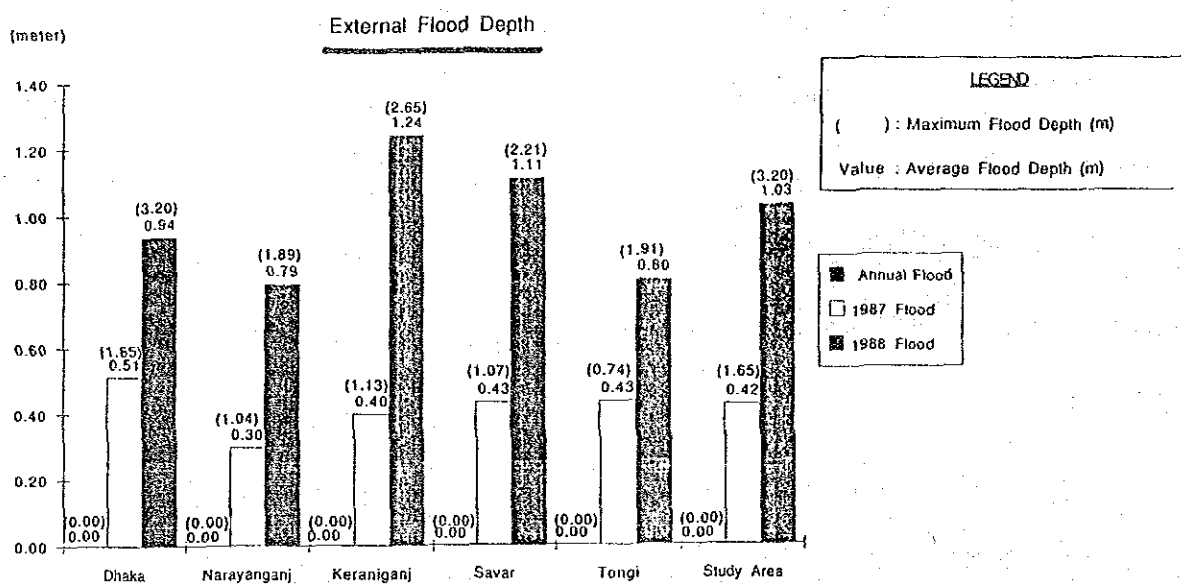
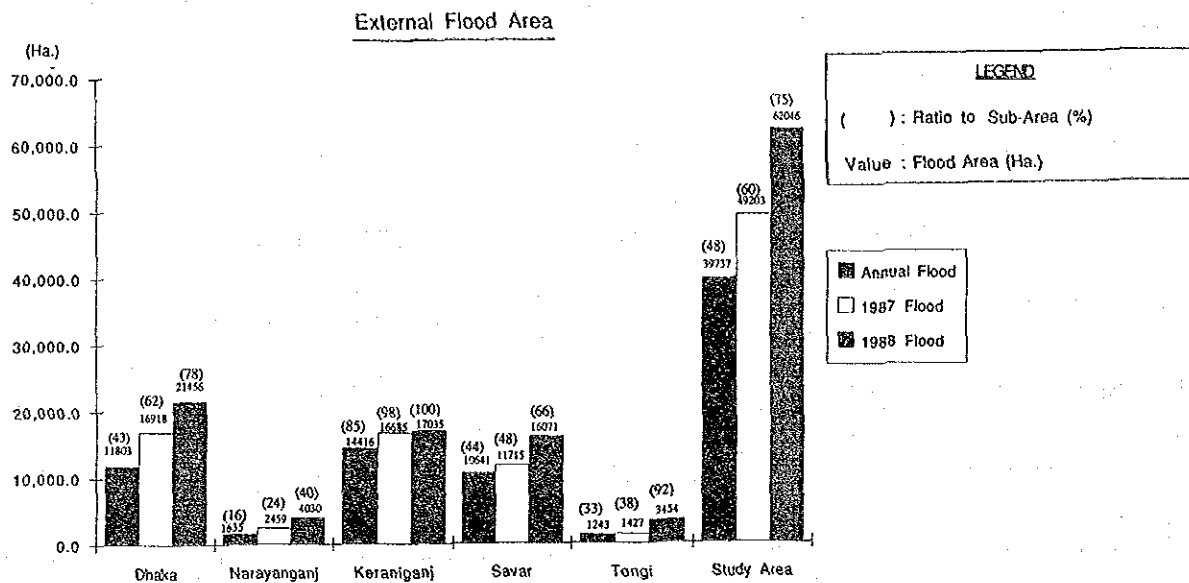


FIG. E.5

EXTERNAL FLOOD CONDITIONS

GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLITAN AREA) OF BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH

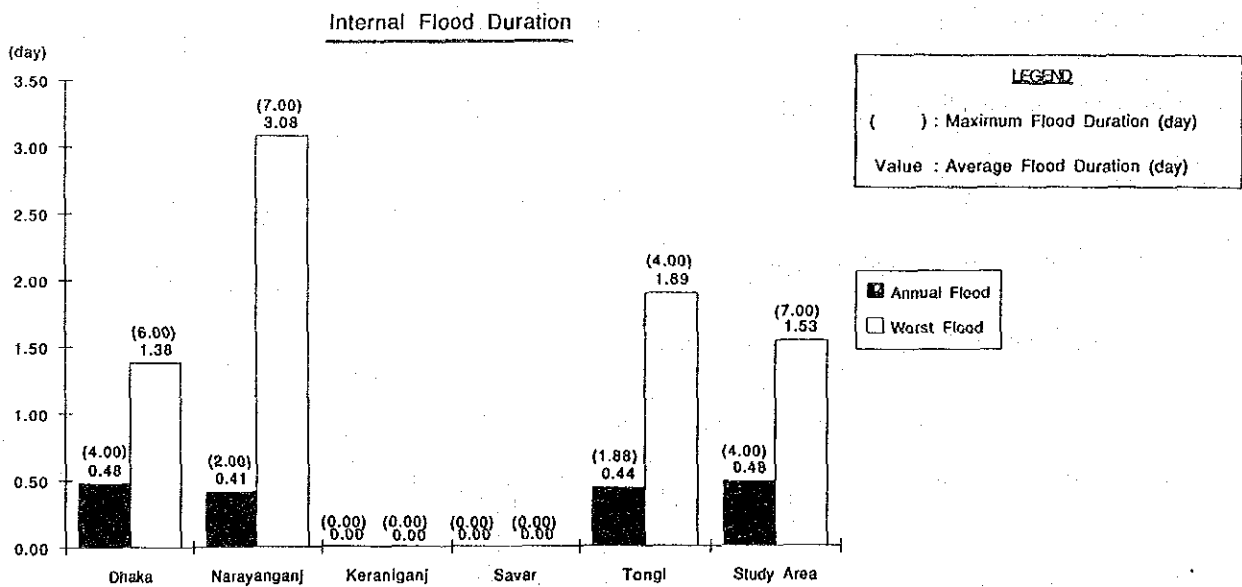
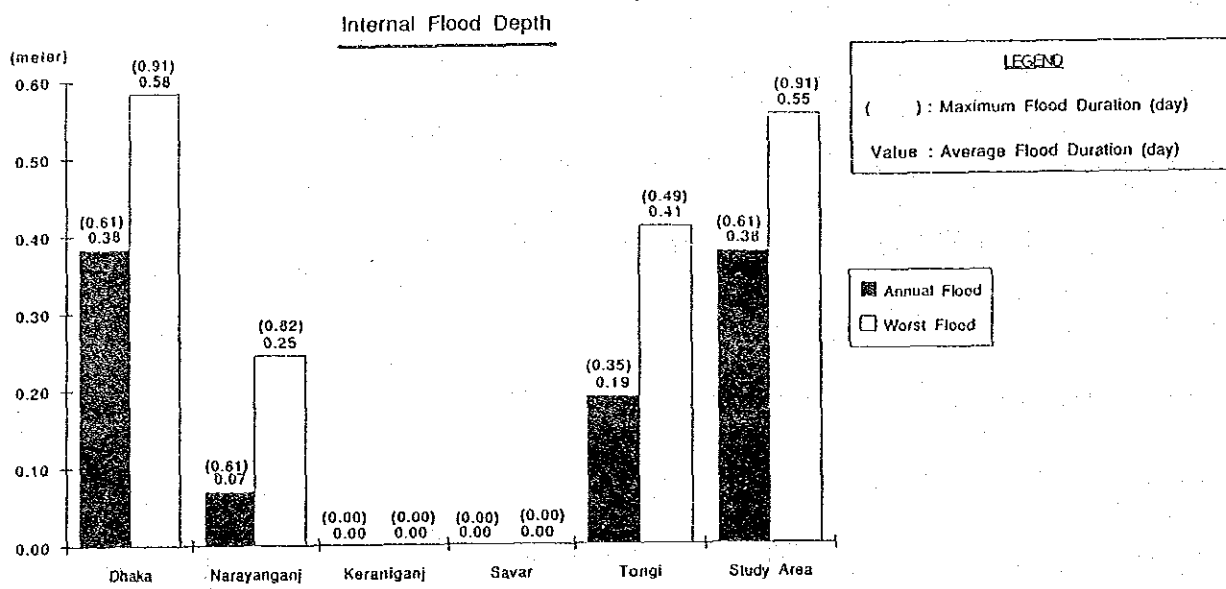
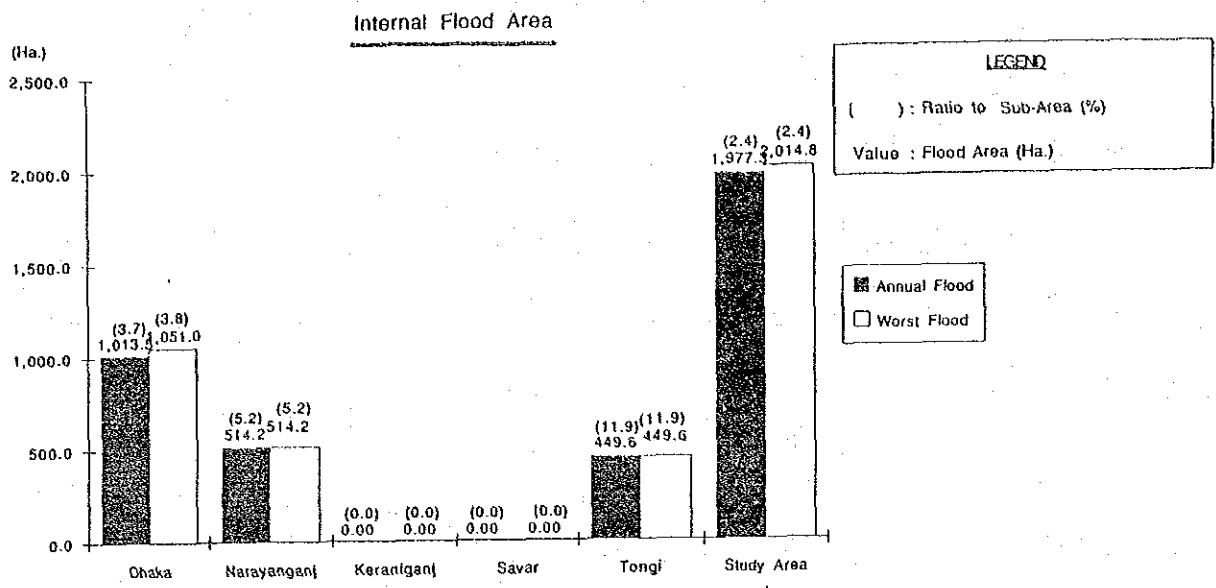


FIG. E.7

INTERNAL FLOOD CONDITIONS

GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLITAN AREA) OF BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH



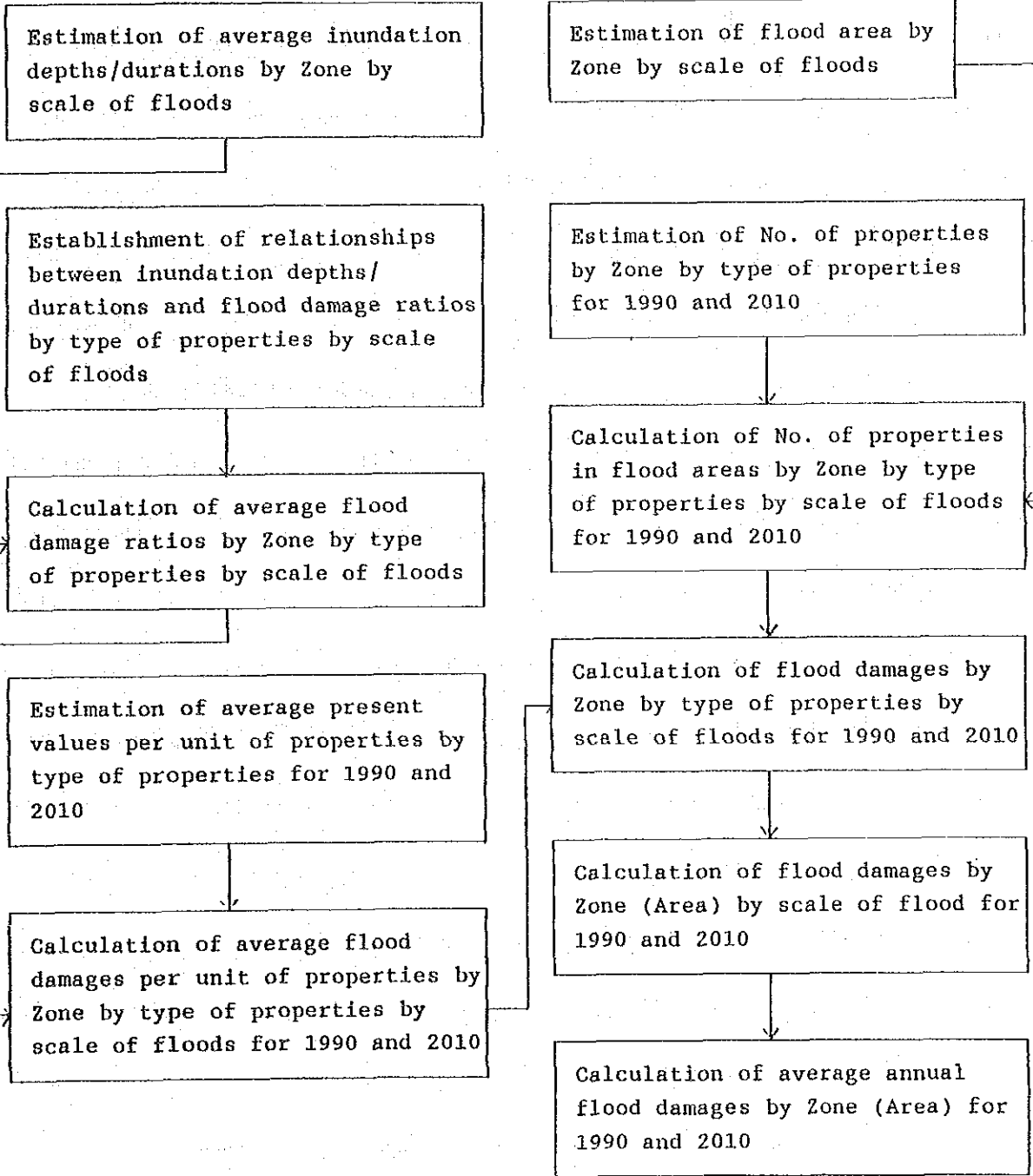
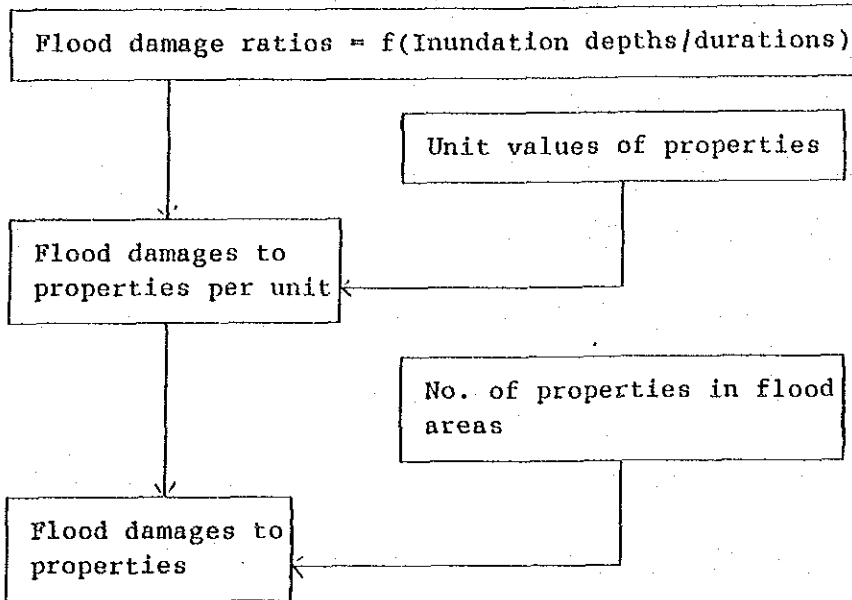


FIG. E.8 METHODOLOGY FOR ESTIMATION OF AVERAGE ANNUAL FLOOD DAMAGES

GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLITAN AREA) OF BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH

1. Direct flood damages to properties (houses, shops, factories and institutions)



2. Income/profit losses for households, shops and factories

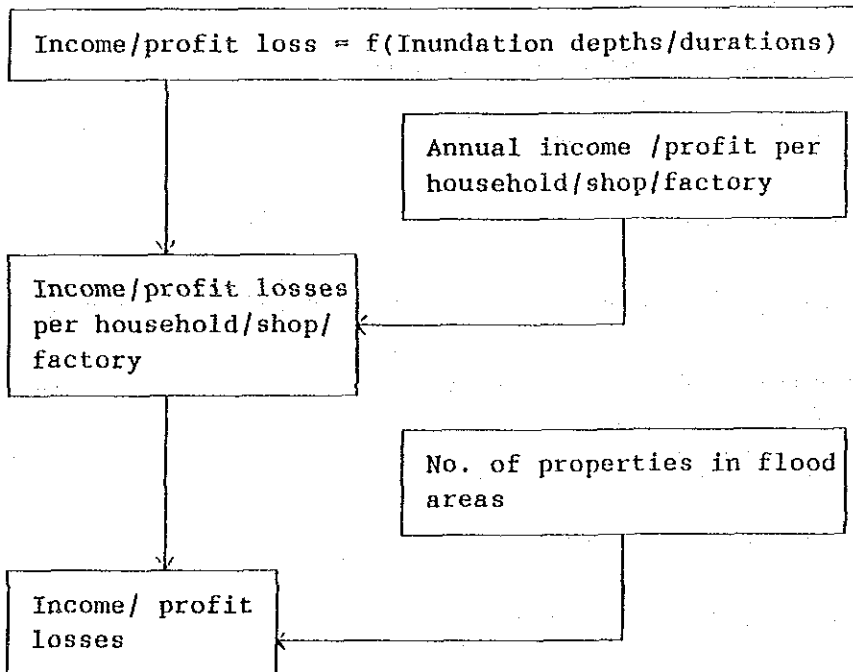
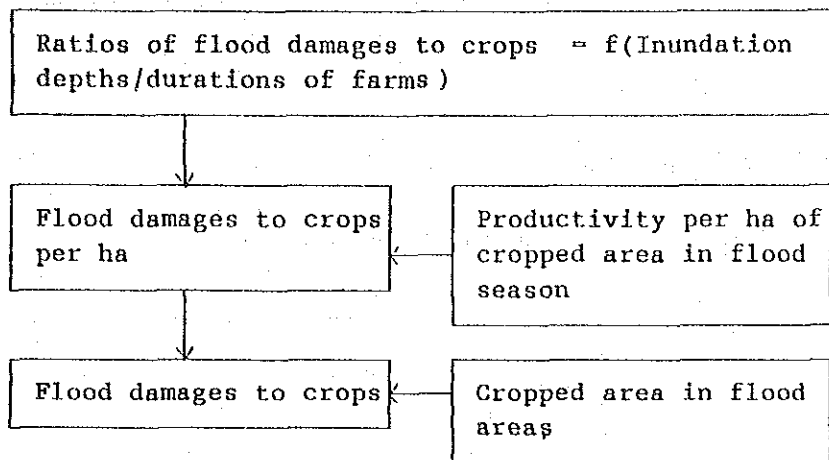


FIG. E.9(1)

STEPS FOR CALCULATION OF SPECIFIC FLOOD DAMAGES

GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLITAN AREA) OF BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH

3. Direct flood damages to agricultural crops



4. Average annual flood damages

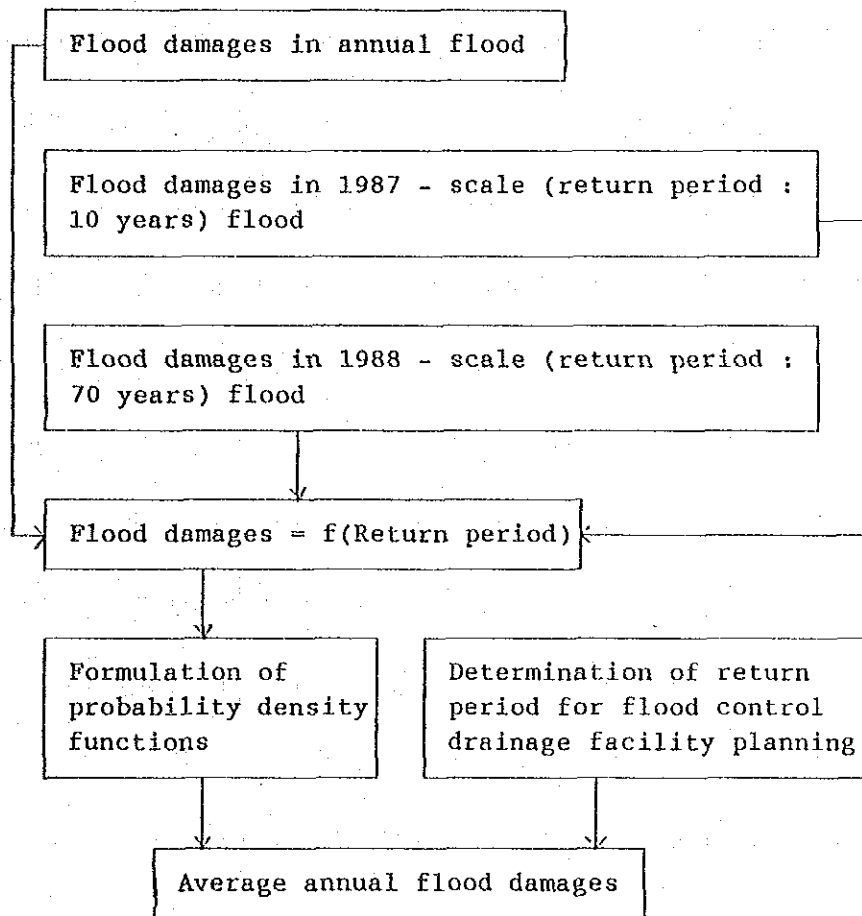
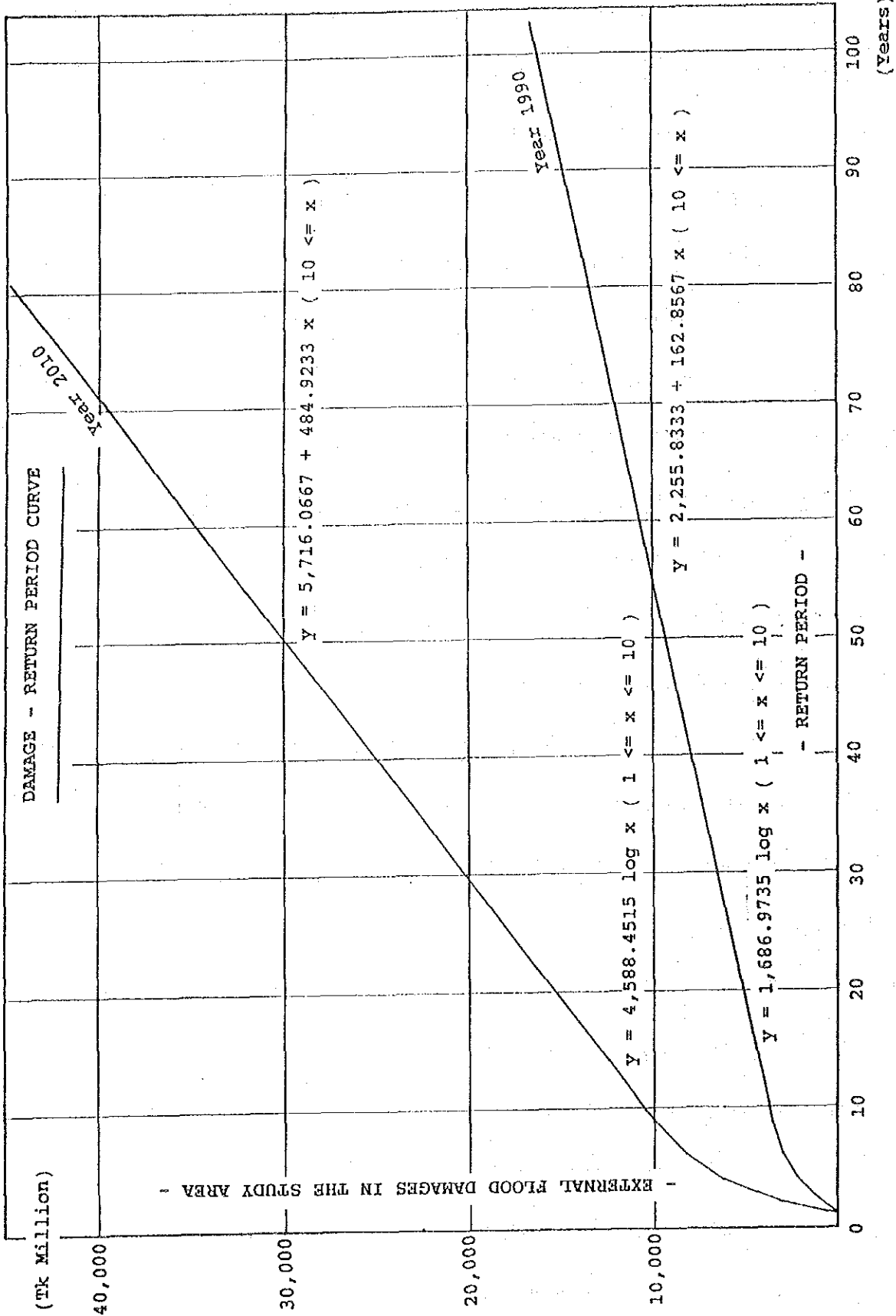


FIG. E.9(2)

STEPS FOR CALCULATION OF SPECIFIC FLOOD DAMAGES

GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLITAN AREA) OF BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH



Note: Flood damages = Flood damages to houses, shops, factories, institutions and agricultural crops

FIG. E.10

EXAMPLE OF DAMAGE - RETURN PERIOD CURVE

GREATTER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLITAN AREA) OF BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH



Return Period and Flood Damage (unit : Tk. Million)

Return Period (Years)	1990 Flood Damage			2010 Flood Damage		
	Internal	External	Total	Internal	External	Total
1	312.4	-	312.4	600.1	-	600.1
10	663.9	3,884.4	4,548.3	1,239.4	10,565.3	11,804.7
70	663.9	13,655.8	14,319.7	1,239.4	39,660.7	40,900.1

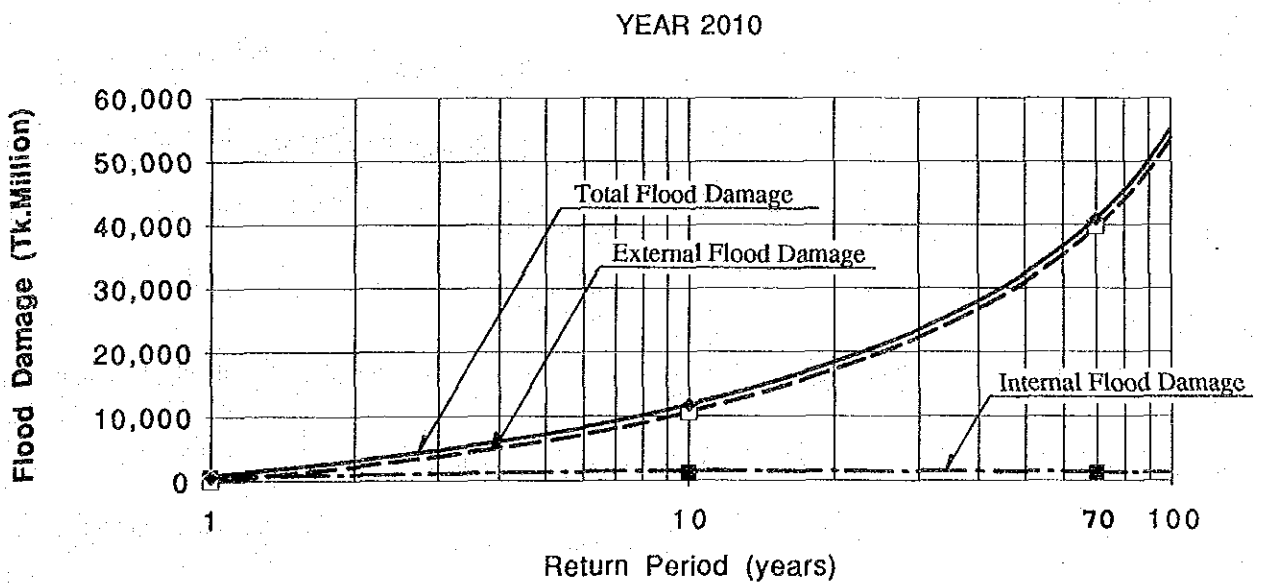
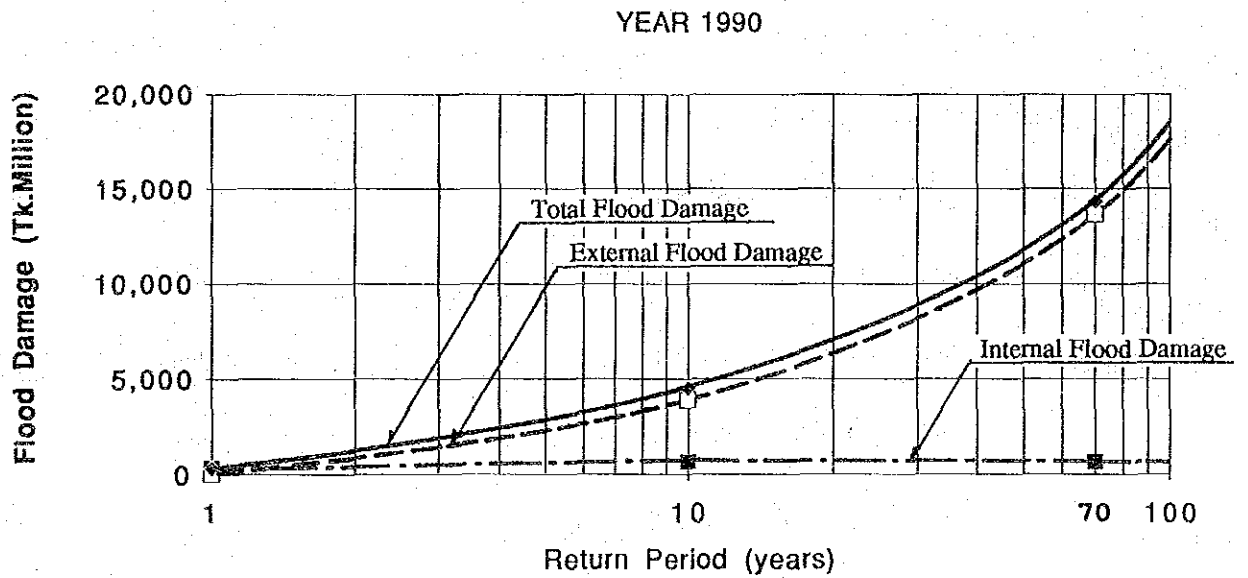


FIG. E.11

SUMMARIZED DAMAGE-RETURN PERIOD CURVE

GREATER DHAKA PROTECTION PROJECT (STUDY IN DHAKA METROPOLITAN AREA) OF BANGLADESH FLOOD ACTION PLAN NO.8A IN THE PEOPLE'S REPUBLIC OF BANGLADESH

