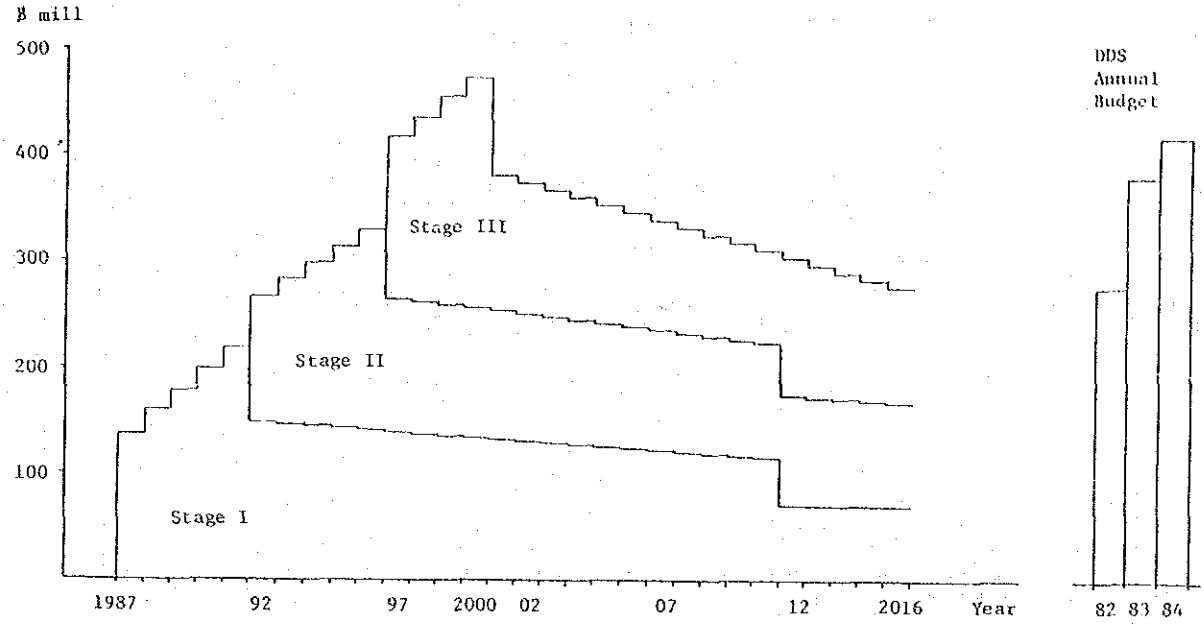


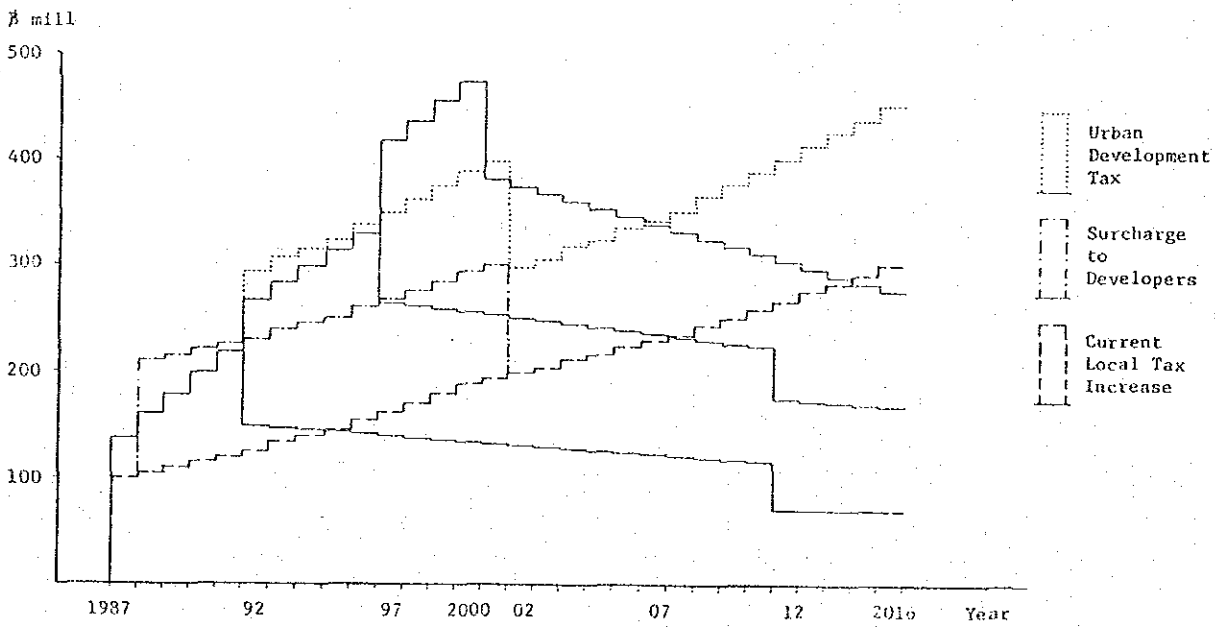


Fig. 0.2 CASH FLOW SCHEDULE OF BMA FOR STAGE I, II & III

MASTER PLAN ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK

JICA 2528B.E 1985A.D

APPENDIX P

FLOOD DAMAGE SURVEY

APPENDIX P FLOOD DAMAGE SURVEY

Table of Contents

List of Figures

Appendix P FLOOD DAMAGE SURVEY

1. Survey Objectives and Method Used

1.1 Objectives of the Survey

A flood survey is usually made to collect data on flood damage relating to households, private establishments and governmental organizations. The survey data will provide the basis for a benefit/cost analysis of the project, and the judgement of feasibility of the project. As severe floods hit Bangkok in 1983, the Study Team was able to conduct a flood damage survey during the Master Plan Study in 1984.

1.2 Survey Method

The Study Team surveyed the damage of the 1983 flood in the Master Plan Area. The survey was done in the form of direct interviews from June 16, 1984 to June 24, 1984, with the cooperation of Dr. Thavivongse, Institute of Environmental Research, Chulalongkorn University.

The number of collected samples was 710, distributed as follows:

444	samples	for	dwelling-houses
119	"	"	commerce
105	"	"	industry
21	"	"	schools
21	"	"	government offices

Three to six samples for dwelling-houses were assigned to each mesh (4 km^2) as shown in Fig. P.1, depending on population density while other samples were distributed based on the existing land use.

1.3 Questionnaires

Four forms of questionnaires, namely: a dwelling house, a private establishment (commerce and industry), school and government office were prepared. Contents of the questionnaires are as follows:

(1) General Question

- Type of House - Material, Landfill or Stilts
- Size of Area
- Number in Family or Employees
- Number of Working Persons
- Income or Revenue
- Have a Car or Motorcycle?

(2) Question on Characteristics of Flood

- Depth
- Duration

(3) Question on Flood Damage

1) Direct Damage
   - Items and Damage

2) Prevention Cost
   - Items and Cost

3) Traffic Problem
   - Means of Communication in normal and flood years
   - Commuting Expenses in normal and flood years
   - Days unable to work due to flood

4) Medical Payment

5) Intangible Damage ... Dwelling house only

(Degree of seriousness)

- Direct Damage
- Loss of Time in Transportation
- Loss of Income
- Environmental Deterioration
- Health Damage
- Psychological Burden

(4) Tolerance of Flood ... Dwelling house only

. Depth

. Duration

(5) Willingness to pay ... Dwelling house only

The survey forms used in the interview are presented in Appendix P.1.

2. Analysis of the Survey Results

2.1 Household Survey

2.1.1 General Characteristics of the Householders

Table P.1 shows a distribution of households interviewed by type of dwelling. More than 80 percent live in detached house (Type A and B). About half of households in detached house were constructed on landfill (Type B).

Table P.1 Type of Dwelling

Item \ Type	A	B	C	D	Total
Number	199	170	56	16	449
%	45	38	13	4	150

Type A Type B Type C Type D

Table P.2 shows a distribution of the houses classified by type of construction material.

Table P.2 Type of House

Category	Number	%
Concrete	287	65
Wood	157	36
Total	444	100

The average size of household is 5.98 persons. The average size of house lot and house are 115 sq. wa (460 m^2) and 44 sq. wa (176 m^2) respectively. 2.3 persons work on average in each household. About 45 percent of households have cars while 15 percent have motorcycles.

About 16 percent of the households earn less than 3,000 Baht per month, and 27 percent earn more than 10,000 Baht per month. An average household income is 9,400 Baht.

Table P.3 Total House Hold Income

Monthly Income Group (Baht)	Average monthly Income (Baht)	Number	Percent
3,000 or less	1,352	75	16
3,001-6,000	4,455	136	31
6,001-10,000	8,004	115	26
over 10,000	21,398	118	27
Total	9,352	444	100

2.1.2 Flood Depth and Duration

The average depth and duration in 1983 was 28 cm and 1.8 months (Fig. P.2) which was an increase from 22 cm and 1.1 months in 1982. Depth and duration in 1982 flood are the result of flood damage survey conducted during the Preliminary Study.

Table P.4 Flood Depth in 1982 and 1983

Depth (cm)	1983		1982	
	Number	Percent	Number	Percent
0	68	15	19	7
0 - 10	47	11	59	20
11 - 20	65	15	88	33
21 - 30	72	16	58	20
31 - 40	52	12	17	6
41 - 50	74	17	13	4
51 - 60	21	5	11	3
61 - 70	9	2	0	0
71 - 80	20	4	7	2
> 81	16	3	15	5
Total	444	100	287	

Table P.5 flood Duration in 1982 and 1983

Duration (month)	1983		1982	
	Number	Percent	Number	Percent
0	110	25	21	7
0 - 1.0	36	8	157	55
1.1 - 2.0	89	20	66	23
2.1 - 3.0	119	27	32	11
3.1 - 4.0	68	15	5	2
> 4.1	22	5	6	2
Total	444	100	287	100

2.1.3 Damage to Household and Propterties

Average damage to a household is 10,786 Baht, out of which direct damage accounts for 8,733 Baht (Table P.6). About one-third households had prepared permanent-type flood prevention facilities while half the households temporary-type facilities. (Tables P.7 to P.8).

Commuting time increased from 0.95 hours to 1.85 hours due to the flood.

Table P.6 Flood Damages for 1983 by Category

Dategory	Mean Damage of Household (Baht)
Direct Damage	8,733
Commuting Expenses	15
Medical Payment	207
Prevention Cost (Permanent Type)	191
Prevention Cost (Temporary Type	1,640
Total	10,786

Note: Prevention cost (permanent type) and that (temporary type) are divided by an assumed life of 50 years and 15 years respectively.

Table P.7 Prevention Cost for Permanent Facility

	Number of Household	Mean Cost (Baht)
Landfill	58	743
Flood-Proof Wall	36	303
Pump	52	216
Others	36	549
No		
Total	444	

Note: Mean cost of landfill = expenses in the past ÷ anticipated life (50 years)
Mean cost of pumps, flood-proof walls and others = Expenses in the past ÷ anticipated life (15 years)

Table P.8 Prevention Cost for Temporary Facility

	Number of Household	Mean Cost (Baht)
Sand Bag	99	2,361
Fuel for Pump	31	33
Others	71	2,658
Repair Costs	32	4,046
No		
Total	444	

2.1.4 Average Damage by Each Category

Mean damage incurred by the higher income group is higher than that of lower group while ratio of damage to income is higher in lower income group (Table P.9 and Fig. P.3). Damage does not show so much difference, by type of dwelling except for flats (Table P.10). Damage to concrete houses is higher by 1.5 times than that of wood houses (Table P.11).

Table P.9 Average Damage by Income Group

Monthly Income (Baht)	Number	Mean Damage (Baht)	Average Yearly Income (Baht)	% of Yearly Income
2,999 or less	75	7,159	16,224	44
3,000 - 5,999	136	7,138	53,460	13
6,000 - 9,999	115	7,971	96,048	8
over 10,000	118	20,057	256,776	7
Total	444	10,786	112,776	10

Table P.10 Flood Damages by Type of Dwelling

Type of Dwelling	Number of Households	Mean Damage (Baht)
A	199	10,498
B	170	11,604
C	56	11,094
D	19	5,577
Total	444	10,786

Table P.11 Flood Damages for 1983 by Type of House

Type of House	Number of Households	Mean Damage (Baht)
Concrete	287	12,778
Wood	157	7,144
Total	444	10,786

2.1.5 Damages by Depth and Duration

Damage increases as depth and duration increases as shown in Fig. P.4. Depth has much influence of damage.

Table P.12 Average Damage by Flood Depth

(Unit: Baht/household)

Depth	Number of Sample	Direct Damage	Commuting Expenses	Medical Payment	Prevention Cost (Permanent type)	Prevention Cost (Temporary type)	Total
0	68	1,375	5	10	24	571	1,985
0 - 10	47	2,387	6	304	119	209	3,025
10 - 20	65	6,963	31	389	92	532	8,007
20 - 30	72	7,345	4	187	168	3,109	10,813
30 - 40	52	9,377	21	155	162	1,550	11,265
40 - 50	74	16,540	13	173	315	1,722	18,763
50 - 60	21	9,361	44	109	215	4,295	14,024
60 - 70	9	25,488	25	122	507	1,377	27,519
70 - 80	20	14,655	16	575	722	3,070	19,038
More than 80	16	16,249	16	155	271	3,117	19,808
Total	444	8,733	15	207	191	1,640	10,786

Note: Prevention cost (permanent type) and that (temporary type) is divided by assumed life time of 50 years and 15 years respectively.

Table P.13 Average Damage by Flood Duration

(Unit: Baht/household)

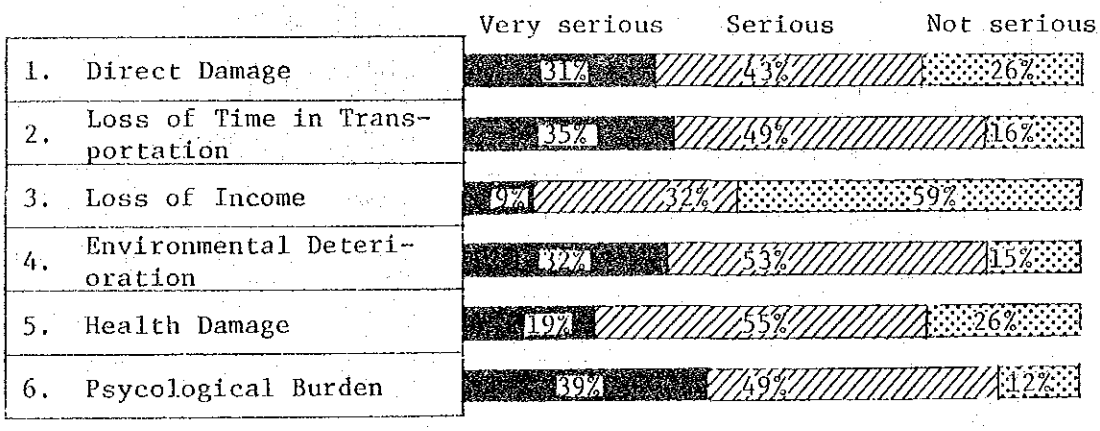
Duration (month)	Number of Sample	Direct Damage	Commuting Expenses	Medical Payment	Prevention Cost (permanent type)	Prevention Cost (temporary type)	Toal
0	110	4,235	27	59	56	1,408	5,785
0 - 0.5	0	0	0	0	0	0	0
0.5 - 1.0	36	3,878	21	2	88	483	4,472
1.0 - 2.0	89	9,701	9	361	202	2,126	12,399
2.0 - 3.0	119	9,731	9	348	182	1,451	11,721
3.0 - 4.0	68	14,127	12	158	361	1,886	16,544
More than 4.0	22	13,190	9	52	513	3,006	16,770
Total	444	8,733	15	207	191	1,640	10,786

Note: Prevention cost (permanent type) and that (temporary type) is divided by assumed life time of 50 years and 15 years respectively.

2.1.6 Intangible Damage

Respondents were asked to rate - very serous, serious or not serious - the following matters when flood occurrred.

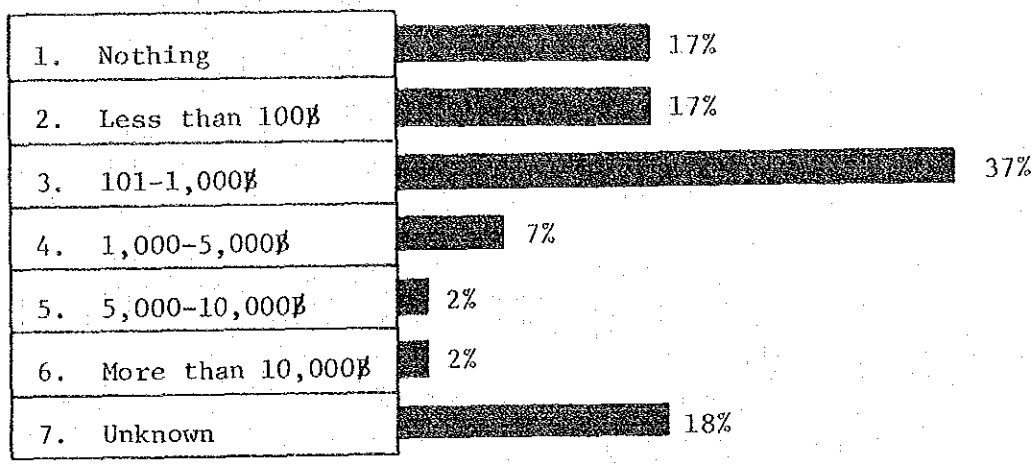
Table P.14 Degree of Flood Problems



2.1.7 Willingness to Pay

The average willingness to pay is 100-1,000 Baht per household.

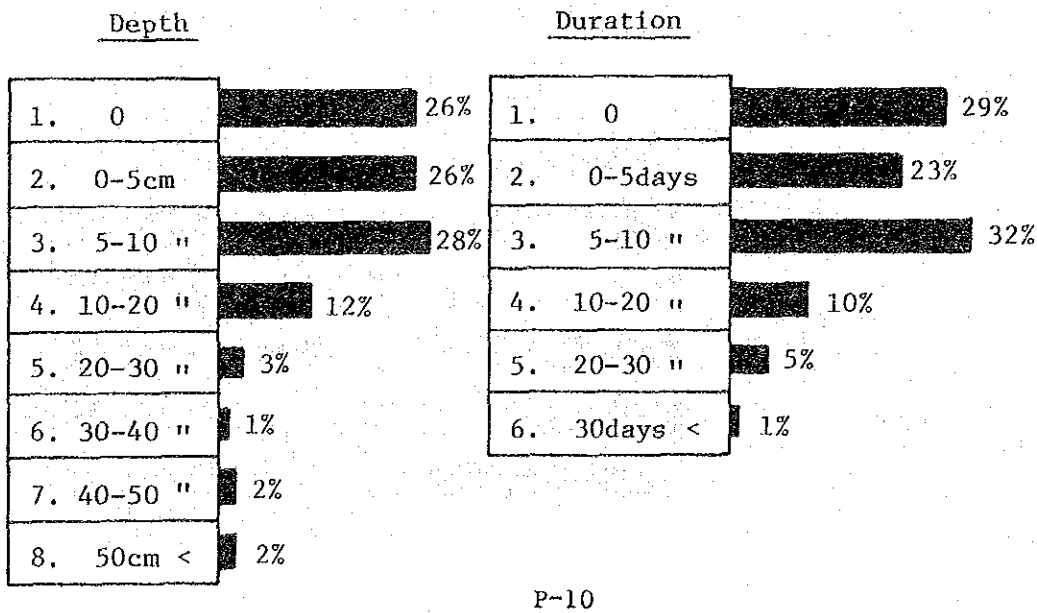
Talbe P.15 Willingness-to-pay



2.1.8 Degree of Protection

About one-fourth of the respondents desire no flooding and about 75 to 80 percent of respondents accept 5-10 cm for 5-10 days flooding as shown below.

Figure Survey on Tolerance of Flooding



2.2 Commercial Survey

2.2.1 General Characteristics of Commerce

The size of commerce or shop in the sample is small.
The average employee is 3.3 persons per shop.
The distribution of commerce by the number of employees is presented in Table P.16.
The mean revenue is 218,000 Baht per year.
The average size of commercial premises is 17.1 m^2.

Table P.16 Employee per Shop

Item \ Number of Employee	1 - 10	11 - 20	More than 21	Total
Number of Sample	113	5	1	119
(%)	95	4	1	100

2.2.2 Flood Depth and Duration

Table P.17 Flood Depth

Depth (cm)	Number	Percent
0	96	81
0-10	10	8
11-20	3	2
21-30	5	4
31-40	1	1
41-50	1	1
51-60	0	0
61-70	2	2
> 71	0	0
Total	119	100

Table P.18 Flood Duration

Duration (month)	Number	Percent
0	43	36
0-1.0	8	7
1.1-2.0	22	18
2.1-3.0	31	26
3.1-4.0	13	11
> 4.1	2	2
Total	119	100

2.2.3 Damage

Average damage is 47,160 Baht per shop.

The smaller sized shop suffers larger damage.

Table P.19 Average Damage by Number of employee

Number of Employee	Number of Sample	Yearly Revenue (Baht/Shop)	Damage (Baht/Shop)
1 ~ 9	113	224,923	
10 ~ 20	5	61,600	
> 20	1	———	———
Total	119	218,000	

Table P.20 Average Damage by Revenue Group

Yearly Revenue (Baht/Shop)	Number of Sample	Damage (Baht/Shop)
Less than 50,000	83	12,074
50,000-99,000	11	46,209
More than 100,000	25	164,067
Total	119	47,160

Table P.21 Average Damage by Duration and Kind

(unit:Baht/Shop)

Duration (month)	Number of Sample	Direct Damage	Indirect Damage	Permanent Facility	Temporary Facility	Total
0	100	11,851	35,032	156	2,096	49,135
0 - 0.5	0	0	0	0	0	0
0.6 - 1.0	10	25,790	5,050	566	4,915	36,321
1.1 - 2.0	4	3,875	1,000	50	800	5,725
2.1 - 3.0	5	24,300	35,400	426	2,400	62,526
3.1 - 4.0	0	0	0	0	0	0
More than 4.1	0	0	0	0	0	0
Total	119	13,277	31,383	198	2,302	Average (47,160)

Note: Prevation cost (Permanent type) and that (temporary type) are divided by assumed life time of 50 years and 15 years respectively.

2.3 Industrial Survey

The size of industry or factory in the sample ranges from 1-10 employees category to more than 101 catetory.
The average number of employees is 82.62 persons.
The mean revenue is 3,240,000 Baht per year.
The average size of an industrial lot is 8,220 m^2 while the average size of the buildings is 3,385 m^2.

Table P.22 Employee per Factory

Item \ Number of Employee	1 - 10	11 - 50	51 - 100	More than 101	Total
Number of Sample	49	24	14	18	105
%	47	23	13	17	100

Table P.23 Average Damage by Revenue Group

Yearly Revenue (Baht/Factory)	Number of Sample	Damage (Baht/Factory)
Less than 50,000	58	42,253
50,000 - 99,999	4	29,160
100,000 - 999,999	19	168,440
More than 1,000,000	24	1,663,000
Total	105	435,044

Table P.24 Average Damage by Depth and Kind

(Baht/Factory)

Depth(cm)	Number of Sample	Direct Damage	Indirect Damage	Permanent Facility	Temporary Facility	Total
0	80	58,670	377,300	871	10,541	447,382
0 - 10	6	11,666	342,500	338	3,466	357,970
11 - 20	11	140,272	471,818	2,824	4,409	619,323
21 - 30	2	10,000	0	900	2,750	13,650
31 - 40	4	142,500	2,500	2,225	68,625	215,850
41 - 50	1	0	0	0	0	0
51 - 60	0	0	0	0	0	0
61 - 70	0	0	0	0	0	0
71 - 80	1	30,000	0	4,666	3,500	38,166
81 - 90	0	0	0	0	0	0
91 - 100	0	0	0	0	0	0
More than 101	0	0	0	0	0	0
Total	105	65,967	356,561	1,125	11,391	Average (435,044)

Note: Expense of permanent facility
= expense of landfill ÷ anticipated life (50 years)
+ expense of pumps, walls and others ÷ 15 years

Table P.25 Average Damage by Duration and Kind

(Baht/Factory)

Duration (month)	Number of Sample	Direct Damage	Indirect Damage	Permanent Facility	Temporary Facility	Total
0	87	60,271	348,666	991	13,040	422,968
0 - 0.5	0	0	0	0	0	0
0.6 - 1.0	6	90,833	834,166	1,088	8,516	934,603
1.1 - 2.0	8	141,250	11,250	3,024	1,312	156,836
2.1 - 3.0	1	0	2,000,000	0	0	2,000,000
3.1 - 4.0	2	4,000	5,000	0	0	9,000
More than 4.1	1	0	0	1,200	0	1,200
Total	105	65,967	356,561	1,125	11,391	Average (435,044)

Note: Expense of permanent facility
= expense of landfill - anticipated Life (50 year)
+ expense of pumps, walls and others ÷ 15 years

3. Estimation of Flood Damagen in 1983

3.1 Household

Average damage suffered by households (5.98 persons per household) is 10,786 Baht. As the total household in 1983 is estimated to be 177,300 (1,060,000 persons ÷ 5.98 persons/household) in the Master Plan Area, total damage of household is 1,910 million Baht.

3.2 Commerce

From the interviews at 119 shops (1,288 employees), average damage suffered by commerce is estimated to be 47,160 Baht per shop or 14,162 Baht per employee.

It is rather difficult to estimate the flood damage suffered by commerce in the Master Plan Area owing to lack of data of number of premises and employees for commerce in the Master Plan Area.

Hence, the number of premises and employees was estimated as follows (Fig. P.9):

(A) Number of commercial establishments in four districts are as follows, which are obtained from the National Statistical Office:

District	Large (more than 10 percent)	Small (5-9 persones)
Phra Khanong	428	335
Bang Kapi	67	75
Huay Kwang	132	48
Bang Khen	106	97
Total	733	555

(B) Number of commercial establishments (more than 5 persons) in the Master Plan Area is estimated by JICA Study Team according to land use map, 1980 as follows:

Large : 423
Small : 307
Total : 730

These figures exclude the number of commercial establishments with "less than 5 persons", while most of the interviewed shops employee 1 to 9 persons. As the average damage of 47,160 Baht per shop is the figure for the shops (1 to 9 persons), and the number of small shops (5-9 persons) is less than half of the total number, total damage obtained from 47,160 Baht per shop times 730 is an underestimated figure. Then, the employee number which is considered suffered from actual flood damage, is estimated as follows:

(C) Average numbers of employees in large establishments "more than 10 persons" and small establishments "5 to 9 persons" are 58.2 persons and 9.8 persons respectively from the following figures of Business Census, 1980 in Greater Bangkok Area:

	Employee (persons)	Number (establishment)
Large	243,730	4,190
Small	151,729	15,400
Total	395,459	19,590

(D) Hence, the number of employees (more than 5 persons per establishment) in the Master Plan Area is estimated from items (B) and (C) as follows:

$$423 \times 58.2 + 307 \times 9.8 = 27,600 \text{ persons}$$

On the other hand, number of employees in commerce including both classifications of "more than 5 persons" and "less than 5 persons" are estimated.

(E) Employee number in Bangkok : 1,005,757 persons
(Population Census, 1980)

(F) Numbers of employees in "more than 5 persons" in Bangkok is estimated to be 359,900 persons by JICA Study Team according to land use based on 395,459 persons (item 3) in Greater Bangkok Area.

(G) Therefore using the ratio of 2.79 (= 1,005,757 ÷ 359,900), the number of employees in the Master Plan Area is estimated to be 77,000 persons (= 2.79 x 27,600 persons).

Hence, the damage suffered by commerce is estimated to be 1,090 million Baht (= 77,000 persons x 14,162 Baht/employee).

3.3 Industry

Average damage to the industries interviewed is estimated to be 435,044 Baht/establishment or 5,265 Baht/employee. Interviewed establishments (factories) are 105 in number with 8,675 persons employed.

Total number of employees in the Master Plan Area is estimated to be 105,000 persons by the same method as is used in the commerce estimate which are shown in Fig. P.10.

Hence, total damage of industry is estimated to be 540 million Baht.

3.4 Total

Household	1,910 million Baht
Commerce	1,090
Industry	540
Total	3,540

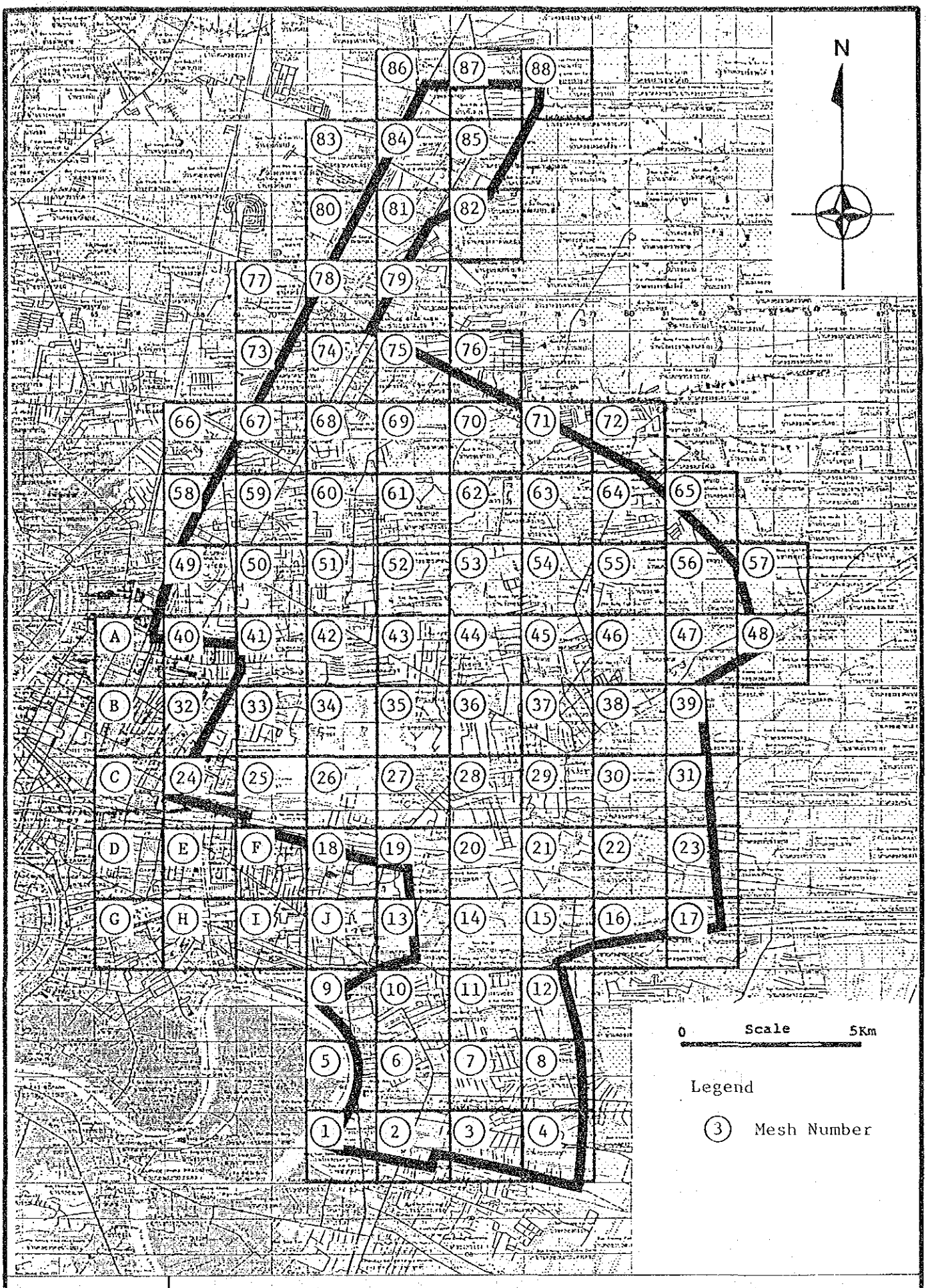


Fig. P.1 MESH NUMBER FOR FLOOD DAMAGE SURVEY

MASTER PLAN ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK

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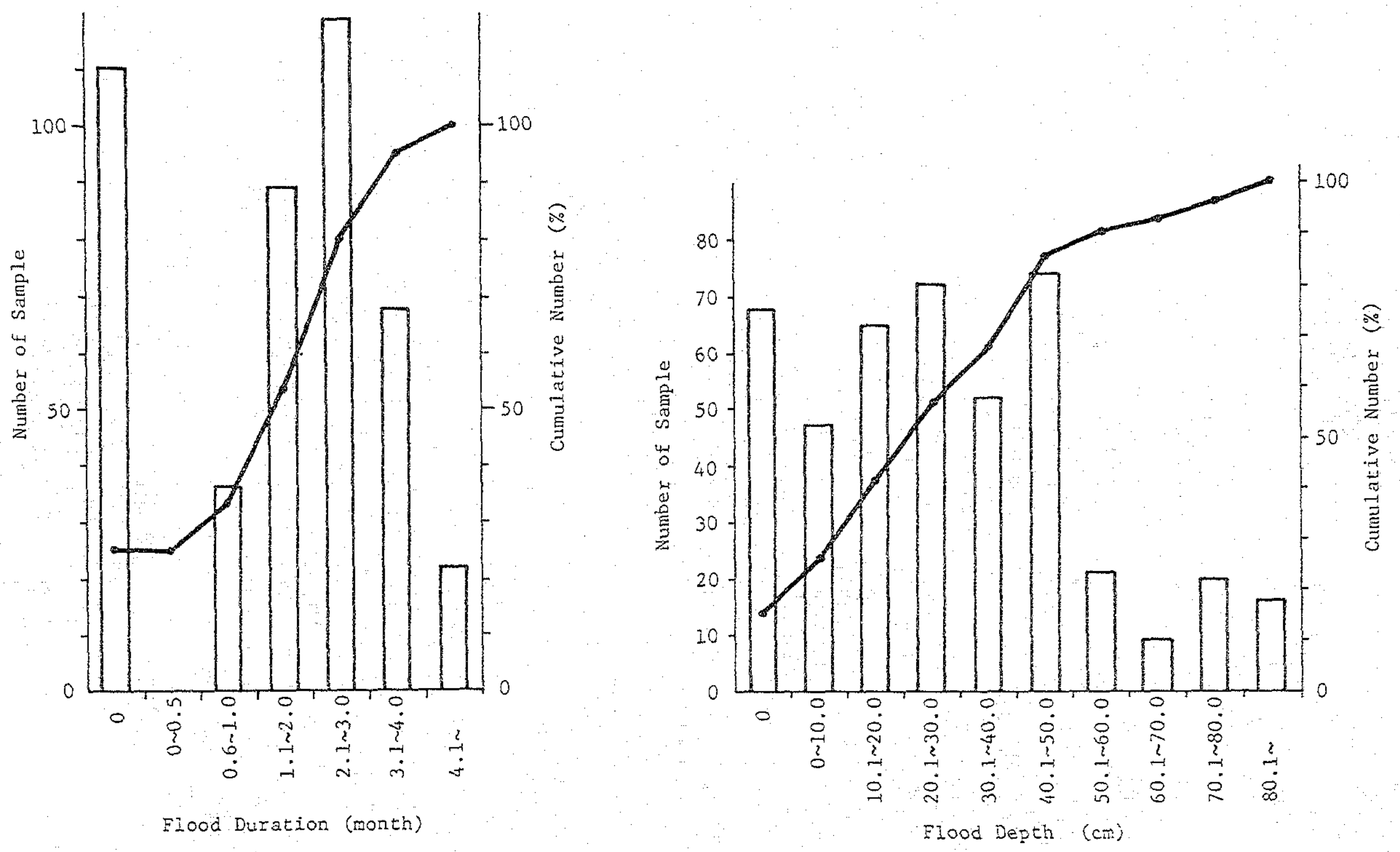

Fig. P.2 DEPTH AND DURATION OF 1983 FLOOD (HOUSEHOLD)

MASTER PLAN ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK

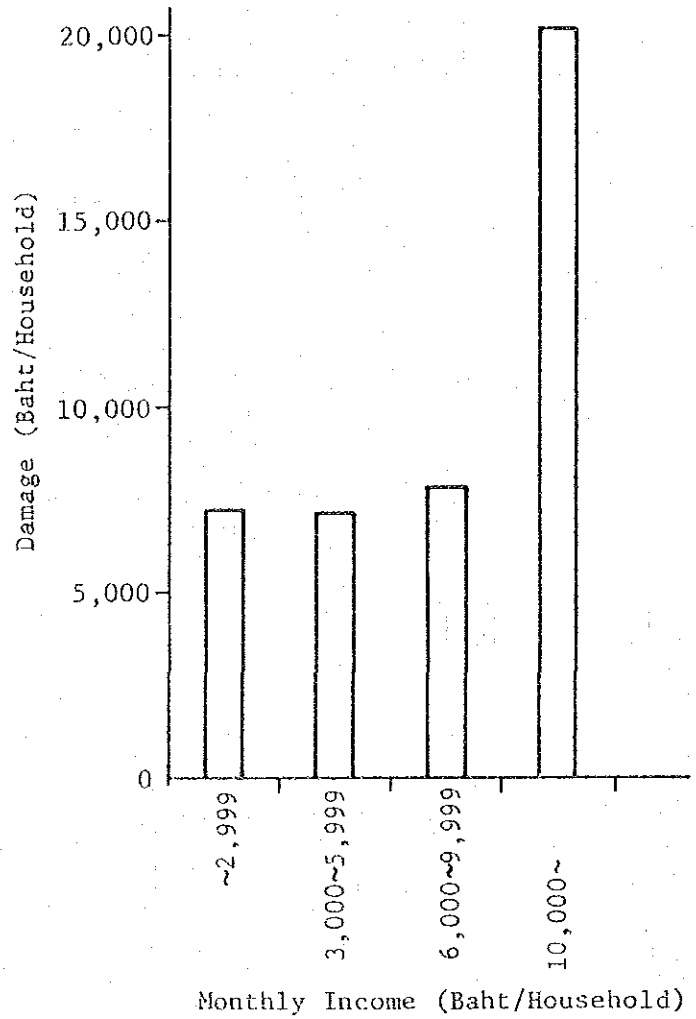

Fig. P.3 AVERAGE DAMAGE BY INCOME GROUP

MASTER PLAN ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK

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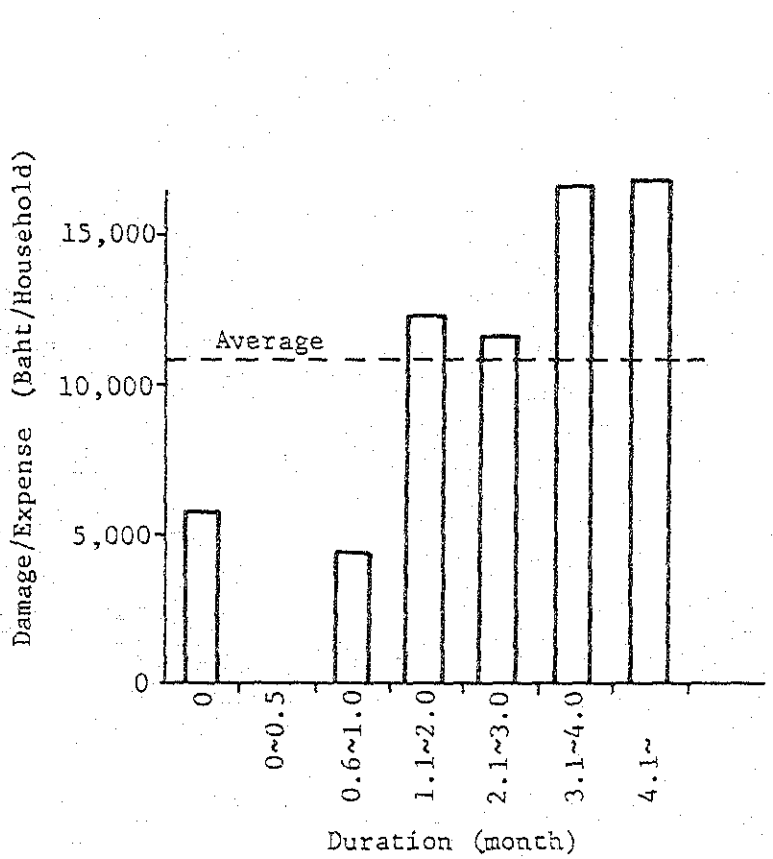


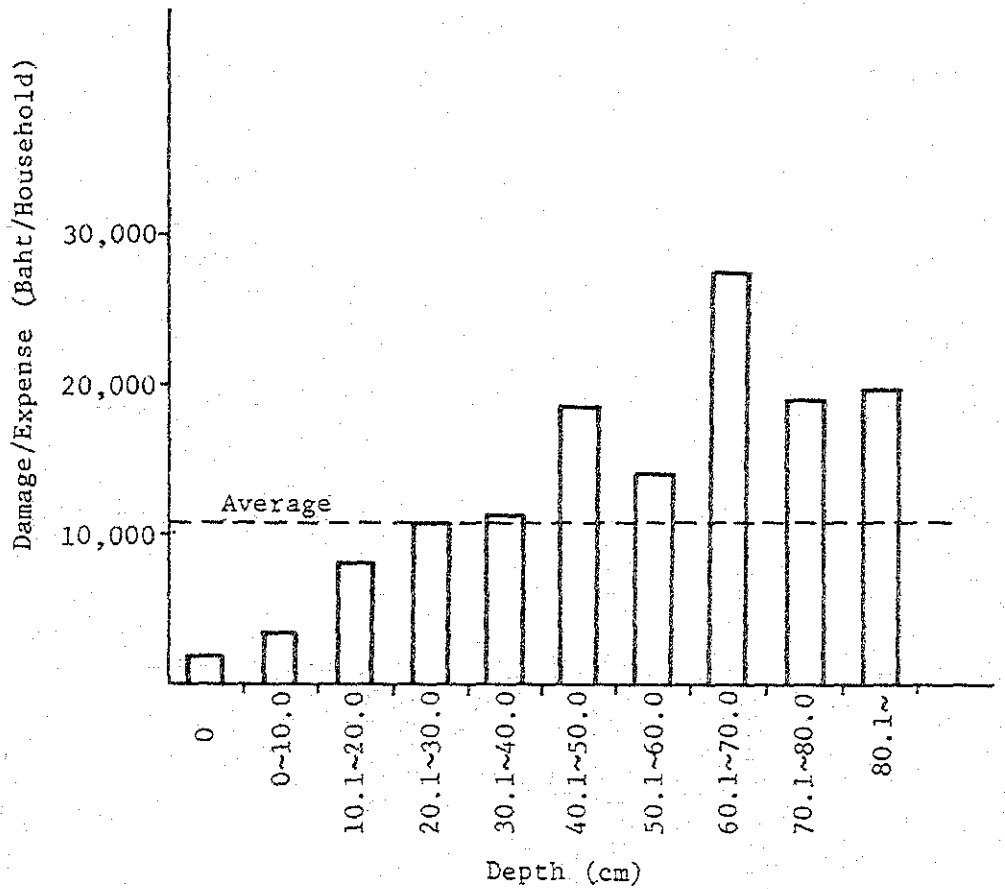
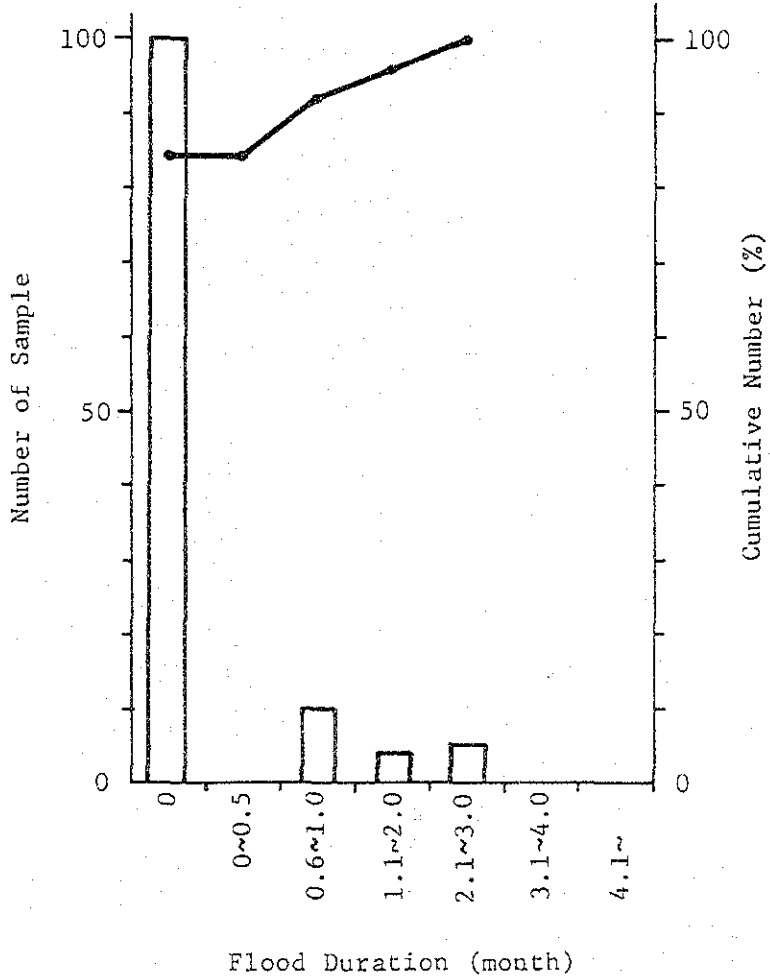


Fig. P.4	DAMAGE/EXPENSE OF HOUSEHOLD BY DEPTH AND DURATION OF FLOODING (HOUSEHOLD)

MASTER PLAN ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK



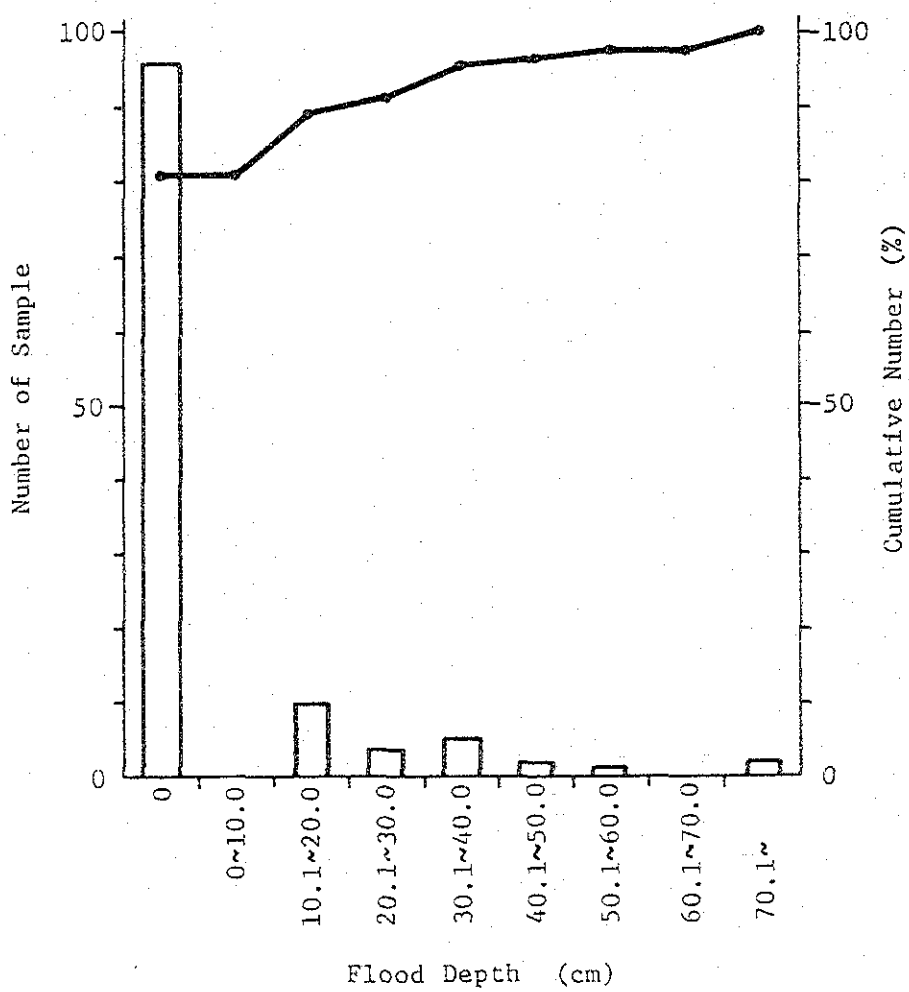
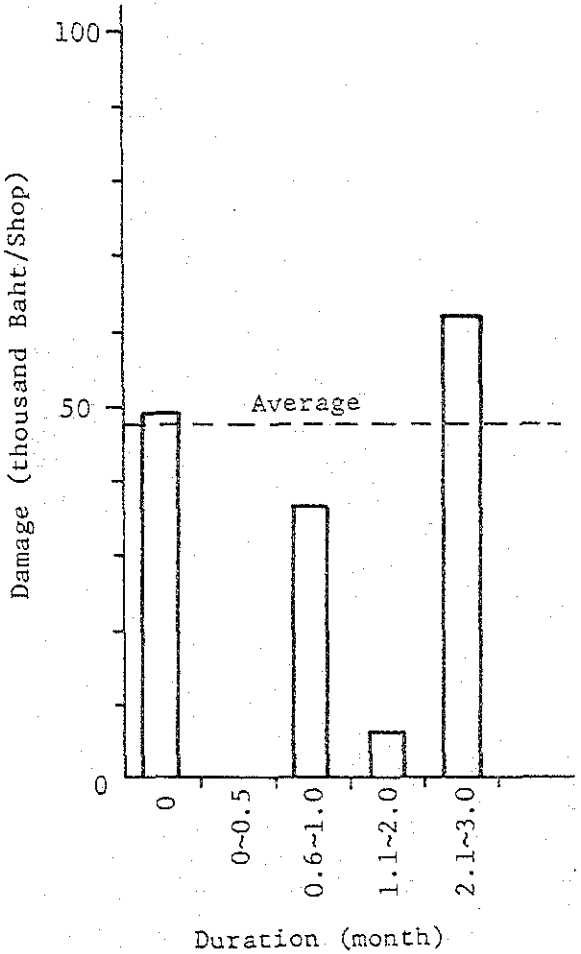


Fig. P.5 DEPTH AND DURATION OF 1983 FLOODING (COMMERCE)

MASTER PLAN ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK

JICA 2528 B.E. 1985 A.D.



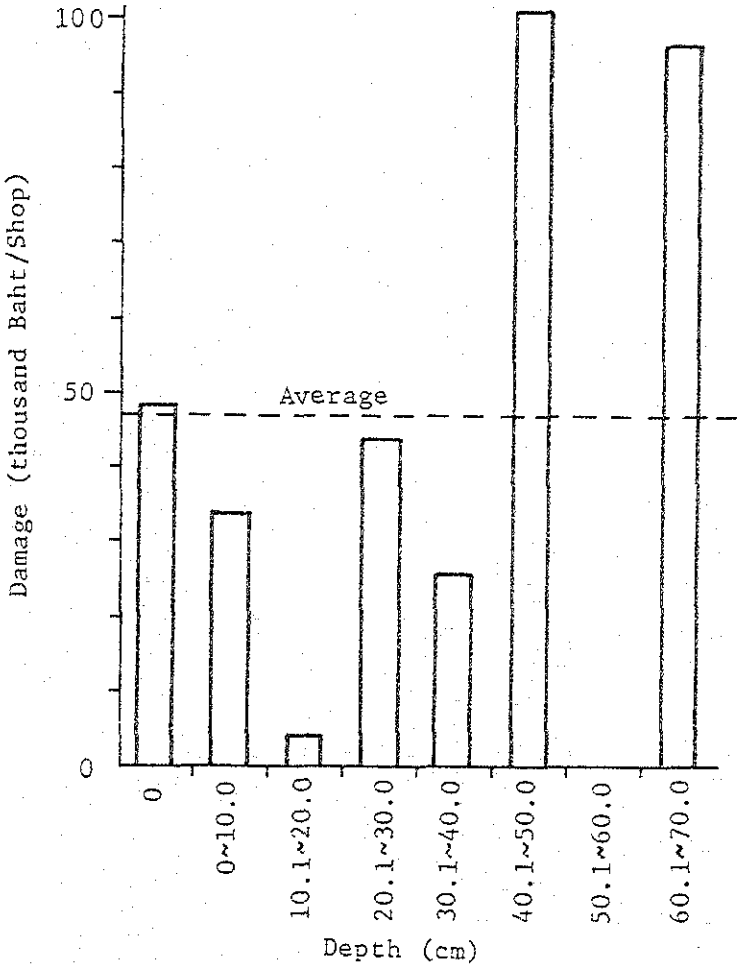


Fig. P.6 DAMAGE BY DEPTH AND DURATION OF FLOODING (COMMERCE)

MASTER PLAN ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK

JICA 2528 B.E. 1985 A.D.

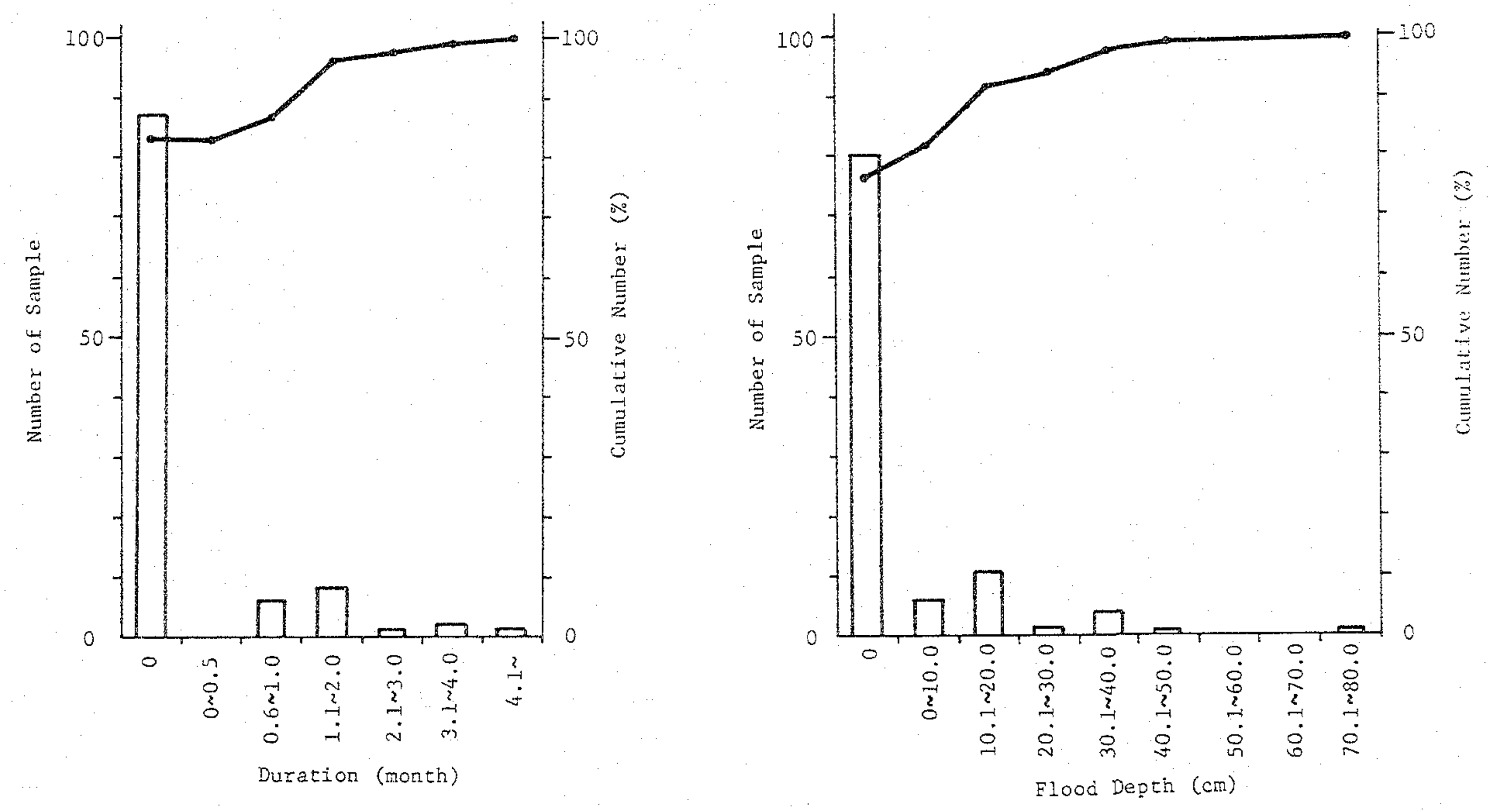


Fig. P.7	DEPTH AND DURATION OF 1983 FLOODING (INDUSTRY)

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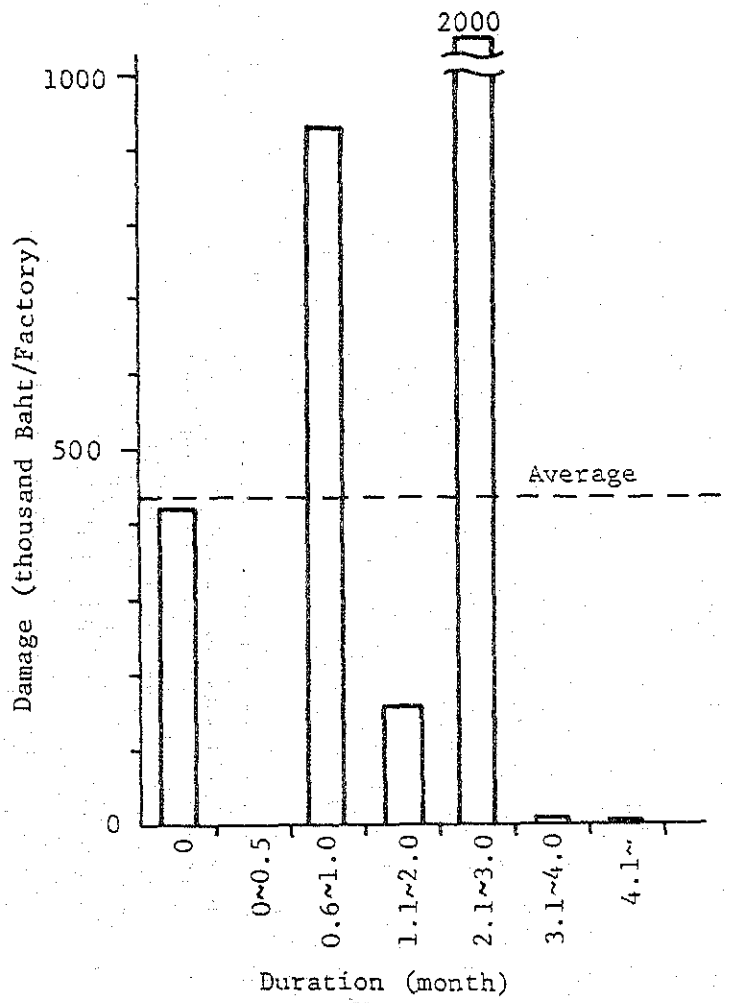

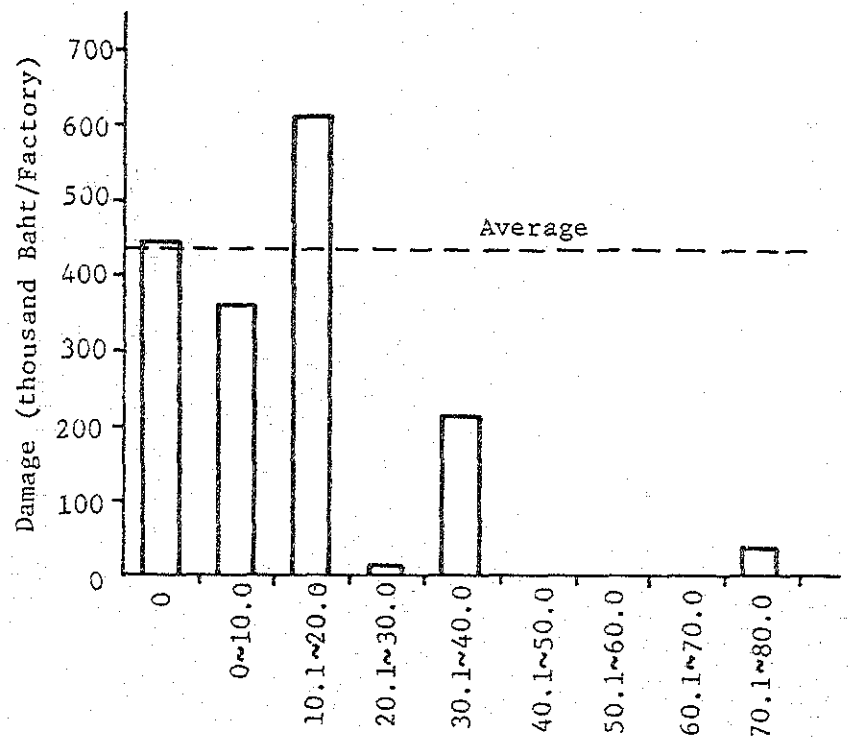

Fig. P.8 DAMAGE BY DEPTH AND DURATION OF FLOODING (INDUSTRY)

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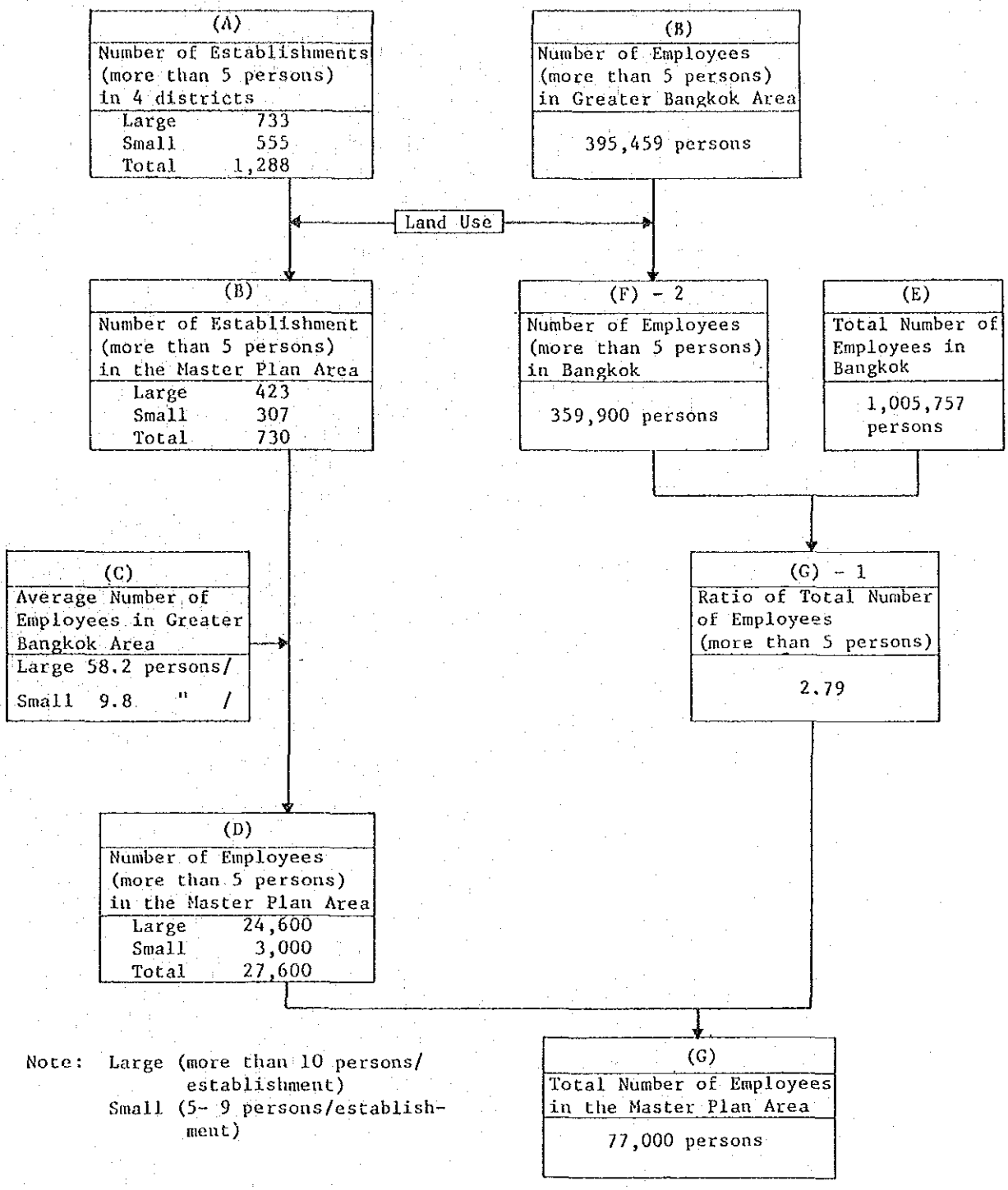

Fig. P.9 ESTIMATION OF EMPLOYEE NUMBER OF COMMERCE IN THE MASTER PLAN AREA

MASTER PLAN ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK

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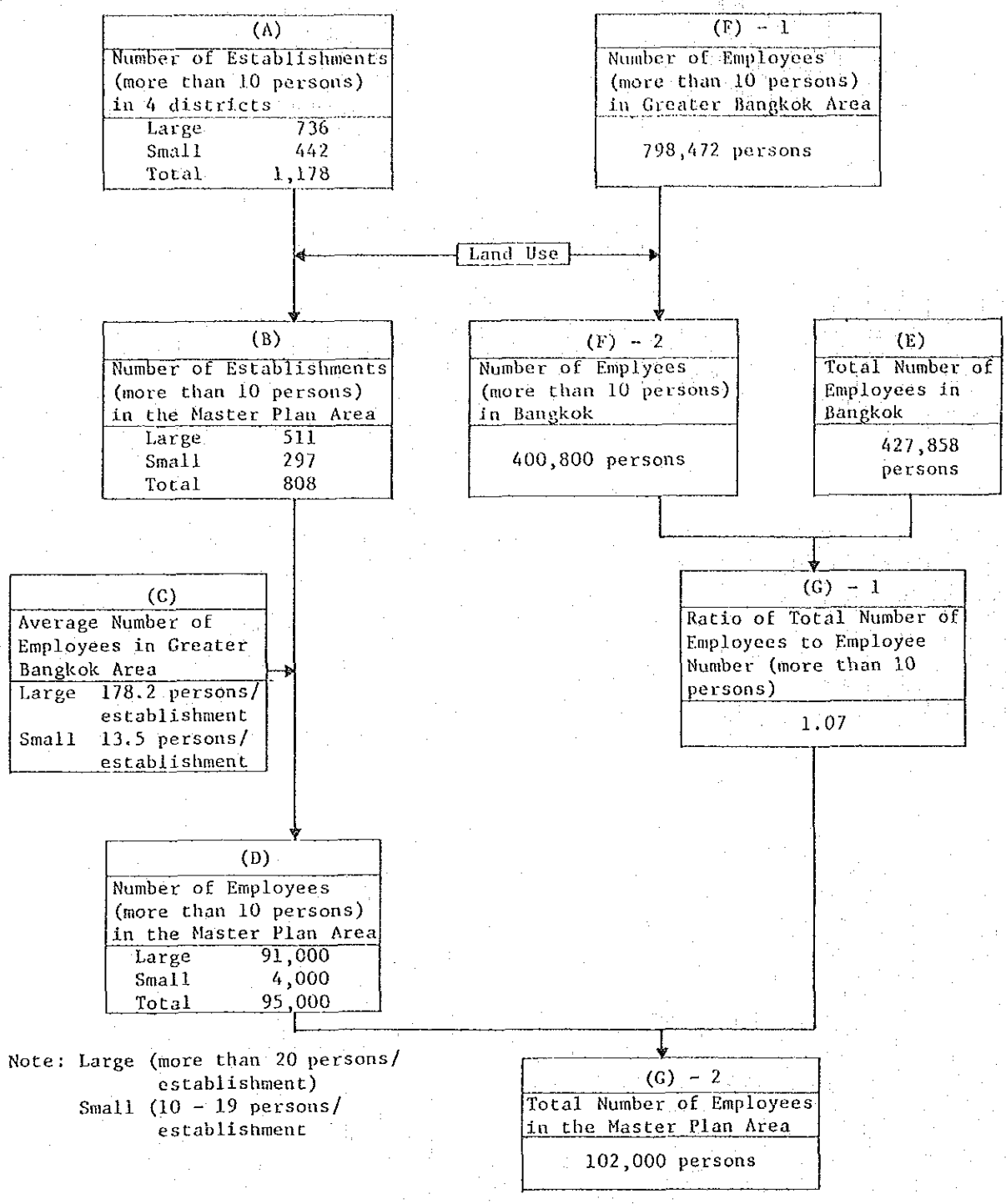

Fig. P.10 ESTIMATE OF NUMBER OF EMPLOYEES IN INDUSTRY IN THE MASTER PLAN AREA

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APPENDIX Q

PROJECT EVALUATION

APPENDIX Q PROJECT EVALUATION

Table of Contents

List of Tables

List of Figures

Appendix Q PROJECT EVALUATION

1. General

In the past, many houses, private establishments, institutional and infrastructural facilities suffered severe damage from flooding, causing hardships and nuisance in the daily life of the inhabitants in the Bangkok Metropolitan Area. Recently, the flood damage is getting worse primarily due to land subsidence, and the rapid increase of population. On the other hand, the living standard is increasing due to the high socio-economic development of Thailand during the past two decades. As the living standard increases, flood damage which once seemed tolerable has come to be recognized as being intolerable. The proposed flood protection/drainage system would alleviate various kinds of flood damage.

The object of this Appendix is to evaluate the economic viability for flood protection/drainage project through the study of benefit cost analysis. The first key factor in analyzing the economic feasibility of the project is to estimate cost and benfit in economic, not financial terms. The financial cost estimated by the engineering study is converted into the opportunity cost of the project, that is, the economic cost. On the other hand, the benefit derived from the flood protection project is estimated through the analysis of the flood damage survey by the JICA Study Team.
Prior to the economic analysis, it should be noted that the proposed project and the Green Belt Project can not be considered separately, as the proposed project has been studied on the basis that the Green Belt Project is implemented. The economic analysis is performed for the following three cases:

1) Green Belt Project
2) Green Belt Project + Proposed Project
3) Proposed Project

In addition, as for the proposed project, Two different implementation programs, Alternative I and II, shown in Chapter K are also examined.

2. Indicators for Economic Evaluation

The following three economic indicators are applied to the economic evaluation of the abovementioned cases.

a) Internal Rate of Return (I.R.R.)

The I.R.R. shows the discount rate which will give the break even point between the present value of benefit and that of cost as given by the following formula:

$$B(r) - C(r) = 0$$

$$B(r) = \sum_{t=1}^{n} \frac{Bt}{(1+r)^t}$$

$$C(r) = \sum_{t=o}^{n-1} \frac{Ct}{(1+r)^t}$$

r : Internal Rate of Return
Bt : Benefit in the year t
Ct : Cost in the year t
n : Project life in years

In order that the project be economically feasible, the I.R.R. should be more than the opportunity cost of capital in Thailand (16%).

b) Net Present Value (N.P.V.)

The N.P.V. indicates the difference between the discounted benefit and cost using the rate of opportunity cost of capital. A positive N.P.V. means the project is economically feasible.

c) Benefit Cost Ratio (B/C Ratio)

The B/C ratio is the ratio obtained by dividing the present value of benefit by that of cost.

For calculation at present value of benefit and cost for NPV and B/C ratio, discount rate of 16 % per year is applied.

3. Economic Cost Estimates

The project cost as shown in Appednix K is converted into economic values assuming the following modification;

1) Transfer elements in the cost such as duties and taxes should be removed. These are assumed to be 10 percent for the foreign portion and 5 percent for the local portion of the project cost.

2) Shadow exchange rate is applied to the foreign currency component and shadow wage rate is applied to the wage of the unskilled labourer of the local currency component to make allowance for the market distortion. These two rates are calculated as follows:

a) Shadow Exchange Rate

A formula proposed in UNIDO method is adopted to convert the official exchange rate into the shadow exchange rate.

$$SER = OER \quad \frac{(M + Ti) + (X - Sx)}{M + X}$$

SER : Shadow exchange rate
OER : Official exchange rate
M : Import (CIF)
X : Export (FOB)
Ti : Import duties
Sx : Export subsidy

In case of Thailand, there is a export duty instead of subsidy. This is added to the export amount in the numerator.

According to Table Q.1, the shadow exchange rate is estimated as 1.06 for the latest year. Therefore, for this study the value of 1.06 is adopted.

Table Q.1 Shadow Exchange Rate with Export and Import Duties

(Unit: ฿ Million)

Item \ Year	1977	1978	1979	1980	1981	1982
(1) Export	71,198	83,965	108,179	133,197	153,001	159,728
(2) Import	94,177	108,899	146,161	188,686	216,746	196,616
(3) Export duties	1,684	1,944	3,020	3,379	2,811	1,790
(4) Import duties	12,458	14,683	17,286	19,463	21,896	20,183
(5) (1) + (2)	165,375	191,964	254,340	321,883	369,747	356,344
(6) (1)+(2)+(3)+(4)	179,517	208,591	274,646	344,725	394,454	378,317
(7) Shadow Exchange Rate	1,086	1,087	1,080	1,071	1,067	1,062

(Source: Quarterly Bulletin, Bank of Thailand)

b) Shadow wage rate

Where there is unemployment of labour, estimated wage costs should reflect the other opportunities for work rather than the actual wage cost. According to the National Statistics of 1981, official unemployment rate shows 1.1 percent. However, considering the actual labour market, the actual unemployment rate is considered to be much higher.

Under such situation, marginal productivity of unskilled labourers is supposed to be a considerably lower level than the average market wage rate. Therefore, as shown in Table Q.2 the economic value of unskilled labourers is assumed to be 0.88, based on the relationship between the actual wage rate and the official minimum wage rate of the unskilled labourer. The former is considered to represent the market price.

Table Q.2 Actual Wage Rate and Minimum Wage Rate of the Unskilled Labourer

(Unit : Baht/day)

Item	1980	1981	1982
(A) Actual Wage Rate of the Unskilled labourer	54.0	65.56	72.74
(B) Official Miminum Wate Rate	54.0	61.0	64.0
B/A	1.0	0.93	0.88

Source : Main economic indicators of Thailand

Following the foregoing procedure, the financial costs of the study project for two cases are converted into the economic cost as shown in Table Q.3(1) - Q.3(2). On the other hand, the economic cost of Green Belt Project is assumed to be 700 million baht.

Table Q.3 (1) Economic Cost - Alternative I -

(Unit: Million Baht)

	1987 - 1991		1992 - 1996		1997 - 2000	
	Foreign	Local	Foreign	Local	Foreign	Local
1. Construction Cost (Land Aquisition)	1,428.2	2,132.3 (115.2)	1,462.6	2,358.2 (241.7)	1,301.4	2,302.2
2. Adjustment for Foreign Portion	85.7		87.8		78.1	
3. Adjustment for Local Portion		-9.3		-9.8		-10.9
4. Import Duties	-112.1		-114.3		-98.0	
5. Tax		-77.8		-81.9		-91.0
6. Economic Cost	1,401.8	2,045.2	1,436.1	2,266.5	1,281.5	2,200.3
7. O/M Cost per Year	80.3		163.7		247.7	

Table Q.3 (2) Economic Cost - Alternative II -

(Unit: Million Baht)

	1987 - 1991		1992 - 1996		1997 - 2000		2001 - 2005		2006 - 2010		2011 - 2015	
	Foreign	Local	Foreign	Local	Foreign	Local	Foreign	Local	Forign	Local	Forign	Local
1. Construction Cost (Land Aquisition)	969.6	1,333.7 (100.0)	897.9	1,286.7 (43.1)	641.7	1,195.6 (213.8)	557.8	986.6	557.8	986.6	567.0	1,003.1
2. Adjustment for Foreign Portion	58.2		53.9		38.5		33.5		33.5		34.0	
3. Adjustment for Local Portion		-5.6		-5.7		-4.6		-4.7		-4.7		-4.8
4. Import Duties	-77.3		-70.7		-49.7		-42.0		-42.0		-42.7	
5. Tax		-47.0		-47.9		-38.2		-39.0		-39.0		-40.3
6. Economic Cost	950.0	1,281.1	881.1	1,233.1	630.5	1,152.8	549.3	942.8	549.3	942.9	558.3	958.3
7. O/M Cost per Year	51.4		101.3		139.1		175.1		211.1		247.7	

4. Project Benefis and its Classification

The benefits are considered to be equivalent to the value of the eliminated flood damage by the execution of the proposed project. Therefore, project benefits are the difference between the value of damage "with the project" and "without the project".

Flood damage is classified into five categories; direct damage, indirect damage, secondary damage, intangible damage and uncertain damage.

1) Direct Damage

This damage is costs for repairs or replacement for goods damaged by inundation.

2) Indirect Damage

This damage includes the value of lost business and services, the cost of alleviating hardship, safeguarding health, rerouting traffic, delays and related phenomena.

3) Secondary Damage

Secondary damage may occur when people who are not living or not working in the flooded area suffer economic losses caused by the flooding, e.g., those who depend on the output from a damaged property or on services which are affected, suffer a substantial reduction in income. Secondary damage, however, is normally smaller than secondary benefits and can be excluded from the evaluation.

4) Intangible Damage

The value of damage to environmental quality, social well-being, etc. cannot be expressed in monetary units and is, therefore, designated as an intanbigle damage.

5) Uncertain Damage

The inhabitants of a flood-prone area suffer continuous uncertainty as to when the next flood will occur and how serious it will be. The cost for flood prevention works belongs into this category.

Amongst these damages, some of the damages may be quantifiable and others, especially category 4), may be unquantifiable.

Table Q.4 shows the items, which are measured in terms of money in this project, considering the geographical and socio-economic characteristics of the project area.

Table Q.4 Categories of Flood Damage

1. Private Sector
1.1 Direct
1) Direct Damage to Houses, Buildings, etc.
a) Household
b) Commerce
c) Industry
2) Loss of Production & Services
a) Commerce
b) Industry
1.2 Indirect
1) Loss of time in the traffice
a) Household
2) Medical expenditure
a) Household
1.3 Expense for Prevention
1) Permanent-Type Facility
a) Household
b) Commerce
c) Industry
2) Temporary-Type Facility
a) Household
b) Commerce
c) Industry

2. Public Sector

2.1 Direct

1) Direct Damage to Buildings, etc

a) Government office and school

2) Loss of Production

a) Public Corporation(BMTA)

2.2 Indirect

1) Medical Expenditure

5. Methodology of the Future Damage Estimate

5.1 Private Sector

1) Methodology of Estimate

Future Damage of the private sector is estimated under the concept of "Anual Average Flood Damage". The definition is as follows;

$$\overline{D} = \int_{Fo}^{\infty} Pr(F) \cdot D(F, Fo, S, Ls) \cdot dF$$

where

D : Flood damage

$\overline{D}$: Average annual flood damage

F : Rainfall

F_o : Capacity of flood control facilities

S : Damage potential, e.g., population

Ls: Land subsidnece

Pr(F): Probability density function of F

The future amount of damage and losses caused by a flood will depend on such factors as depth, duration, and time of occurrence. These factors vary according to the amount of rainfall, rate of land subsidence, degree of flood protection/drainage facilities etc.

2) Unit Damages by Depth and Duration

According to the results of the flood damage survey, the relationship between the amount of flood damage per household or establishment and the inundation depth and duration can be estimated on the basis of the following equation:

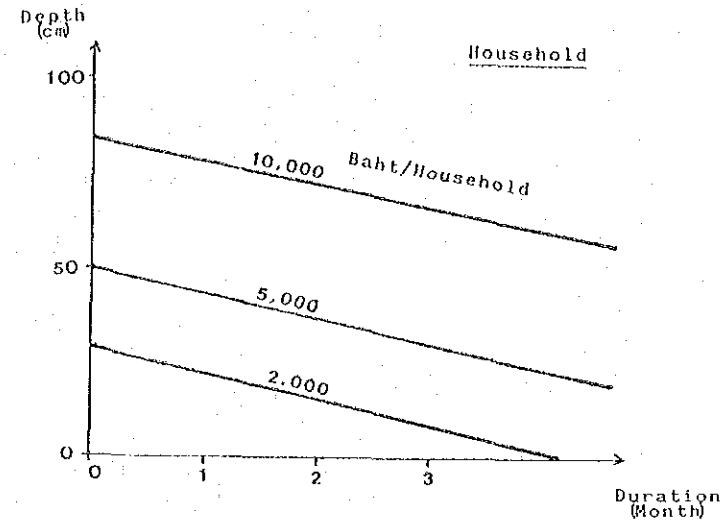
$$D = a_0 + a_1 H + a_2 L$$

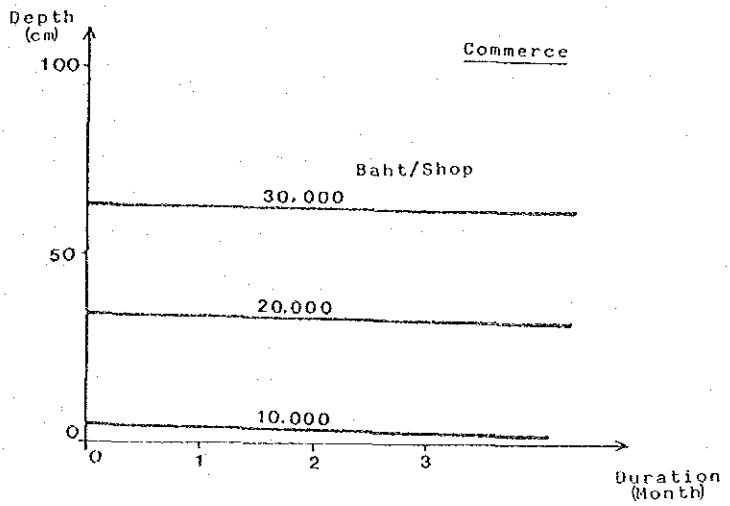
D : The amount of flood damages and losses per household or establishment

H : Flood depth (cm)

L : Flood duration (month)

a_0, a_1, a_2 : parameters





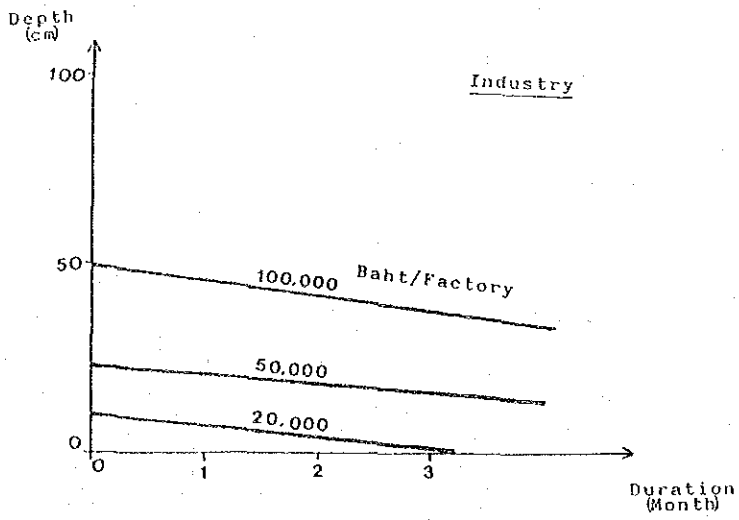


Fig. Q.1	DIRECT FLOOD DAMAGE VS.FLOOD DEPTH AND DURATION

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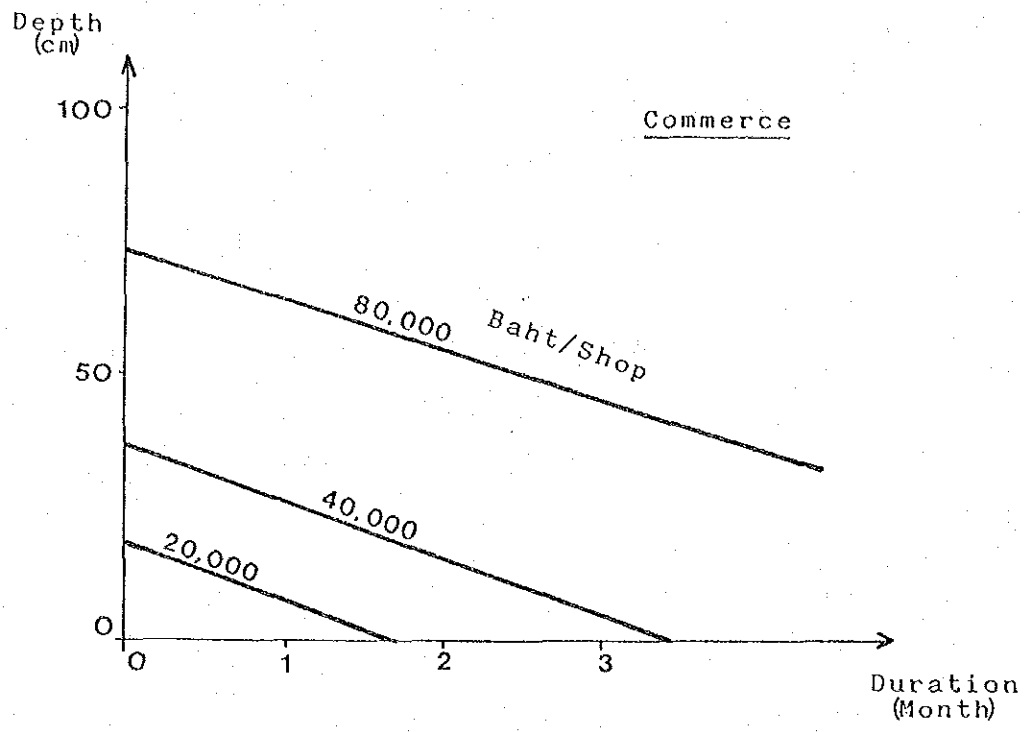

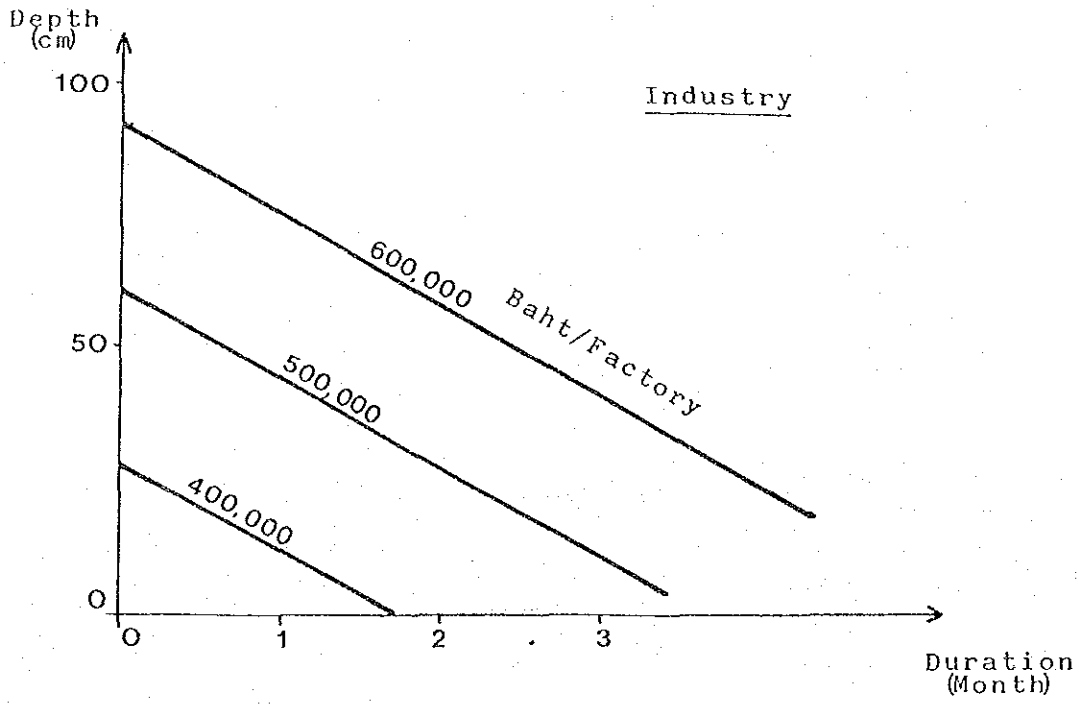

Fig. Q.2	LOSS OF PRODUCTION AND SERVICES VS.FLOOD DEPTH AND DURATION

MASTER PLAN ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK

JICA 2528B.E 1985A.D

Table Q.5, Fig.Q.1 and Fig.Q.2 show the estimeated parameters for each items of the flood damages. The back data used by this this estimation is shown in Table Q.13 to Q.17

Table Q.5 Estimated Parameters

Items of the flood damages		Constant a_0	Flood Depth a_1	Flood Duration a_2	Correlation Coefficient
Direct Damage to Houses, Buildings, etc.	Household	-1961.109	140.2839	909.8498	0.9451
	Commerce	8498.05	336.975	134.4	1.000
	Industry	-3413.925	2298.7875	5580.6	0.9909
Loss of Production and Services	Commerce		1115.628	11572.86	1.000
	Industry	310991.6	3125.0	53002.8	1.000
Loss of Transportation cost (Household)		-1.95318	0.17988	4.11992	0.8835
Medical Expenditure (Household)		10.1180	1.00779	57.6	0.9388
Expense for Permanent Prevention	Household	-48.353	2.27787	55.7333	0.8818
	Commerce	52.9178	5.2822	61.2329	0.9913
	Industry	455.45	40.475	47.6	0.9999
Expense for Temporary Prevention	Household	134.2896	14.02582	269.3333	0.9361
	Commerce	218.0	77.8	168.0	1.000
	Industry	1977.225	31.6625	239.8	0.9684

5.2 Public Sector

The survey for the damages and losses to the public sector is conducted on public offices, schools, and public corporation(BMTA). However, the result of the analysis for this survey is not sufficient from a statistical point of view. Therefore, the estimate of the flood damage (benefit) to public sector is not based on the aforementioned "Annual Average Flood Damage" but on the following method.

1) Public Expenditure for Flood

The public expenditure for flood such as direct damages to the buildings and extra medical expenditure is assumed to be 10 percent of total flood damages taking into account past flood surveys.

2) Public Corporation(BMTA)

Among the damage of public corporations, the flood damages to the Bangkok Mass Transit Authority (BMTA) is well recognized to be a fairly large. In this project, the amount of this damages is estimated according to the BFCD (City Core) study. The method of this estimateion is as follows:

a. Repair and maintenance due to flood (D_1)

$$D_1 = 1.0 \times 8{,}020 \times (4{,}285 \times r_1 \times 0.35 \times L)$$

b. Large repair cost and damage (D_2)

$$D_2 = 0.05 \times 6{,}100 \times (4{,}285 \times r_1 \times 0.35 \times L)$$

c. Extra fuel cost (D_3)

$$D_3 = (4{,}285 \times r_1 \times 0.35 \times L)$$

r_1, the percentage of buses, operational inside the Master Plan Area, assumed to be 0.25, which is based on the rate of population between core area and the Master Plan Area. On the other hand, L represents the flood duration around Skumvit Road in Bang Na where buses became inaccessible due to flooding.

Table Q.6 (1) Summary of Flood Damges (Without Green Belt and Proposed Project)

[Unit: million Baht]

Rainfall Frequency Item (Year)		Direct Damage	Loss of Trans-Portation Cost	Medical Payment	Prevention Works of Permanent Type	Prevention Works of Temporary Type	Total
Household	5	2,941	5	54	74	411	3,487
	10	3,282	6	60	82	456	3,887
	20	3,469	6	64	87	484	4,113
	50	4,034	7	70	99	549	4,761

		Direct Damage	Reduction of Revenue	Permanent Protection	Temporary Protection	Total
Commerce	5	372	1,728	8	92	2,200
	10	414	1,891	9	102	2,416
	20	442	2,017	9	108	2,578
	50	493	2,217	10	121	2,842

		Direct Damage	Reduction of Revenue	Permanent Protection	Temporary Protection	Total
Industry	5	329	650	5	5	990
	10	349	707	5	5	1,069
	20	376	756	6	6	1,145
	50	393	786	6	6	1,193

Table Q.6 (2) Summary of Flood Damages (With Green Belt Project)

[Unit: ฿ thousand]

Rainfall Frequency Item (Year)		Direct Damage	Loss of Trans-portation Cost	Medical Payment	Prevention Works of Permanent Type	Prevention Works of Temporary Type	Total
Household	5	1,528	3	32	42	229	1,836
	10	2,179	4	40	55	304	2,584
	20	2,694	5	48	67	372	3,188
	50	3,026	5	54	75	416	3,579

		Direct Damage	Reduction of Revenue	Permanent Protection	Temporary Protection	Total
Commerce	5	221	1,136	5	56	1,419
	10	324	1,483	7	79	1,895
	20	346	1,603	7	85	2,043
	50	406	1,834	8	99	2,350

		Direct Damage	Reduction of Revenue	Permanent Protection	Temporary Protection	Total
Industry	5	73	234	1	1	310
	10	186	403	3	3	596
	20	204	437	3	3	648
	50	274	540	4	4	823

Table Q.6 (3) Summary of Flood Damages (With Green Belt and Proposed Project)

[Unit: ¥ thousand]

Rainfall Frequency Item (Year)		Direct Damage	Loss of Transportation Cost	Medical Payment	Prevention Works of Permanent Type	Prevention Works of Temporary Type	Total
Household	5	10	0	0	0	1	12
	10	172	0	1	2	17	193
	20	343	0	2	5	34	386
	50	494	1	4	8	49	555

		Direct Damage	Reduction of Revenue	Permanent Protection	Temporary Protection	Total
Commerce	5	15	51	0	3	70
	10	37	123	1	8	169
	20	74	246	1	17	338
	50	80	267	1	18	367

		Direct Damage	Reduction of Revenue	Permanent Protection	Temporary Protection	Total
Industry	5	0	0	0	0	0
	10	16	22	0	0	40
	20	33	45	1	0	80
	5o	50	68	1	1	121

Table Q.7 (1) Flood Damages of Public Sector
(Without Green Belt and Proposed Project)
[Unit: million Baht]

Rainfall Frequency (Year)	Flood Damages of BMTA				Public Expenditure	Total
	repair & Maintenance	large repair cost	extra fuel cost	sub-Total		
5	13	5	1	20	744	764
10	15	5	2	22	821	844
20	16	6	2	25	873	898
50	17	6	2	26	980	1006

Table Q.7 (2) Flood Damages of Public Sector
(With Green Belt Project)
[Unit: million Baht]

Rainfall Frequency (Year)	Flood Damages of BMTA				Public Expenditure	Total
	repair & Maintenance	large repair cost	extra fuel cost	sub-Total		
5	8	3	1	13	397	410
10	9	3	1	14	565	579
20	9	3	1	15	655	670
50	10	4	2	16	752	768

Table Q.7 (3) Flood Damages of Public Sector
(With Green Belt and Proposed Project)
[Unit: million Baht]

Rainfall Frequency (Year)	Flood Damages of BMTA				Public Expenditure	Total
	repair & Maintenance	large repair cost	extra fuel cost	sub-Total		
5	0	0	0	0	9	9
10	0	0	0	0	44	44
20	0	0	0	0	89	89
50	0	0	0	0	116	116

6. Projection of Flood Damages in 2000

Future damages for the year 2000 are estimated with the same methodology for each mesh based on the future flood depth, flood duration, and the number of households, stores and factories. The summary of the damage projection in 2000 is shown in Table Q.6 to Table Q.8. According to these Tables, the followings are pointed out;

1 The estimated damages to household and commerce in 2000 are about 1.5 - 2.5 times (varying according to the probability of rainfall) as large as those of 1983, respectively.
2 The combination of the Green Belt and the study project can significantly decrease the flood damage to about one-tenth of the estimated flood damage compared with the situation without both project.
3 The damage of the public sector is very small (about one tenth) compared with that of the private sectors.

7. Calculation of Benefit

Fig. Q.3 represents the relationship between the probability of rainfall and the flood damage based on Table Q.8. Since the benefit from the study project can be calculated as the difference between the amount of flood damage of "without project" and that of "with project", the benefits for the following projects are shown as the shaded area of Fig. Q.3, that is,

Table Q.8 Summary of Flood Damage

[Unit: million Baht]

Rainfall Frequency (Year)		Damage to Private Sector	Damage to Public Sector	Total
Without Green Belt and Proposed Project	5	6,678	764	7,443
	10	7,373	844	8,218
	20	7,836	898	8,734
	50	8,797	1,006	9,804
With Green Belt Project	5	3,565	410	3,976
	10	5,076	579	5,656
	20	5,880	670	6,550
	50	6,752	768	7,521
With Green Belt and Proposed Project	5	82	9	91
	10	403	44	448
	20	806	89	895
	50	1,044	116	1,160

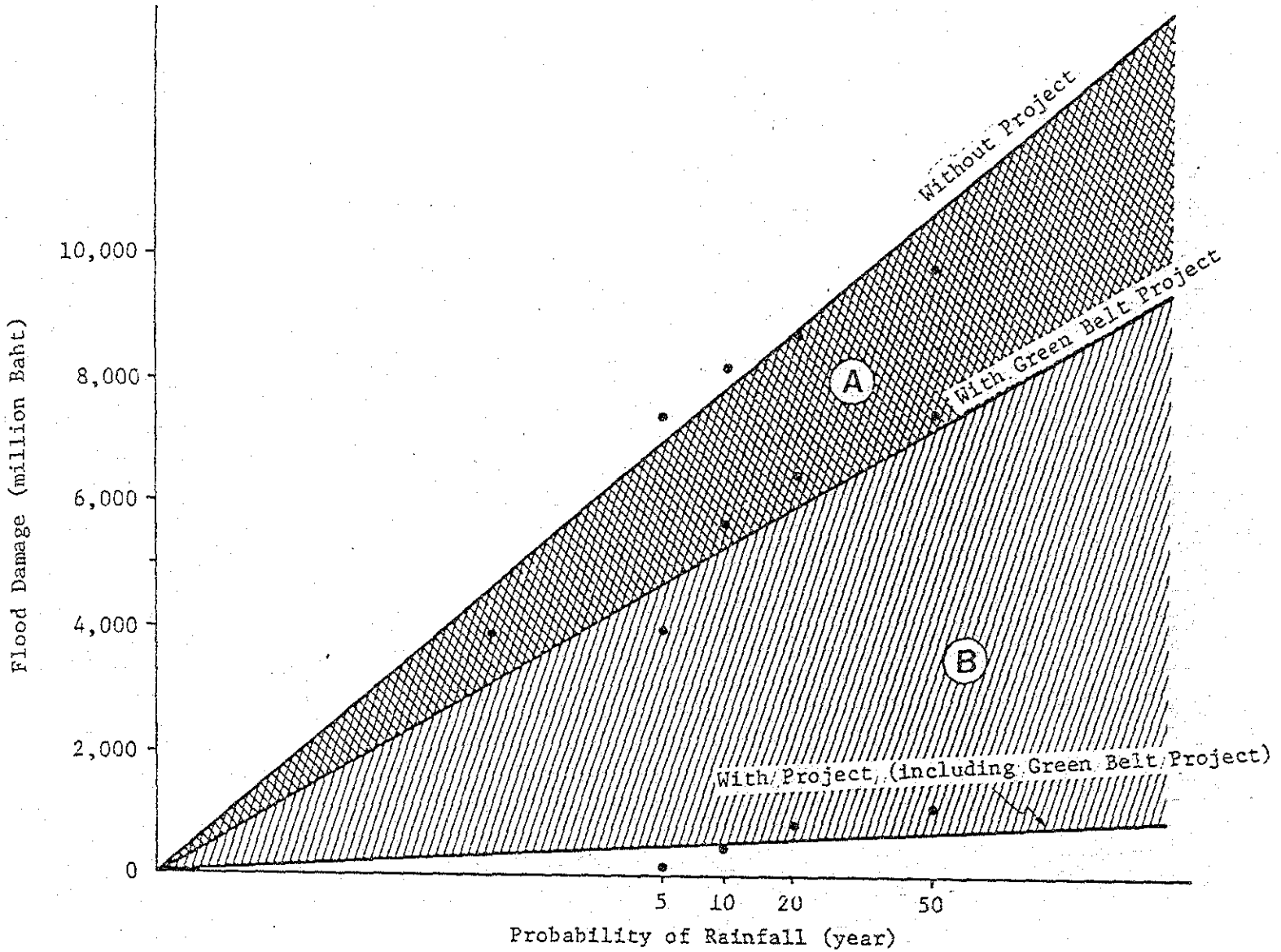

Fig. Q.3 RELATION BETWEEN THE PROBABLE RAINFALL AND THE FLOOD DAMAGE

MASTER PLAN ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK

JICA 2528B.E 1985A.D

1) Benefit from Green Belt Project

   Area A

2) Benefit from Green Belt + the Study Project

   Area A + B

3) Benefit from the Study Project

   Area B

Therefore, the monetary values of yearly average benefits in each project is approximately calculated according to Table Q.9.

1) Benefit from Green Belt Project

   ₿ 4,630 million - ₿ 2,716 million = ₿ 1,914 million

2) Benefit from the Green Belt plus the Study Project

   ₿ 4,630 million - ₿ 147 million = ₿ 4,483 million

3) Benefit from the Study Project

   ₿ 2,716 million - ₿ 147 million = ₿ 2,569 million

The result means that the implemented Green Belt Project shows almost the same benefit as the study project even though the former cost is smaller than the latter cost.

8. Economic Analysis

In this section, the economic justificatioin of the project is investigated by comparing the economic cost with economic benefit. The economic justification is performed for Green Belt Project, Green Belt + the Study Project, and the Study Project. In addition, as for the study project, two different implementation programs are also examined.

Table Q.9 Calculation of Benefit

(Unit: million Baht)

	Rainfall * Frequency (A)	1.00-(A) (B)	Total Damage (C)	$(C+C^{-})\times 2/1$ (D)	(D)×(A) (E)	Total Annual Average Damage (F)
Without Green Belt Project	1/1=1.00	-	-	-	-	
	1/5=0.2	0.8	7,443	3,772	2,978	
	1/10=0.1	0.1	8,218	7,831	783	
	1/20=0.05	0.05	8,735	8,477	424	
	1/50=0.002	0.048	9,804	9,270	445	4,630
With Green Belt Project	1/1=1.000	-	-	-	-	
	1/5=0.2	0.8	3,977	1,989	1,59	
	1/10=0.1	0.1	5,656	4,817	482	
	1/20=0.05	0.05	6,551	6,104	305	
	1/50=0.002	0.048	7,522	7,037	338	2,716
Withe Green Belt Project + Proposed Project	1/1=1.000	-	-	-	-	
	1/5=0.2	0.8	92	46	37	
	1/10=0.1	0.1	449	271	27	
	1/20=0.05	0.05	896	673	34	
	1/50=0.002	0.048	1,161	1,029	49	147

Note: $(C)^{-}$: Total damage (C) in the upper colum.

8.1 Premises of the Economic Analysis

The premises for the economic analysis are as follows.

1) Project Life

40 years is applied for the project life in economic cost and benefit calculation.

2) Construction Cost

The flow of the economic cost is assumed to be the same for each year within each construction stage.

3) Operation and Maintenance Cost

Operation and maintenance cost is assumed to be 3 percent of the construction cost excluding engineering and supervision fees, contingency, and land acquisition.

4) Opportunity Cost of Capital

According to the Report of Bank of Thailand, the prime rate of 16 percent is used as the opportunity cost of capital, since it is the prime lending rate in 1984.

5) Flow of Benefit

a) Alternative-I of Implementation Schedule

Annual benefit flow of each project is proportionally estimated depending on the amount of the yearly construction cost. And the annual benefits after 2000 are assumed to be the same in the year 2000 by making allowance for the difficulty of forcasting.

b) Alternative II of Implementation Schedule

According to the implementation schedule, the entire facilities are constructed until the year of 2015.

So, some part of the tertiary facilities (main pipe) is not constructed up to the year of 2000. Therefore, the benefit of this case was projected under the assumption that the share of the benefit of the main facilities (embankment, gate, and main klong) is 70 percent of the benefit of the entire facilities.

8.2 Results of the Economic Analysis

Benefit and cost flows of each project are shown in Table Q.10 and the three economic indicators are shown in Table Q.11 including the results of the sensitivity analysis. Judging from the results of the economic evaluation (N.P.V., B/C, I.R.R.) shown in Table Q.11, I.R.R. of Green Belt Project shows the highest value of 137 percent, which means that the most crucial facilities for flood protection were initially constructed at relatively low cost. Nevertheless, it is found that even after the completion of Green Belt Project, the considerable amount of flood damage would have remained in the Master Plan Area. From this point, the proposed project is indispensable to alleviate flood damage. Therefore, the implemented Green Belt Project and the proposed project must be considered as one system for the flood protection. In which case, the I.R.R. shows more than 106 percent.

The value of the proposed project is evaluated excluding the benefit from the Green Belt Project. The I.R.R. shows 21.6 percent for the Alternative I and 26.5 percent for the Alternative II, which are sufficient high as the infrastructure development project.