Supporting Report H

Economic Evaluation

Supporting Report H Economic Evaluation

H.1 Methodology

The objective of economic evaluation is to evaluate the project efficiency from the viewpoint of economics of the Study Area. An economic analysis is carried out using the economic costs and economic benefits from the projects of Master Plan, which is not directly related to the cash flow of the projects. For example, subsidies or taxes, which are internal transfers of cash within the country, are not included in economic analysis.

The economic cost is obtained by deducting the transfer payment from the financial cost. The economic benefit is defined as the impact of flood control measures, which is composed of the flood damage reduction impact and the effect of multipurpose dam.

The economic effects and feasibility of the project are examined by making a comparison between both present values of the economic cost and benefit, by means of the Cost Benefit Ratio (B/C), the Net Present Value (NPV) and the Economic Internal Rate of Return (EIRR).

H.2 Economic Cost

For the economic evaluation, the project cost estimated in financial cost is converted to the economic cost. In order to derive the economic cost from the financial cost, transfer payments such as taxes and price escalation are deducted. In addition to subtracting the transfer payments, a standard conversion factor of 0.9 is applied for converting to the shadow price for all the costs except imported goods.

H.3 Economic Benefit

Benefit of the project is generally defined as an economic difference between "with-project" and "without-project" situation. As for the Study, "With-project" means the condition that the structural measures and non-structural measures for flood damage reduction proposed in this Study are developed completely or gradually, and "Without-project" means the condition without any such measures.

Generally, there are two kinds of benefit, namely tangible benefit and intangible benefit. Further, tangible benefit would be classified into direct benefit and indirect benefit.

The direct/tangible benefits derived from the implementation of countermeasures will be estimated as a reduction in damage to assets such as building, household effects, livestock, crops, infrastructure and other facilities. Indirect/tangible benefit also would be estimated as a reduction in damage, which would be caused by the direct damage of disaster.

H.3.1 Types of Project Benefits

Two types of project benefits are estimated for economic evaluation of the Proposed Plan: 1) flood damage reduction benefit and 2) the benefit of multiple uses of dam.

1) Flood damage reduction benefit is characterized as flood damage reduced by implementation of the flood control plan, which includes damage to property, damage to infrastructure and disturbance to economic activities.

2) The benefit of multiple uses of dam is characterized as the effect of dam utilization with other objectives except flood control such as power generation and water supply.

H.3.2 Flood Damage Reduction Benefit

The flood damage reduction benefit expected from the flood control project is estimated by the following procedure.

1) Selection of evaluation items
2) Estimation of unit value of assets
3) Estimation of damage by inundation depth
4) Estimation of probable flood damage
5) Conversion to annual average flood damage

(1) Selection of Evaluation Items

The following items are selected for estimation of the expected flood damage considering the data availability of the Study Area.

(Direct damage)

- House damage
- Household property damage
- Agricultural damage (paddy)
- Public infrastructure damage

(Indirect damage)

- Interruption to business operations

(2) Estimation of Unit Value of Assets

The value of the assets for the study area is determined by review of past study data and additional data collection from publications and related agencies. The details of each item are described below.

1) House and Household Property

According to the Census of Population and Housing 2001, houses in Sri Lanka have been divided into the following three housing types, which are classified based on materials of construction used for wall, floor and roof:

- Improvised: The walls and roof were made of cadjan, palmyrah or other inferior or non-durable material
- Semi-Permanent: A mixture of durable and non-durable materials
- Permanent: Materials used are of the durable type like bricks, cement, tile, asbestos sheets, etc.

The following table shows the basic conditions applied to estimate the value of a house.

Table H.3.1 Estimation of Value of House in June, 2007

Housing Type	Floor Area (m2) *1	Average Unit Value (Rs/m2) *2	Average Value of Houses	Depreciation Ratio *1	Residual Value (Rs./unit)
Improvised	36	3,474	125,075	0.5	62,538
Semi-Permanent	92	20,528	1,888,554	0.5	944,277
Permanent	185	20,528	3,797,636	0.5	1,898,818

Note: *1: "The Study on Storm Water Drainage Plan for the Colombo Metropolitan Region", 2003 March, JICA
*2: "The Study on Storm Water Drainage Plan for the Colombo Metropolitan Region", 2003 March, JICA,
and "Bulletin of Construction Statistics", 2007 June, ICTAD

The household property value is also estimated for three groups. The household property value is estimated by a ratio to the average value of the house.

Table H.3.2 Estimation of Value of Household Property in June, 2007

Housing Type	Average Value of House (Rs.)	Ratio of Household Property Value (%) *1	Estimated Household Property (Rs.)
Improvised	62,538	30	18,761
Semi-Permanent	944,277	30	283,283
Permanent	1,898,818	30	569,645

Note: *1: "The Study on Storm Water Drainage Plan for the Colombo Metropolitan Region", 2003 March, JICA

The proportion of housing type is various in districts as shown in the table below. In the analysis, number of damaged house is calculated using this proportion.

Table H.3.3 Number and Percentage of Housing Units by District and Type of Housing Unit

District	Total Housing Units	Permanent		Semi Permanent		Improvised	
	No.	No.	%	No.	%	No.	%
Colombo	473,045	408,473	86.3%	54,234	11.5%	1,293	0.3%
Gampaha	475,847	380,985	80.1%	83,351	17.5%	5,251	1.1%
Kalutara	245,784	193,973	78.9%	48,347	19.7%	1,094	0.4%
Nuwara Eliya	164,886	106,766	64.8%	54,618	33.1%	300	0.2%
Galle	229,521	166,119	72.4%	60,304	26.3%	1,722	0.8%
Matara	174,712	126,683	72.5%	46,118	26.4%	1,096	0.6%
Hambantota	126,362	75,720	59.9%	49,367	39.1%	590	0.5%
Ratnapura	242,882	148,266	61.0%	92,413	38.0%	406	0.2%
Kegalle	193,578	133,244	68.8%	57,960	29.9%	980	0.5%
Total	2,326,617	1,740,229	74.8%	546,712	23.5%	12,732	0.5%

Source: Census of Population and Housing 2001

2) Paddy

The value of paddy is estimated separately based on the productivity (average yield) and producer price of paddy. The average yield by districts as shown in the table below and Rs.13.34/kg of the all island producer prices of 2005 from Statistical Abstract 2006 by Department of Census and Statistics are applied for estimation of the value of paddy.

Table H.3.4 Average Yield of Paddy by District

District	Average Yield 2006 Total (kg/Hectare)
Colombo	3,206
Gampaha	3,507
Kalutara	2,791
Nuwara Eliya	3,710
Galle	3,299
Matara	3,817
Hambantota	4,798
Ratnapura	3,167
Kegalle	3,686
Sri Lanka	4,137

Source: http://www.statistics.gov.lk/agriculture/index.htm
Web Site of Agriculture and Environment Statistics
Division, Department of Census and Statistics

(3) Estimation of damage by inundation depth

1) House

The rate of damage caused by inundation to the assets is mainly related to water depth. In this analysis, the relationship between inundation depth and damage rate prepared by the Ministry of Land, Infrastructure and Transport, Japan is utilized for estimation of the house damage by inundation depth.

The above damage rate is defined by the slope of inundation area such as less than 1/1000, 1/1000-1/500 and more than 1/500. Average gradient of the riverbed of each target river is less than 1/1000. Accordingly, damage rate of less than 1/1000 as shown in the table below is applied for flood damage estimation in this Study.

Table H.3.5 Rate of Flood Damage to House

	Water Depth				
	< 50 m	50 – 99cm	100 – 199cm	200 – 299cm	300cm =<
Damage Rate	0.092	0.119	0.266	0.580	0.834

Source: "Manual for Economic Study on Flood Control", Ministry of Land, Infrastructure and Transport, Japan

2) Household Property

The damage rate for household property is shown in the table below, which is also from the manual prepared by the Ministry of Land, Infrastructure and Transport, Japan.

Table H.3.6 Rate of Flood Damage to Assets and Effects

	Water Depth				
	< 50 m	50 – 99cm	100 – 199cm	200 – 299cm	300cm =<
Damage Rate	0.145	0.326	0.508	0.928	0.991

Source: "Manual for Economic Study on Flood Control", Ministry of Land, Infrastructure and Transport, Japan

(4) Estimation of Probable Flood Damage

1) House, Household Property and Paddy Damage

The probable flood damage of house, household property and paddy, is estimated under the various magnitudes of flood events. For the estimation, number of affected damaged house by water depth and inundated area of paddy are analyzed using GIS database and the result of hydraulic analysis.

Detailed analysis using GIS has been done for two flood events with probabilities of 2 and 50 years in each basin.

Conditions of analysis and data used for analysis are as follow;

- Population: 2001 data (GIS data) from UGA
- House and household number: Calculated by dividing the population by 4.2, which is the average size (persons) of household from Census of Population and Housing 2001. According to the Census, number of household and number of house were almost same.
- Proportion of housing type: 2001 data from Census of Population and Housing 2001
- Landuse condition (area of paddy field): 1999 data (GIS data) from Survey Department

Results of the analysis for damage to house and household property, and damage to paddy are shown in Table H.4.2 and the table below, respectively.

Table H.3.7 Damage to Paddy in Basins by Zone

Basin	Zone	Flood Return Period	Inundation Area (km^2)	Damage Amount (Million Rs.)
Kelani	Unprotected Area	2 years	0.02	0.07
		50 years	3.86	16.91
	Other Area	2 years	20.25	90.83
		50 years	36.45	163.05
	Total	**2 years**	**20.27**	**90.89**
		50 years	**40.31**	**179.96**
Kalu	Zone A	2 years	4.72	17.57
		50 years	33.47	124.60
	Zone B	2 years	0	0
		50 years	2.44	10.32
	Zone C	2 years	0	0
		50 years	1.27	5.39
	Total	**2 years**	**4.72**	**17.57**
		50 years	**37.18**	**140.30**
Gin	Zone A	2 years	2.44	10.74
		50 years	8.34	36.68
	Zone B	2 years	5.77	25.38
		50 years	10.17	44.74
	Total	**2 years**	**8.21**	**36.12**
		50 years	**18.50**	**81.42**
Nilwala	Zone A	2 years	0.29	1.47
		50 years	8.86	45.09
	Zone B	2 years	16.50	84.04
		50 years	21.92	111.60
	Total	**2 years**	**16.79**	**85.51**
		50 years	**30.77**	**156.69**

Note: Estimated by JICA Study Team

Damages of other flood events with probabilities of 5, 10, 20 and 30 years are calculated using the above result of each two flood events and the result of hydraulic analysis. Table H.4.3 shows the result of calculation.

2) Infrastructure Damage and Interruption to Business Operations

Damage due to interruption to business operations and infrastructure is estimated applying the ratio used in "The Study on Storm Water Drainage Plan for the Colombo Metropolitan Region", 2003 March, JICA, which was based on the ratio set by the Ministry of Land, Infrastructure and Transport, Japan. The interruption to business operations is estimated at 6% of the sum of house and household property damage, and the damage to infrastructure (roads, bridges) is estimated at 28% of the sum of house and household property damage. Table H.4.3 shows the result of calculation including house, household property and paddy damage for four basins, and the following table is a summarized one.

Table H.3.8 Summary of Probable Flood Damage

(Unit: Million Rs.)

Flood Return Period	Kelani	Kalu	Gin	Nilwala
2 years	5,353.7	652.0	1,355.2	2,925.6
5 years	10,910.7	4,425.2	2,125.5	4,252.9
10 years	14,948.6	7,300.1	2,646.9	5,416.9
20 years	18,637.0	10,243.3	3,413.4	6,003.2
30 years	20,840.7	11,853.5	4,255.0	6,494.9
50 years	23,614.3	14,336.0	5,027.6	7,137.7

Note: Estimated by JICA Study Team

(5) Conversion of Probable Flood Damage to Annual Average Flood Damage

Table H.4.4 shows the annual average flood damage for the four basins and the table below shows the summary of it. The estimated annual average flood damage is considered as a base for the flood reduction benefits. The flood damage reduction benefit is derived from the annual average flood damage and the effect of the flood control measures, which is estimated from the reduced damage by them.

Table H.3.9 Summary of Annual Average Flood Damage

(Unit: Million Rs.)

Flood Return Period	Kelani	Kalu	Gin	Nilwala
2 years	1,338.4	163.0	338.8	731.4
5 years	3,778.1	924.6	860.9	1,808.2
10 years	5,071.1	1,510.9	1,099.5	2,291.7
20 years	5,910.7	1,949.4	1,251.0	2,577.2
30 years	6,239.7	2,133.6	1,314.9	2,681.3
50 years	6,536.1	2,308.2	1,376.8	2,772.2

Note: Estimated by JICA Study Team

H.3.3 Benefit of Multiple Uses of Dam

The benefit of multiple uses of dam is characterized as the effect of dam utilization with other objectives except flood control such as power generation and water supply, since the effect of flood control by dam is already included in the benefit of flood damage reduction. In this analysis, the

function of power generation is counted as other economic benefit from the multipurpose dam. The benefit is calculated by the construction and O&M cost of alternative thermal power generation plant, which has the same capacity and average annual generation as the proposed dam.

The table below shows the unit values for the evaluation of the benefits of multiple uses of dam.

Table H.3.10 Unit Values of Benefit of Multiple Uses of Dam

Type of Alternative Thermal Plants	Construction Cost (US$/kW)	Fixed O&M Cost (US$/kW Month)	Variable O&M Cost (USCts/kWh)	Fuel Cost (USCts/kWh)
Steam - Fuel Oil (Capacity: 150 MW)	1304.8	0.802	0.439	5.29

Source: "Long Term Generation Expansion Plan, 2006-2020", December 2005, Ceylon Electricity Board

The following table summarizes the benefit of multiple uses of proposed dams, which is calculated using the above unit values.

Table H.3.11 Benefit of Multiple Uses of Dam

Name of Dam	Basin	Installed Capacity	Constructin Cost of Alternative Thermal Power	Annual Energy Generation	Annual Benefit from Alternative O&M Cost of Thermal Power Plant				Annual Benefit (extracted from the Report concerned)	Source
					Fixed O&M Cost	Variable O&M Cost	Fuel Cost	Total	For Reference	
		MW	Million Rs.	Gwh	Million Rs.	Million Rs.	Million Rs.	Million Rs.	Million Rs.	
Nawata-Parusella	Kelani	44,774 *2	6,491,148	124.87	15.5	60.9	733.9	810.3		*2: DHI 1992
Malwara (Multi-purpose)	Kalu	33,000 *1	4,784,219	111.58 *1	13.8	54.4	655.8	724.1	420 *1	*1: Pre Feasibility Study Assessment of Kalu Ganga Flood Protection with Special Reference to Ratnapura, Drainage & Flood Protection Branch, Irrigation Department, July 2004
Malwara (Flood Control)	Kalu	29,872 *1	4,330,694	94.00 *1	11.6	45.8	552.5	610.0	420 *1	
Jasmin (High)	Gin	20,661 *4	2,995,388	48.73	6.0	23.8	286.4	316.2		*4: ECI 1968
Jasmin (Low)	Gin	9,298 *4	1,347,925	29.59	3.7	14.4	173.9	192.0		*4: ECI 1968
Siyambalagoda (High)	Nilwala	16,164	2,343,353	39.99	4.9	19.5	235.1	259.5		
Siyambalagoda (Low)	Nilwala	11,870	1,720,900	32.76	4.1	16.0	192.6	212.6		

Conditions of Above Calculation

Exchange Rate (US$ - Rs.)	111.11	Rs.

Unit Value for Construction Cost of Thermal Power Generatio Source: Long Term Generation Expansion Plan, 2006-2005, December 2005, CEB

Plant	Installed Capacity (MW)	Const Period (Years)	Total Construction Cost Including of IDC (US$/kW)	Economic Life (Years)	
Steam - Fuel Oil	150	4	1,305	30	Selected the most highest unit rate of thermal power generation type in the CEB's Report.

Unit Value for O&M Cost of Thermal Power Generation Plant Source: Long Term Generation Expansion Plan, 2006-2005, December 2005, CEB

Plant	Installed Capacity (MW)	Fixed O&M Cost (US$/kW)	Variable O&M Cost (USCts/kwh)	Fuel Cost (USCts/kwh)	
Steam - Fuel Oil	150	0.802	0.439	5.29	Selected the most highest unit rate of thermal power generation type in the CEB's Report.

H.3.4 Intangible Benefit

In addition to the quantitative benefits discussed and estimated in the previous sections, it should be noted that the proposed project would produce a lot of intangible benefits that cannot be measured quantitatively. The following intangible benefits can be expected through the implementation of the project.

1) Promotion of Landuse Development and Economic Development

The proposed project creates flood free land and the flood free land can be utilized for industry, commercial and residential purposes. Consequently, the economic development of the region is promoted.

2) Hygienic Improvement of the Environment

The flooding causes health hazards such as breeding of mosquitoes, contaminating the water and the spread of intestinal diseases, which are identified as one of the major causes of death among children and elderly. The project will improve the hygienic environment and improve the people's health. It eventually contributes to savings in health care cost.

3) Alleviation of Inconvenience to People's Life

The flooding usually affects the people's life and causes inconvenience such as a decline in the standard of their living due to damage to their assets and public facilities, shortage of goods, steep rise in prices, lowering of administrative and educational activities, etc. As the project aims at reducing flooding in space and time, thee people's lives will become much more convenient due to the project.

4) Elimination of the Menace of Flooding

The people living in the lowlands are exposed to the menace of flooding. The project will eliminate the menace of flooding by reducing flooding or protecting the people from flood.

H.4 Economic Evaluation for the Proposed Alternative Projects

H.4.1 Basic Conditions

On the basis of the estimated construction cost, operation and maintenance cost (O&M cost) and estimated economic benefits, the Economic Internal Rate of Return (EIRR), B-C and B/C of proposed alternative projects are calculated based on the following assumptions.

1) Project life of 50 years
2) Discount rate of 10%
3) Project cost of short term is disbursed according to the construction schedule.
4) Project cost of medium and long term is disbursed according to the construction schedule.
5) The O&M cost is assumed to disbursed for the entire project lifetime from the year following completion of the project works in each term of short term and medium and long term.
6) Benefit is produced over the entire project life from the year following completion of the project works in each term of short term and medium and long term.
7) The benefit is expected not to increase.

H.4.2 Economic Evaluation for Proposed Alternative Projects

The flood control benefit for the project is composed of the flood damage reduction benefit and the benefit of multiple uses of dam. The flood damage reduction benefit is calculated based on the annual average flood damage and the impact of the projects measured by the difference between the inundation area with and without the project. The impact of the projects is calculated by the size of reduction of the expected

inundation area with the project. The benefit of multiple uses of dam is calculated based on construction and O&M cost of alternative thermal power generation plant.

H.4.3 Results of the Evaluations

The results of the evaluations for the proposed alternative projects for each basin are expressed in B-C (Rs. million), B/C and EIRR (%). Economic feasibility line of the project is considered to be positive for B-C, one or above for B/C and 10% or higher for EIRR, which is based on the discount rate of 10%. Cost benefit streams of the proposed alternative projects for each basin are shown in Table H.4.5, and results of the evaluations of selected projects in each basin are summarized in the table below:

Table H.4.1 Economic Evaluation for the Selected Proposed Projects

Short-term Plan

Basin	B-C (Million Rs.)	B/C	EIRR (%)
Kelani (5-yr)	8,811	3.2	24.4
Kalu (10-yr)	7,617	2.89	23.5
Gin (10-yr)	1,512	1.23	12.4
Nilwala (10-yr)	6,105	2.00	19.2

Long-term Plan

Basin	B-C (Million Rs.)	B/C	EIRR (%)
Kelani (20-yr)	9,611	2.4	20.7
Kalu (30-yr)	7,438	2.24	20.7
Gin (30-yr)	555	1.07	10.7
Nilwala (30-yr)	5,890	1.85	18.0

Note: Estimated by JICA Study Team

Table H.4.2 (1) Damage to House and Household Property with Inundation Depth in Kelani Basin

Kelani (1/2)

Item	Inundation Depth					Total
	<50cm	50-99cm	100-199cm	200-299cm	>=300cm	
Damaged House Number by Housing	16,570	0	0	0	0	16,570
Permanent	14,074	0	0	0	0	14,074
Simi-Permanent	2,387	0	0	0	0	2,387
Improvised	109	0	0	0	0	109
Damage to House (Million Rs.)	2,666.6	0.0	0.0	0.0	0.0	2,666.6
Damage to Household Property (Million Rs.)	1,260.9	0.0	0.0	0.0	0.0	1,260.9
Total Damage (Million Rs.)	3,927.5	0.0	0.0	0.0	0.0	3,927.5

Kelani (1/50)

Item	Inundation Depth					Total
	<50cm	50-99cm	100-199cm	200-299cm	>=300cm	
Damaged House Number by Housing	70,710	21	97	243	101	71,171
Permanent	60,627	17	82	206	89	61,022
Simi-Permanent	9,688	4	14	35	12	9,753
Improvised	394	0	1	2	0	397
Damage to House (Million Rs.)	11,435.0	4.3	45.1	245.8	150.4	11,880.6
Damage to Household Property (Million Rs.)	5,406.8	3.5	25.8	118.0	53.6	5,607.7
Total Damage (Million Rs.)	16,841.7	7.8	70.9	363.9	204.0	17,488.3

Table H.4.2 (2) Damage to House and Household Property with Inundation Depth in Kalu Basin

Zone A (1/2)

Item	Inundation Depth					Total
	<50cm	50-99cm	100-199cm	200-299cm	>=300cm	
Damaged House Number by Housing	1,555	134	92	0	0	1,781
Permanent	1,239	107	74	0	0	1,419
Simi-Permanent	309	27	18	0	0	354
Improvised	7	1	0	0	0	8
Damage to House (Million Rs.)	243.4	27.1	41.7	0.0	0.0	312.2
Damage to Household Property (Million Rs.)	115.1	22.3	23.9	0.0	0.0	161.3
Total Damage (Million Rs.)	358.4	49.4	65.7	0.0	0.0	473.5

Zone A (1/50)

Item	Inundation Depth					Total
	<50cm	50-99cm	100-199cm	200-299cm	>=300cm	
Damaged House Number by Housing	6,070	1,055	2,241	1,229	442	11,037
Permanent	4,835	841	1,783	979	352	8,791
Simi-Permanent	1,207	210	448	245	88	2,197
Improvised	27	5	10	6	2	50
Damage to House (Million Rs.)	949.7	213.6	1,013.3	1,212.4	627.0	4,016.0
Damage to Household Property (Million Rs.)	449.1	175.5	580.6	581.9	223.5	2,010.6
Total Damage (Million Rs.)	1,398.8	389.1	1,593.9	1,794.3	850.5	6,026.5

Zone B (1/2)

Item	Inundation Depth					Total
	<50cm	50-99cm	100-199cm	200-299cm	>=300cm	
Damaged House Number by Housing	0	0	0	0	0	0
Permanent	0	0	0	0	0	0
Simi-Permanent	0	0	0	0	0	0
Improvised	0	0	0	0	0	0
Damage to House (Million Rs.)	0.0	0.0	0.0	0.0	0.0	0.0
Damage to Household Property (Million Rs.)	0.0	0.0	0.0	0.0	0.0	0.0
Total Damage (Million Rs.)	0.0	0.0	0.0	0.0	0.0	0.0

Zone B (1/50)

Item	Inundation Depth					Total
	<50cm	50-99cm	100-199cm	200-299cm	>=300cm	
Damaged House Number by Housing	631	185	232	149	304	1,500
Permanent	388	113	143	92	187	922
Simi-Permanent	242	71	89	57	116	575
Improvised	1	0	0	0	1	3
Damage to House (Million Rs.)	88.8	33.6	94.5	132.0	387.3	736.2
Damage to Household Property (Million Rs.)	42.0	27.6	54.1	63.4	138.1	325.2
Total Damage (Million Rs.)	130.8	61.2	148.6	195.4	525.4	1,061.4

Zone C (1/2)

Item	Inundation Depth					Total
	<50cm	50-99cm	100-199cm	200-299cm	>=300cm	
Damaged House Number by Housing	0	0	0	0	0	0
Permanent	0	0	0	0	0	0
Simi-Permanent	0	0	0	0	0	0
Improvised	0	0	0	0	0	0
Damage to House (Million Rs.)	0.0	0.0	0.0	0.0	0.0	0.0
Damage to Household Property (Million Rs.)	0.0	0.0	0.0	0.0	0.0	0.0
Total Damage (Million Rs.)	0.0	0.0	0.0	0.0	0.0	0.0

Zone C (1/50)

Item	Inundation Depth					Total
	<50cm	50-99cm	100-199cm	200-299cm	>=300cm	
Damaged House Number by Housing	1,366	131	71	119	1,720	3,408
Permanent	840	81	44	73	1,058	2,096
Simi-Permanent	524	50	27	46	659	1,306
Improvised	2	0	0	0	3	6
Damage to House (Million Rs.)	192.3	23.8	29.1	105.6	2,194.8	2,545.6
Damage to Household Property (Million Rs.)	90.9	19.6	16.7	50.7	782.4	960.3
Total Damage (Million Rs.)	283.2	43.4	45.7	156.3	2,977.2	3,505.9

Total (1/2)

Item	Inundation Depth					Total
	<50cm	50-99cm	100-199cm	200-299cm	>=300cm	
Damaged House Number by Housing	1,555	134	92	0	0	1,781
Permanent	1,239	107	74	0	0	1,419
Simi-Permanent	309	27	18	0	0	354
Improvised	7	1	0	0	0	8
Damage to House (Million Rs.)	243	27	42	0	0	312.2
Damage to Household Property (Million Rs.)	115	22	24	0	0	161.3
Total Damage (Million Rs.)	358.4	49.4	65.7	0.0	0.0	473.5

Total (1/50)

Item	Inundation Depth					Total
	<50cm	50-99cm	100-199cm	200-299cm	>=300cm	
Damaged House Number by Housing	8,067	1,371	2,545	1,497	2,466	15,945
Permanent	6,064	1,035	1,970	1,144	1,597	11,809
Simi-Permanent	1,973	330	564	347	864	4,078
Improvised	31	5	11	6	5	58
Damage to House (Million Rs.)	1,231	271	1,137	1,450	3,209	7,297.8
Damage to Household Property (Million Rs.)	582	223	651	696	1,144	3,296.0
Total Damage (Million Rs.)	1,812.8	493.7	1,788.2	2,146.0	4,353.1	10,593.8

Table H.4.2 (3) Damage to House and Household Property with Inundation Depth in Gin Basin

Zone A (1/2)

Item	Inundation Depth					Total
	<50cm	50-99cm	100-199cm	200-299cm	>=300cm	
Damaged House Number by Housing	567	52	64	21	27	731
Permanent	413	38	47	15	20	532
Simi-Permanent	150	14	17	6	7	193
Improvised	4	0	0	0	0	6
Damage to House (Million Rs.)	85.2	10.1	27.8	19.7	36.5	179.3
Damage to Household Property (Million Rs.)	40.3	8.3	15.9	9.5	13.0	87.0
Total Damage (Million Rs.)	125.4	18.4	43.7	29.2	49.5	266.2

Zone A (1/50)

Item	Inundation Depth					Total
	<50cm	50-99cm	100-199cm	200-299cm	>=300cm	
Damaged House Number by Housing	1,060	40	132	121	448	1,801
Permanent	771	29	96	88	326	1,311
Simi-Permanent	280	11	35	32	118	476
Improvised	8	0	1	1	3	14
Damage to House (Million Rs.)	159.1	7.8	57.5	114.1	609.9	948.5
Damage to Household Property (Million Rs.)	75.2	6.4	33.0	54.8	217.4	386.8
Total Damage (Million Rs.)	234.4	14.2	90.5	168.9	827.3	1,335.3

Zone B (1/2)

Item	Inundation Depth					Total
	<50cm	50-99cm	100-199cm	200-299cm	>=300cm	
Damaged House Number by Housing	699	86	234	180	65	1,265
Permanent	509	63	170	131	48	921
Simi-Permanent	185	23	62	48	17	334
Improvised	5	1	2	1	0	10
Damage to House (Million Rs.)	105.1	16.8	101.5	170.5	89.2	482.9
Damage to Household Property (Million Rs.)	49.7	13.8	58.1	81.8	31.8	235.2
Total Damage (Million Rs.)	154.7	30.6	159.6	252.3	120.9	718.2

Zone B (1/50)

Item	Inundation Depth					Total
	<50cm	50-99cm	100-199cm	200-299cm	>=300cm	
Damaged House Number by Housing	1,051	60	70	132	1,012	2,324
Permanent	765	43	51	96	737	1,692
Simi-Permanent	278	16	18	35	267	614
Improvised	8	0	1	1	8	18
Damage to House (Million Rs.)	157.8	11.6	30.4	125.4	1,377.8	1,703.0
Damage to Household Property (Million Rs.)	74.6	9.5	17.4	60.2	491.2	652.9
Total Damage (Million Rs.)	232.4	21.1	47.8	185.6	1,869.0	2,355.9

Total (1/2)

Item	Inundation Depth					Total
	<50cm	50-99cm	100-199cm	200-299cm	>=300cm	
Damaged House Number by Housing	1,266	138	298	201	92	1,996
Permanent	922	101	217	146	67	1,453
Simi-Permanent	335	37	79	53	24	527
Improvised	10	1	2	2	1	15
Damage to House (Million Rs.)	190	27	129	190	126	662.2
Damage to Household Property (Million Rs.)	90	22	74	91	45	322.2
Total Damage (Million Rs.)	280.2	49.0	203.3	281.5	170.4	984.4

Total (1/50)

Item	Inundation Depth					Total
	<50cm	50-99cm	100-199cm	200-299cm	>=300cm	
Damaged House Number by Housing	2,110	100	202	253	1,460	4,125
Permanent	1,536	73	147	184	1,063	3,004
Simi-Permanent	558	26	53	67	386	1,090
Improvised	16	1	2	2	11	31
Damage to House (Million Rs.)	317	19	88	240	1,988	2,651.5
Damage to Household Property (Million Rs.)	150	16	50	115	709	1,039.7
Total Damage (Million Rs.)	466.8	35.3	138.2	354.5	2,696.3	3,691.2

Table H.4.2 (4) Damage to House and Household Property with Inundation Depth in Nilwala Basin

Zone A (1/2)

Item	Inundation Depth					Total
	<50cm	50-99cm	100-199cm	200-299cm	>=300cm	
Damaged House Number by Housing	2,220	119	146	6	0	2,491
Permanent	1,617	87	106	4	0	1,815
Simi-Permanent	589	32	39	2	0	661
Improvised	14	1	1	0	0	16
Damage to House (Million Rs.)	333.8	23.1	63.4	5.6	0.0	426.0
Damage to Household Property (Million Rs.)	157.8	19.0	36.3	2.7	0.0	215.9
Total Damage (Million Rs.)	491.6	42.2	99.7	8.3	0.0	641.8

Zone A (1/50)

Item	Inundation Depth					Total
	<50cm	50-99cm	100-199cm	200-299cm	>=300cm	
Damaged House Number by Housing	3,417	193	321	190	366	4,488
Permanent	2,489	141	234	139	267	3,270
Simi-Permanent	906	51	85	51	97	1,190
Improvised	22	1	2	1	2	28
Damage to House (Million Rs.)	513.7	37.6	139.7	180.5	498.9	1,370.4
Damage to Household Property (Million Rs.)	242.9	30.9	80.0	86.7	177.8	618.3
Total Damage (Million Rs.)	756.5	68.5	219.8	267.2	676.7	1,988.7

Zone B (1/2)

Item	Inundation Depth					Total
	<50cm	50-99cm	100-199cm	200-299cm	>=300cm	
Damaged House Number by Housing	4,726	318	295	83	0	5,423
Permanent	3,443	232	215	61	0	3,950
Simi-Permanent	1,253	84	78	22	0	1,438
Improvised	30	2	2	1	0	34
Damage to House (Million Rs.)	710.5	61.9	128.1	79.0	0.0	979.5
Damage to Household Property (Million Rs.)	336.0	50.9	73.4	37.9	0.0	498.1
Total Damage (Million Rs.)	1,046.5	112.8	201.4	116.9	0.0	1,477.6

Zone B (1/50)

Item	Inundation Depth					Total
	<50cm	50-99cm	100-199cm	200-299cm	>=300cm	
Damaged House Number by Housing	4,143	208	625	634	494	6,104
Permanent	3,018	152	455	462	360	4,447
Simi-Permanent	1,099	55	166	168	131	1,619
Improvised	26	1	4	4	3	38
Damage to House (Million Rs.)	622.8	40.5	271.7	600.8	673.3	2,209.1
Damage to Household Property (Million Rs.)	294.5	33.3	155.6	288.4	240.0	1,011.8
Total Damage (Million Rs.)	917.3	73.8	427.3	889.2	913.3	3,221.0

Zone B (1/2)

Item	Inundation Depth					Total
	<50cm	50-99cm	100-199cm	200-299cm	>=300cm	
Damaged House Number by Housing	6,946	438	440	89	0	7,914
Permanent	5,060	319	321	65	0	5,765
Simi-Permanent	1,842	116	117	24	0	2,099
Improvised	44	3	3	1	0	50
Damage to House (Million Rs.)	1,044	85	191	85	0	1,405.5
Damage to Household Property (Million Rs.)	494	70	110	41	0	714.0
Total Damage (Million Rs.)	1,538.1	155.0	301.2	125.2	0.0	2,119.5

Zone B (1/50)

Item	Inundation Depth					Total
	<50cm	50-99cm	100-199cm	200-299cm	>=300cm	
Damaged House Number by Housing	7,560	402	946	824	860	10,592
Permanent	5,507	293	689	601	627	7,716
Simi-Permanent	2,005	107	251	219	228	2,809
Improvised	48	3	6	5	5	67
Damage to House (Million Rs.)	1,136	78	411	781	1,172	3,579.5
Damage to Household Property (Million Rs.)	537	64	236	375	418	1,630.2
Total Damage (Million Rs.)	1,673.8	142.3	647.1	1,156.4	1,590.1	5,209.7

Table H.4.3 (1) Probable Flood Damage in Kelani Basin by Zone

Basin	Return Period (Year)	Discharge at Downstream (m3/sec.)	Damage to Households (Million Rs.)	Damage to Household Property (Million Rs.)	Damage to Paddy (Million Rs.)	Disturbance to Business Activities (Million Rs.)	Damage to Infrastructure (Million Rs.)	Total Damage (Million Rs.)
Kelani	2	1,671.6	2,666.6	1,260.9	90.9	235.7	1,099.7	5,353.7
	5	2,803.8	5,470.6	2,583.7	118.0	483.3	2,255.2	10,910.7
	10	3,626.5	7,508.0	3,544.9	137.7	663.2	3,094.8	14,948.6
	20	4,378.0	9,369.1	4,422.9	155.7	827.5	3,861.8	18,637.0
	30	4,827.0	10,481.1	4,947.5	166.4	925.7	4,320.0	20,840.7
	50	5,392.1	11,880.6	5,607.7	180.0	1,049.3	4,896.7	23,614.3

Table H.4.3 (2) Probable Flood Damage in Kalu Basin by Zone

Zone	Return Period (Year)	Discharge at Downstream (m3/sec.)	Damage to Households (Million Rs.)	Damage to Household Property (Million Rs.)	Damage to Paddy (Million Rs.)	Disturbance to Business Activities (Million Rs.)	Damage to Infrastructure (Million Rs.)	Total Damage (Million Rs.)
Zone A	2	711.0	312.2	161.3	17.6	28.4	132.6	652.0
	5	1,244.6	1,321.1	665.0	46.7	119.2	556.1	2,708.0
	10	1,654.7	2,096.4	1,052.1	69.1	188.9	881.6	4,288.2
	20	2,075.0	2,891.1	1,448.9	92.1	260.4	1,215.2	5,907.8
	30	2,286.8	3,291.7	1,648.9	103.7	296.4	1,383.4	6,724.1
	50	2,669.9	4,016.0	2,010.6	124.6	361.6	1,687.4	8,200.1
Zone B	2	504.4	0.0	0.0	0.0	0.0	0.0	0.0
	5	816.1	198.0	87.4	2.8	17.1	79.9	385.3
	10	1,062.4	354.4	156.5	5.0	30.7	143.1	689.7
	20	1,315.2	515.0	227.5	7.2	44.6	207.9	1,002.2
	30	1,468.7	612.5	270.5	8.6	53.0	247.3	1,191.9
	50	1,663.4	736.2	325.2	10.3	63.7	297.2	1,432.6
Zone C	2	443.9	0.0	0.0	0.0	0.0	0.0	0.0
	5	683.5	720.9	271.9	1.5	59.6	278.0	1,331.9
	10	861.7	1,256.9	474.1	2.7	103.9	484.7	2,322.3
	20	1,043.7	1,804.2	680.6	3.8	149.1	695.7	3,333.3
	30	1,152.4	2,131.1	803.9	4.5	176.1	821.8	3,937.5
	50	1,290.2	2,545.6	960.3	5.4	210.4	981.6	4,703.3
Kalu Basin Total	2	—	312.2	161.3	17.6	28.4	132.6	652.0
	5	—	2,239.9	1,024.4	51.0	195.9	914.0	4,425.2
	10	—	3,707.8	1,682.8	76.8	323.4	1,509.4	7,300.1
	20	—	5,210.3	2,357.0	103.1	454.0	2,118.9	10,243.3
	30	—	6,035.4	2,723.4	116.8	525.5	2,452.5	11,853.5
	50	—	7,297.8	3,296.0	140.3	635.6	2,966.3	14,336.0

Table H.4.3 (3) Probable Flood Damage in Gin Basin by Zone

Zone	Return Period (Year)	Discharge at Downstream (m3/sec.)	Damage to Households (Million Rs.)	Damage to Household Property (Million Rs.)	Damage to Paddy (Million Rs.)	Disturbance to Business Activities (Million Rs.)	Damage to Infrastructure (Million Rs.)	Total Damage (Million Rs.)
Zone A	2	634.2	179.3	87.0	10.7	16.0	74.5	367.5
	5	1,026.9	417.2	179.7	18.8	35.8	167.1	818.7
	10	1,293.7	579.0	242.8	24.2	49.3	230.1	1,125.3
	20	1,554.4	736.9	304.4	29.5	62.5	291.6	1,424.9
	30	1,702.9	826.9	339.4	32.6	70.0	326.6	1,595.5
	50	1,903.5	948.5	386.8	36.7	80.1	373.9	1,826.0
Zone B	2	543.2	482.9	235.2	25.4	43.1	201.1	987.7
	5	900.5	658.8	295.4	28.2	57.3	267.2	1,306.8
	10	1,140.9	777.1	335.9	30.0	66.8	311.7	1,521.5
	20	1,663.8	1,034.5	424.0	34.1	87.5	408.4	1,988.6
	30	2,414.9	1,404.2	550.6	40.0	117.3	547.4	2,659.5
	50	3,021.9	1,703.0	652.9	44.7	141.4	659.6	3,201.6
Gin Basin Total	2	—	662.2	322.2	36.1	59.1	275.6	1,355.2
	5	—	1,076.0	475.1	46.9	93.1	434.3	2,125.5
	10	—	1,356.1	578.7	54.3	116.1	541.7	2,646.9
	20	—	1,771.4	728.4	63.7	150.0	700.0	3,413.4
	30	—	2,231.2	890.0	72.6	187.3	873.9	4,255.0
	50	—	2,651.5	1,039.7	81.4	221.5	1,033.5	5,027.6

Table H.4.3 (4) Probable Flood Damage in Nilwala Basin by Zone

Zone	Return Period (Year)	Discharge at Downstream (m3/sec.)	Damage to Households (Million Rs.)	Damage to Household Property (Million Rs.)	Damage to Paddy (Million Rs.)	Disturbance to Business Activities (Million Rs.)	Damage to Infrastructure (Million Rs.)	Total Damage (Million Rs.)
Zone A	2	637.0	426.0	215.9	1.5	38.5	179.7	861.5
	5	1,214.4	720.7	341.5	15.1	63.7	297.4	1,438.3
	10	1,878.5	1,059.6	485.9	30.7	92.7	432.7	2,101.6
	20	1,983.5	1,113.2	508.7	33.2	97.3	454.1	2,206.6
	30	2,198.7	1,223.0	555.5	38.3	106.7	498.0	2,421.5
	50	2,487.5	1,370.4	618.3	45.1	119.3	556.8	2,710.0
Zone B	2	544.7	979.5	498.1	84.0	88.7	413.7	2,064.1
	5	1,051.1	1,369.9	661.2	92.8	121.9	568.7	2,814.6
	10	1,388.9	1,630.4	770.1	98.6	144.0	672.1	3,315.2
	20	1,713.7	1,880.8	874.7	104.2	165.3	771.5	3,796.6
	30	1,900.5	2,024.8	934.8	107.5	177.6	828.7	4,073.4
	50	2,139.6	2,209.1	1,011.8	111.6	193.3	901.9	4,427.7
Nilwala Basin Total	2	–	1,405.5	714.0	85.5	127.2	593.5	2,925.6
	5	–	2,090.6	1,002.7	107.9	185.6	866.1	4,252.9
	10	–	2,690.0	1,255.9	129.4	236.8	1,104.9	5,416.9
	20	–	2,994.0	1,383.4	137.4	262.6	1,225.7	6,003.2
	30	–	3,247.8	1,490.4	145.7	284.3	1,326.7	6,494.9
	50	–	3,579.5	1,630.2	156.7	312.6	1,458.7	7,137.7

Table H.4.4 (1) Annual Average Flood Damage in Kelani Basin by Zone

Basin	Return Period (Year)	Exceedance	Difference of Exceedance	Damage (Rs. Million)		Annual Damage (Rs. Million)	
				Amount	Average	Segment	Cumulative
Kelani		1.00					
	2	0.50	0.50	5,353.7	2,676.9	1,338.4	1,338.4
	5	0.20	0.30	10,910.7	8,132.2	2,439.7	3,778.1
	10	0.10	0.10	14,948.6	12,929.6	1,293.0	5,071.1
	20	0.05	0.05	18,637.0	16,792.8	839.6	5,910.7
	30	0.03	0.02	20,840.7	19,738.9	329.0	6,239.7
	50	0.02	0.01	23,614.3	22,227.5	296.4	6,536.1

Table H.4.4 (2) Annual Average Flood Damage in Kalu Basin by Zone

Zone	Return Period (Year)	Exceedance	Difference of Exceedance	Damage (Rs. Million)		Annual Damage (Rs. Million)	
				Amount	Average	Segment	Cumulative
Zone A		1.00					
	2	0.50	0.50	652.0	326.0	163.0	163
	5	0.20	0.30	2,708.0	1,680.0	504.0	667
	10	0.10	0.10	4,288.2	3,498.1	349.8	1,017
	20	0.05	0.05	5,907.8	5,098.0	254.9	1,272
	30	0.03	0.02	6,724.1	6,315.9	105.3	1,377
	50	0.02	0.01	8,200.1	7,462.1	99.5	1,476
Zone B		1.00					
	2	0.50	0.50	0.0	0.0	0.0	0.0
	5	0.20	0.30	385.3	192.6	57.8	57.8
	10	0.10	0.10	689.7	537.5	53.7	111.5
	20	0.05	0.05	1,002.2	845.9	42.3	153.8
	30	0.03	0.02	1,191.9	1,097.1	18.3	172.1
	50	0.02	0.01	1,432.6	1,312.3	17.5	189.6
Zone C		1.00					
	2	0.50	0.50	0.0	0.0	0.0	0.0
	5	0.20	0.30	1,331.9	666.0	199.8	199.8
	10	0.10	0.10	2,322.3	1,827.1	182.7	382.5
	20	0.05	0.05	3,333.3	2,827.8	141.4	523.9
	30	0.03	0.02	3,937.5	3,635.4	60.6	584.5
	50	0.02	0.01	4,703.3	4,320.4	57.6	642.1
Total		1.00				0	
	2	0.50	0.50	652.0	326.0	163.0	163.0
	5	0.20	0.30	4,425.2	2,538.6	761.6	924.6
	10	0.10	0.10	7,300.1	5,862.7	586.3	1,510.9
	20	0.05	0.05	10,243.3	8,771.7	438.6	1,949.4
	30	0.03	0.02	11,853.5	11,048.4	184.1	2,133.6
	50	0.02	0.01	14,336.0	13,094.7	174.6	2,308.2

Table H.4.4 (3) Annual Average Flood Damage in Gin Basin by Zone

Zone	Return Period (Year)	Exceedance	Difference of Exceedance	Damage (Rs. Million)		Annual Damage (Rs. Million)	
				Amount	Average	Segment	Cumulative
Zone A		1.00					
	2	0.50	0.50	367.5	183.8	91.9	92
	5	0.20	0.30	818.7	593.1	177.9	270
	10	0.10	0.10	1,125.3	972.0	97.2	367
	20	0.05	0.05	1,424.9	1,275.1	63.8	431
	30	0.03	0.02	1,595.5	1,510.2	25.2	456
	50	0.02	0.01	1,826.0	1,710.8	22.8	479
Zone B		1.00					
	2	0.50	0.50	987.7	493.9	246.9	246.9
	5	0.20	0.30	1,306.8	1,147.2	344.2	591.1
	10	0.10	0.10	1,521.5	1,414.2	141.4	732.5
	20	0.05	0.05	1,988.6	1,755.1	87.8	820.3
	30	0.03	0.02	2,659.5	2,324.0	38.7	859.0
	50	0.02	0.01	3,201.6	2,930.5	39.1	898.1
Total		1.00				0	
	2	0.50	0.50	1,355.2	677.6	338.8	338.8
	5	0.20	0.30	2,125.5	1,740.3	522.1	860.9
	10	0.10	0.10	2,646.9	2,386.2	238.6	1,099.5
	20	0.05	0.05	3,413.4	3,030.2	151.5	1,251.0
	30	0.03	0.02	4,255.0	3,834.2	63.9	1,314.9
	50	0.02	0.01	5,027.6	4,641.3	61.9	1,376.8

Table H.4.4 (4) Annual Average Flood Damage in Nilwala Basin by Zone

Zone	Return Period (Year)	Exceedance	Difference of Exceedance	Damage (Rs. Million)		Annual Damage (Rs. Million)	
				Amount	Average	Segment	Cumulative
Zone A		1.00					
	2	0.50	0.50	861.5	430.8	215.4	215.4
	5	0.20	0.30	1,438.3	1,149.9	345.0	560.4
	10	0.10	0.10	2,101.6	1,770.0	177.0	737.4
	20	0.05	0.05	2,206.6	2,154.1	107.7	845.1
	30	0.03	0.02	2,421.5	2,314.1	38.6	883.6
	50	0.02	0.01	2,710.0	2,565.8	34.2	917.8
Zone B		1.00					
	2	0.50	0.50	2,064.1	1,032.0	516.0	516.0
	5	0.20	0.30	2,814.6	2,439.3	731.8	1,247.8
	10	0.10	0.10	3,315.2	3,064.9	306.5	1,554.3
	20	0.05	0.05	3,796.6	3,555.9	177.8	1,732.1
	30	0.03	0.02	4,073.4	3,935.0	65.6	1,797.7
	50	0.02	0.01	4,427.7	4,250.5	56.7	1,854.4
Total		1.00				0	
	2	0.50	0.50	2,925.6	1,462.8	731.4	731.4
	5	0.20	0.30	4,252.9	3,589.3	1,076.8	1,808.2
	10	0.10	0.10	5,416.9	4,834.9	483.5	2,291.7
	20	0.05	0.05	6,003.2	5,710.0	285.5	2,577.2
	30	0.03	0.02	6,494.9	6,249.0	104.2	2,681.3
	50	0.02	0.01	7,137.7	6,816.3	90.9	2,772.2

Table H.4.5 (1) Cost Benefit Stream of Alternative Plan of Case 1 in Kelani River Basin

River:	Kelani	Overall
Case:	1	

(Unit: Million Rs.)

Year	Cost								Benefit								B-C (NPV)	Cost Net Present Value	Benefit Net Present Value		EIRR Verification
	Costruction Cost			O&M			Grand Total	NPV	Flood Control			Power Generation			Grand Total	NPV					
	Short Term	Long Term	Total	Short Term	Long Term	Total			Short Term	Long Term	Total	Short Term	Long Term	Total							
1	1,041		1,041			0	1,041	946	0	0	0			0	0	0	-946	915	0		-1041
2	945		945			0	945	781	0	0	0			0	0	0	-781	730	0		-945
3	1,540		1,540			0	1,540	1,157	0	0	0			0	0	0	-1157	1046	0		-1540
4	1,137		1,137			0	1,137	777	0	0	0			0	0	0	-777	679	0		-1137
5	736		736			0	736	457	0	0	0			0	0	0	-457	386	0		-736
6		3,765	3,765	54		54	3,819	2,156	2,078	0	2,078			0	2,078	1,173	-983	1762	959		-1741
7		3,082	3,082	54		54	3,136	1,609	2,078	0	2,078			0	2,078	1,066	-543	1272	843		-1058
8		2,558	2,558	54		54	2,612	1,219	2,078	0	2,078			0	2,078	969	-249	931	741		-535
9		1,615	1,615	54		54	1,669	708	2,078	0	2,078			0	2,078	881	173	523	651		409
10		458	458	54		54	512	197	2,078	0	2,078			0	2,078	801	604	141	572		1,566
11		496	496	54		54	550	193	2,078	0	2,078			0	2,078	728	535	133	503		1,528
12		538	538	54		54	592	189	2,078	0	2,078			0	2,078	662	473	126	442		1,486
13		585	585	54		54	639	185	2,078	0	2,078			0	2,078	602	417	120	389		1,439
14		483	483	54		54	537	141	2,078	0	2,078			0	2,078	547	406	88	342		1,541
15		187	187	54		54	241	58	2,078	0	2,078			0	2,078	497	440	35	300		1,837
16			0	54	138	192	192	42	0	3,217	3,217			0	3,217	700	658	24	409		3,025
17			0	54	138	192	192	38	0	3,217	3,217			0	3,217	636	598	21	359		3,025
18			0	54	138	192	192	34	0	3,217	3,217			0	3,217	579	544	19	316		3,025
19			0	54	138	192	192	31	0	3,217	3,217			0	3,217	526	495	17	278		3,025
20			0	54	138	192	192	28	0	3,217	3,217			0	3,217	478	450	15	244		3,025
21			0	54	138	192	192	26	0	3,217	3,217			0	3,217	435	409	13	215		3,025
22			0	54	138	192	192	24	0	3,217	3,217			0	3,217	395	372	11	189		3,025
23			0	54	138	192	192	21	0	3,217	3,217			0	3,217	359	338	10	166		3,025
24			0	54	138	192	192	19	0	3,217	3,217			0	3,217	327	307	9	146		3,025
25			0	54	138	192	192	18	0	3,217	3,217			0	3,217	297	279	8	128		3,025
26			0	54	138	192	192	16	0	3,217	3,217			0	3,217	270	254	7	113		3,025
27			0	54	138	192	192	15	0	3,217	3,217			0	3,217	245	231	6	99		3,025
28			0	54	138	192	192	13	0	3,217	3,217			0	3,217	223	210	5	87		3,025
29			0	54	138	192	192	12	0	3,217	3,217			0	3,217	203	191	5	77		3,025
30			0	54	138	192	192	11	0	3,217	3,217			0	3,217	184	173	4	67		3,025
31			0	54	138	192	192	10	0	3,217	3,217			0	3,217	168	158	4	59		3,025
32			0	54	138	192	192	9	0	3,217	3,217			0	3,217	152	143	3	52		3,025
33			0	54	138	192	192	8	0	3,217	3,217			0	3,217	139	130	3	46		3,025
34			0	54	138	192	192	8	0	3,217	3,217			0	3,217	126	118	2	40		3,025
35			0	54	138	192	192	7	0	3,217	3,217			0	3,217	114	108	2	35		3,025
36			0	54	138	192	192	6	0	3,217	3,217			0	3,217	104	98	2	31		3,025
37			0	54	138	192	192	6	0	3,217	3,217			0	3,217	95	89	2	27		3,025
38			0	54	138	192	192	5	0	3,217	3,217			0	3,217	86	81	1	24		3,025
39			0	54	138	192	192	5	0	3,217	3,217			0	3,217	78	74	1	21		3,025
40			0	54	138	192	192	4	0	3,217	3,217			0	3,217	71	67	1	19		3,025
41			0	54	138	192	192	4	0	3,217	3,217			0	3,217	65	61	1	16		3,025
42			0	54	138	192	192	3	0	3,217	3,217			0	3,217	59	55	1	14		3,025
43			0	54	138	192	192	3	0	3,217	3,217			0	3,217	53	50	1	13		3,025
44			0	54	138	192	192	3	0	3,217	3,217			0	3,217	49	46	1	11		3,025
45			0	54	138	192	192	3	0	3,217	3,217			0	3,217	44	42	1	10		3,025
46			0	54	138	192	192	2	0	3,217	3,217			0	3,217	40	38	1	9		3,025
47			0	54	138	192	192	2	0	3,217	3,217			0	3,217	36	34	0	8		3,025
48			0	54	138	192	192	2	0	3,217	3,217			0	3,217	33	31	0	7		3,025
49			0	54	138	192	192	2	0	3,217	3,217			0	3,217	30	28	0	6		3,025
50			0	54	138	192	192	2	0	3,217	3,217			0	3,217	27	26	0	5		3,025
	5,398	13,765					26,410	11,213							133,362	15,354	4,140	9,086	9,085	-0.75	13.76%
		19,163																			

IRR	13.76%
B-C	4,140
B/C	1.37

Table H.4.5 (2) Cost Benefit Stream of Alternative Plan of Case 1 in Kelani River Basin

River:	Kelani	Short
Case:	1	

(Unit: Million Rs.)

Year	Cost								Benefit								B-C (NPV)	Cost Net Present Value	Benefit Net Present Value		EIRR Verification
	Costruction Cost			O&M			Grand Total	NPV	Flood Control			Power Generation			Grand Total	NPV					
	Short Term	Long Term	Total	Short Term	Long Term	Total			Short Term	Long Term	Total	Short Term	Long Term	Total							
1	1041		1040.548			0	1,041	946	0	0	0			0	0	0	-946	844	0		-1,041
2	945		945.1715			0	945	781	0	0	0			0	0	0	-781	621	0		-945
3	1540		1539.842			0	1,540	1,157	0	0	0			0	0	0	-1,157	820	0		-1,540
4	1137		1137.078			0	1,137	777	0	0	0			0	0	0	-777	491	0		-1,137
5	736		735.5332			0	736	457	0	0	0			0	0	0	-457	258	0		-736
6			0	54		54	54	30	2,078	0	2,078			0	2,078	1,173	1,142	15	590		2,024
7			0	54		54	54	28	2,078	0	2,078			0	2,078	1,066	1,038	12	478		2,024
8			0	54		54	54	25	2,078	0	2,078			0	2,078	969	944	10	388		2,024
9			0	54		54	54	23	2,078	0	2,078			0	2,078	881	858	8	314		2,024
10			0	54		54	54	21	2,078	0	2,078			0	2,078	801	780	7	255		2,024
11			0	54		54	54	19	2,078	0	2,078			0	2,078	728	709	5	207		2,024
12			0	54		54	54	17	2,078	0	2,078			0	2,078	662	645	4	167		2,024
13			0	54		54	54	16	2,078	0	2,078			0	2,078	602	586	4	136		2,024
14			0	54		54	54	14	2,078	0	2,078			0	2,078	547	533	3	110		2,024
15			0	54		54	54	13	2,078	0	2,078			0	2,078	497	484	2	89		2,024
16			0	54		54	54	12	2,078	0	2,078			0	2,078	452	440	2	72		2,024
17			0	54		54	54	11	2,078	0	2,078			0	2,078	411	400	2	59		2,024
18			0	54		54	54	10	2,078	0	2,078			0	2,078	374	364	1	48		2,024
19			0	54		54	54	9	2,078	0	2,078			0	2,078	340	331	1	39		2,024
20			0	54		54	54	8	2,078	0	2,078			0	2,078	309	301	1	31		2,024
21			0	54		54	54	7	2,078	0	2,078			0	2,078	281	273	1	25		2,024
22			0	54		54	54	7	2,078	0	2,078			0	2,078	255	249	1	21		2,024
23			0	54		54	54	6	2,078	0	2,078			0	2,078	232	226	0	17		2,024
24			0	54		54	54	5	2,078	0	2,078			0	2,078	211	205	0	13		2,024
25			0	54		54	54	5	2,078	0	2,078			0	2,078	192	187	0	11		2,024
26			0	54		54	54	5	2,078	0	2,078			0	2,078	174	170	0	9		2,024
27			0	54		54	54	4	2,078	0	2,078			0	2,078	158	154	0	7		2,024
28			0	54		54	54	4	2,078	0	2,078			0	2,078	144	140	0	6		2,024
29			0	54		54	54	3	2,078	0	2,078			0	2,078	131	128	0	5		2,024
30			0	54		54	54	3	2,078	0	2,078			0	2,078	119	116	0	4		2,024
31			0	54		54	54	3	2,078	0	2,078			0	2,078	108	105	0	3		2,024
32			0	54		54	54	3	2,078	0	2,078			0	2,078	98	96	0	3		2,024
33			0	54		54	54	2	2,078	0	2,078			0	2,078	89	87	0	2		2,024
34			0	54		54	54	2	2,078	0	2,078			0	2,078	81	79	0	2		2,024
35			0	54		54	54	2	2,078	0	2,078			0	2,078	74	72	0	1		2,024
36			0	54		54	54	2	2,078	0	2,078			0	2,078	67	65	0	1		2,024
37			0	54		54	54	2	2,078	0	2,078			0	2,078	61	60	0	1		2,024
38			0	54		54	54	1	2,078	0	2,078			0	2,078	56	54	0	1		2,024
39			0	54		54	54	1	2,078	0	2,078			0	2,078	50	49	0	1		2,024
40			0	54		54	54	1	2,078	0	2,078			0	2,078	46	45	0	0		2,024
41			0	54		54	54	1	2,078	0	2,078			0	2,078	42	41	0	0		2,024
42			0	54		54	54	1	2,078	0	2,078			0	2,078	38	37	0	0		2,024
43			0	54		54	54	1	2,078	0	2,078			0	2,078	34	34	0	0		2,024
44			0	54		54	54	1	2,078	0	2,078			0	2,078	31	31	0	0		2,024
45			0	54		54	54	1	2,078	0	2,078			0	2,078	29	28	0	0		2,024
46			0	54		54	54	1	2,078	0	2,078			0	2,078	26	25	0	0		2,024
47			0	54		54	54	1	2,078	0	2,078			0	2,078	24	23	0	0		2,024
48			0	54		54	54	1	2,078	0	2,078			0	2,078	21	21	0	0		2,024
49			0	54		54	54	1	2,078	0	2,078			0	2,078	19	19	0	0		2,024
50			0	54		54	54	0	2,078	0	2,078			0	2,078	18	17	0	0		2,024
	5,398	0					7,827	4,448							93,496	12,724	8,276	3,115	3,116	0.83	23.35%
		5,398																			

IRR	23.35%
B-C	8,276
B/C	2.86

Table H.4.5 (3) Cost Benefit Stream of Alternative Plan of Case 2 in Kelani River Basin

River:	Kelani	Overall
Case:	2	

(Unit: Million Rs.)

Year	Cost								Benefit								B-C (NPV)	Cost Net Present Value	Benefit Net Present Value		EIRR Verification
	Costruction Cost			O&M			Grand Total	NPV	Flood Control			Power Generation			Grand Total	NPV					
	Short Term	Long Term	Total	Short Term	Long Term	Total			Short Term	Long Term	Total	Short Term	Long Term	Total							
1	919		919			0	919	835	0	0	0			0	0	0	-835	823	0		-919
2	1,050		1,050			0	1,050	868	0	0	0			0	0	0	-868	842	0		-1,050
3	1,531		1,531			0	1,531	1,151	0	0	0			0	0	0	-1,151	1,100	0		-1,531
4	1,205		1,205			0	1,205	823	0	0	0			0	0	0	-823	775	0		-1,205
5	896		896			0	896	556	0	0	0			0	0	0	-556	516	0		-896
6		4,686	4,686	56		56	4,742	2,677	2,078	0	2,078			0	2,078	1,173	-1,504	2,448	1,073		-2,664
7		3,737	3,737	56		56	3,793	1,946	2,078	0	2,078			0	2,078	1,066	-880	1,754	961		-1,715
8		5,173	5,173	56		56	5,229	2,439	2,078	0	2,078			0	2,078	969	-1,470	2,165	860		-3,151
9		4,288	4,288	56		56	4,344	1,842	2,078	0	2,078			0	2,078	881	-961	1,611	771		-2,266
10		3,176	3,176	56		56	3,232	1,246	2,078	0	2,078			0	2,078	801	-445	1,074	690		-1,154
11		3,480	3,480	56		56	3,536	1,239	2,078	0	2,078			0	2,078	728	-511	1,052	618		-1,458
12		3,815	3,815	56		56	3,871	1,233	2,078	0	2,078			0	2,078	662	-571	1,032	554		-1,793
13		4,183	4,183	56		56	4,239	1,228	2,078	0	2,078			0	2,078	602	-626	1,012	496		-2,162
14		3,208	3,208	56		56	3,264	860	2,078	0	2,078			0	2,078	547	-312	698	444		-1,186
15		479	479	56		56	535	128	2,078	0	2,078			0	2,078	497	369	102	398		1,543
16			0	56	362	418	418	91	0	6,721	6,721			0	6,721	1,463	1,372	72	1,153		6,303
17			0	56	362	418	418	83	0	6,721	6,721			0	6,721	1,330	1,247	64	1,032		6,303
18			0	56	362	418	418	75	0	6,721	6,721			0	6,721	1,209	1,134	58	925		6,303
19			0	56	362	418	418	68	0	6,721	6,721			0	6,721	1,099	1,031	52	828		6,303
20			0	56	362	418	418	62	0	6,721	6,721			0	6,721	999	937	46	742		6,303
21			0	56	362	418	418	57	0	6,721	6,721			0	6,721	908	852	41	664		6,303
22			0	56	362	418	418	51	0	6,721	6,721			0	6,721	826	774	37	595		6,303
23			0	56	362	418	418	47	0	6,721	6,721			0	6,721	751	704	33	533		6,303
24			0	56	362	418	418	42	0	6,721	6,721			0	6,721	682	640	30	477		6,303
25			0	56	362	418	418	39	0	6,721	6,721			0	6,721	620	582	27	428		6,303
26			0	56	362	418	418	35	0	6,721	6,721			0	6,721	564	529	24	383		6,303
27			0	56	362	418	418	32	0	6,721	6,721			0	6,721	513	481	21	343		6,303
28			0	56	362	418	418	29	0	6,721	6,721			0	6,721	466	437	19	307		6,303
29			0	56	362	418	418	26	0	6,721	6,721			0	6,721	424	397	17	275		6,303
30			0	56	362	418	418	24	0	6,721	6,721			0	6,721	385	361	15	246		6,303
31			0	56	362	418	418	22	0	6,721	6,721			0	6,721	350	328	14	221		6,303
32			0	56	362	418	418	20	0	6,721	6,721			0	6,721	318	299	12	198		6,303
33			0	56	362	418	418	18	0	6,721	6,721			0	6,721	289	271	11	177		6,303
34			0	56	362	418	418	16	0	6,721	6,721			0	6,721	263	247	10	159		6,303
35			0	56	362	418	418	15	0	6,721	6,721			0	6,721	239	224	9	142		6,303
36			0	56	362	418	418	14	0	6,721	6,721			0	6,721	217	204	8	127		6,303
37			0	56	362	418	418	12	0	6,721	6,721			0	6,721	198	185	7	114		6,303
38			0	56	362	418	418	11	0	6,721	6,721			0	6,721	180	169	6	102		6,303
39			0	56	362	418	418	10	0	6,721	6,721			0	6,721	163	153	6	91		6,303
40			0	56	362	418	418	9	0	6,721	6,721			0	6,721	149	139	5	82		6,303
41			0	56	362	418	418	8	0	6,721	6,721			0	6,721	135	127	5	73		6,303
42			0	56	362	418	418	8	0	6,721	6,721			0	6,721	123	115	4	66		6,303
43			0	56	362	418	418	7	0	6,721	6,721			0	6,721	112	105	4	59		6,303
44			0	56	362	418	418	6	0	6,721	6,721			0	6,721	101	95	3	53		6,303
45			0	56	362	418	418	6	0	6,721	6,721			0	6,721	92	86	3	47		6,303
46			0	56	362	418	418	5	0	6,721	6,721			0	6,721	84	79	3	42		6,303
47			0	56	362	418	418	5	0	6,721	6,721			0	6,721	76	71	2	38		6,303
48			0	56	362	418	418	4	0	6,721	6,721			0	6,721	69	65	2	34		6,303
49			0	56	362	418	418	4	0	6,721	6,721			0	6,721	63	59	2	30		6,303
50			0	56	362	418	418	4	0	6,721	6,721			0	6,721	57	54	2	27		6,303
	5,601	36,225					57,024	20,037							256,012	23,444	3,407	17,678	17,678	-0.31	11.65%
		41,825																			

IRR	11.65%
B-C	3,407
B/C	1.17

Table H.4.5 (4) Cost Benefit Stream of Alternative Plan of Case 2 in Kelani River Basin

River:	Kelani	Short
Case:	2	

(Unit: Million Rs.)

Year	Cost								Benefit								B-C (NPV)	Cost Net Present Value	Benefit Net Present Value		EIRR Verification
	Costruction Cost			O&M			Grand Total	NPV	Flood Control			Power Generation			Grand Total	NPV					
	Short Term	Long Term	Total	Short Term	Long Term	Total			Short Term	Long Term	Total	Short Term	Long Term	Total							
1	919		919			0	919	835	0	0	0			0	0	0	-835	746	0		-919
2	1,050		1,050			0	1,050	868	0	0	0			0	0	0	-868	693	0		-1,050
3	1,531		1,531			0	1,531	1,151	0	0	0			0	0	0	-1,151	822	0		-1,531
4	1,205		1,205			0	1,205	823	0	0	0			0	0	0	-823	525	0		-1,205
5	896		896			0	896	556	0	0	0			0	0	0	-556	317	0		-896
6			0	56		56	56	32	2,078	0	2,078			0	2,078	1,173	1,141	16	598		2,022
7			0	56		56	56	29	2,078	0	2,078			0	2,078	1,066	1,037	13	486		2,022
8			0	56		56	56	26	2,078	0	2,078			0	2,078	969	943	11	395		2,022
9			0	56		56	56	24	2,078	0	2,078			0	2,078	881	857	9	321		2,022
10			0	56		56	56	22	2,078	0	2,078			0	2,078	801	779	7	261		2,022
11			0	56		56	56	20	2,078	0	2,078			0	2,078	728	709	6	212		2,022
12			0	56		56	56	18	2,078	0	2,078			0	2,078	662	644	5	172		2,022
13			0	56		56	56	16	2,078	0	2,078			0	2,078	602	586	4	140		2,022
14			0	56		56	56	15	2,078	0	2,078			0	2,078	547	532	3	114		2,022
15			0	56		56	56	13	2,078	0	2,078			0	2,078	497	484	2	92		2,022
16			0	56		56	56	12	2,078	0	2,078			0	2,078	452	440	2	75		2,022
17			0	56		56	56	11	2,078	0	2,078			0	2,078	411	400	2	61		2,022
18			0	56		56	56	10	2,078	0	2,078			0	2,078	374	364	1	50		2,022
19			0	56		56	56	9	2,078	0	2,078			0	2,078	340	331	1	40		2,022
20			0	56		56	56	8	2,078	0	2,078			0	2,078	309	301	1	33		2,022
21			0	56		56	56	8	2,078	0	2,078			0	2,078	281	273	1	27		2,022
22			0	56		56	56	7	2,078	0	2,078			0	2,078	255	248	1	22		2,022
23			0	56		56	56	6	2,078	0	2,078			0	2,078	232	226	0	18		2,022
24			0	56		56	56	6	2,078	0	2,078			0	2,078	211	205	0	14		2,022
25			0	56		56	56	5	2,078	0	2,078			0	2,078	192	187	0	12		2,022
26			0	56		56	56	5	2,078	0	2,078			0	2,078	174	170	0	9		2,022
27			0	56		56	56	4	2,078	0	2,078			0	2,078	158	154	0	8		2,022
28			0	56		56	56	4	2,078	0	2,078			0	2,078	144	140	0	6		2,022
29			0	56		56	56	4	2,078	0	2,078			0	2,078	131	127	0	5		2,022
30			0	56		56	56	3	2,078	0	2,078			0	2,078	119	116	0	4		2,022
31			0	56		56	56	3	2,078	0	2,078			0	2,078	108	105	0	3		2,022
32			0	56		56	56	3	2,078	0	2,078			0	2,078	98	96	0	3		2,022
33			0	56		56	56	2	2,078	0	2,078			0	2,078	89	87	0	2		2,022
34			0	56		56	56	2	2,078	0	2,078			0	2,078	81	79	0	2		2,022
35			0	56		56	56	2	2,078	0	2,078			0	2,078	74	72	0	1		2,022
36			0	56		56	56	2	2,078	0	2,078			0	2,078	67	65	0	1		2,022
37			0	56		56	56	2	2,078	0	2,078			0	2,078	61	59	0	1		2,022
38			0	56		56	56	1	2,078	0	2,078			0	2,078	56	54	0	1		2,022
39			0	56		56	56	1	2,078	0	2,078			0	2,078	50	49	0	1		2,022
40			0	56		56	56	1	2,078	0	2,078			0	2,078	46	45	0	1		2,022
41			0	56		56	56	1	2,078	0	2,078			0	2,078	42	41	0	0		2,022
42			0	56		56	56	1	2,078	0	2,078			0	2,078	38	37	0	0		2,022
43			0	56		56	56	1	2,078	0	2,078			0	2,078	34	34	0	0		2,022
44			0	56		56	56	1	2,078	0	2,078			0	2,078	31	31	0	0		2,022
45			0	56		56	56	1	2,078	0	2,078			0	2,078	29	28	0	0		2,022
46			0	56		56	56	1	2,078	0	2,078			0	2,078	26	25	0	0		2,022
47			0	56		56	56	1	2,078	0	2,078			0	2,078	24	23	0	0		2,022
48			0	56		56	56	1	2,078	0	2,078			0	2,078	21	21	0	0		2,022
49			0	56		56	56	1	2,078	0	2,078			0	2,078	19	19	0	0		2,022
50			0	56		56	56	0	2,078	0	2,078			0	2,078	18	17	0	0		2,022
	5,601	0					8,121	4,576							93,496	12,724	8,148	3,190	3,190	-0.13	23.07%
		5,601																			

IRR	23.07%
B-C	8,148
B/C	2.78

Table H.4.5 (5) Cost Benefit Stream of Alternative Plan of Case 3 in Kelani River Basin

River:	Kelani	Overall
Case:	3	

(Unit: Million Rs.)

Year	Cost								Benefit								B-C (NPV)	Cost	Benefit		EIRR Verification
	Costruction Cost			O&M			Grand Total	NPV	Flood Control			Power Generation			Grand Total	NPV		Net Present Value	Net Present Value		
	Short Term	Long Term	Total	Short Term	Long Term	Total			Short Term	Long Term	Total	Short Term	Long Term	Total							
1	1046		1046.474			0	1,046	951	0	0	0			0	0	0	-951	904	0		-1,046
2	1,162		1,162			0	1,162	960	0	0	0			0	0	0	-960	866	0		-1,162
3	1,598		1,598			0	1,598	1,201	0	0	0			0	0	0	-1,201	1,029	0		-1,598
4	1,230		1,230			0	1,230	840	0	0	0			0	0	0	-840	683	0		-1,230
5	869		869			0	869	540	0	0	0			0	0	0	-540	417	0		-869
6		1,996	1,996	59		59	2,055	1,160	2,078	0	2,078			0	2,078	1,173	13	851	861		23
7		1,855	1,855	59		59	1,914	982	2,078	0	2,078			0	2,078	1,066	84	685	743		164
8		1,545	1,545	59		59	1,604	748	2,078	0	2,078			0	2,078	969	221	496	642		473
9		1,191	1,191	59		59	1,251	530	2,078	0	2,078			0	2,078	881	351	333	554		827
10		752	752	59		59	812	313	2,078	0	2,078			0	2,078	801	488	187	478		1,266
11		817	817	59		59	876	307	2,078	0	2,078			0	2,078	728	421	174	413		1,202
12		888	888	59		59	947	302	2,078	0	2,078			0	2,078	662	360	162	357		1,131
13		965	965	59		59	1,025	297	2,078	0	2,078			0	2,078	602	305	152	308		1,053
14		1,051	1,051	59		59	1,110	292	2,078	0	2,078			0	2,078	547	255	142	266		968
15		1,145	1,145	59		59	1,204	288	2,078	0	2,078			0	2,078	497	209	133	230		873
16			0	59	122	181	181	39	0	3,586	3,586			0	3,586	780	741	17	342		3,405
17			0	59	122	181	181	36	0	3,586	3,586			0	3,586	709	674	15	295		3,405
18			0	59	122	181	181	33	0	3,586	3,586			0	3,586	645	612	13	255		3,405
19			0	59	122	181	181	30	0	3,586	3,586			0	3,586	586	557	11	220		3,405
20			0	59	122	181	181	27	0	3,586	3,586			0	3,586	533	506	10	190		3,405
21			0	59	122	181	181	24	0	3,586	3,586			0	3,586	485	460	8	164		3,405
22			0	59	122	181	181	22	0	3,586	3,586			0	3,586	441	418	7	142		3,405
23			0	59	122	181	181	20	0	3,586	3,586			0	3,586	400	380	6	122		3,405
24			0	59	122	181	181	18	0	3,586	3,586			0	3,586	364	346	5	106		3,405
25			0	59	122	181	181	17	0	3,586	3,586			0	3,586	331	314	5	91		3,405
26			0	59	122	181	181	15	0	3,586	3,586			0	3,586	301	286	4	79		3,405
27			0	59	122	181	181	14	0	3,586	3,586			0	3,586	274	260	3	68		3,405
28			0	59	122	181	181	13	0	3,586	3,586			0	3,586	249	236	3	59		3,405
29			0	59	122	181	181	11	0	3,586	3,586			0	3,586	226	215	3	51		3,405
30			0	59	122	181	181	10	0	3,586	3,586			0	3,586	206	195	2	44		3,405
31			0	59	122	181	181	9	0	3,586	3,586			0	3,586	187	177	2	38		3,405
32			0	59	122	181	181	9	0	3,586	3,586			0	3,586	170	161	2	33		3,405
33			0	59	122	181	181	8	0	3,586	3,586			0	3,586	154	147	1	28		3,405
34			0	59	122	181	181	7	0	3,586	3,586			0	3,586	140	133	1	24		3,405
35			0	59	122	181	181	6	0	3,586	3,586			0	3,586	128	121	1	21		3,405
36			0	59	122	181	181	6	0	3,586	3,586			0	3,586	116	110	1	18		3,405
37			0	59	122	181	181	5	0	3,586	3,586			0	3,586	105	100	1	16		3,405
38			0	59	122	181	181	5	0	3,586	3,586			0	3,586	96	91	1	14		3,405
39			0	59	122	181	181	4	0	3,586	3,586			0	3,586	87	83	1	12		3,405
40			0	59	122	181	181	4	0	3,586	3,586			0	3,586	79	75	1	10		3,405
41			0	59	122	181	181	4	0	3,586	3,586			0	3,586	72	68	0	9		3,405
42			0	59	122	181	181	3	0	3,586	3,586			0	3,586	65	62	0	8		3,405
43			0	59	122	181	181	3	0	3,586	3,586			0	3,586	60	57	0	6		3,405
44			0	59	122	181	181	3	0	3,586	3,586			0	3,586	54	51	0	6		3,405
45			0	59	122	181	181	2	0	3,586	3,586			0	3,586	49	47	0	5		3,405
46			0	59	122	181	181	2	0	3,586	3,586			0	3,586	45	42	0	4		3,405
47			0	59	122	181	181	2	0	3,586	3,586			0	3,586	41	39	0	4		3,405
48			0	59	122	181	181	2	0	3,586	3,586			0	3,586	37	35	0	3		3,405
49			0	59	122	181	181	2	0	3,586	3,586			0	3,586	34	32	0	3		3,405
50			0	59	122	181	181	2	0	3,586	3,586			0	3,586	31	29	0	2		3,405
	5,906	12,207					25,043	10,131							146,284	16,206	6,075	7,340	7,340	-0.07	15.82%
		18,113																			

IRR	15.82%
B-C	6,075
B/C	1.60

Table H.4.5 (6) Cost Benefit Stream of Alternative Plan of Case 3 in Kelani River Basin

River:	Kelani	Short
Case:	3	

(Unit: Million Rs.)

Year	Cost								Benefit								B-C (NPV)	Cost Net Present Value	Benefit Net Present Value		EIRR Verification
	Costruction Cost			O&M			Grand Total	NPV	Flood Control			Power Generation			Grand Total	NPV					
	Short Term	Long Term	Total	Short Term	Long Term	Total			Short Term	Long Term	Total	Short Term	Long Term	Total							
1	1,046		1,046			0	1,046	951	0	0	0			0	0	0	-951	858	0		-1,046
2	1,162		1,162			0	1,162	960	0	0	0			0	0	0	-960	781	0		-1,162
3	1,598		1,598			0	1,598	1,201	0	0	0			0	0	0	-1,201	880	0		-1,598
4	1,230		1,230			0	1,230	840	0	0	0			0	0	0	-840	555	0		-1,230
5	869		869			0	869	540	0	0	0			0	0	0	-540	322	0		-869
6			0	59		59	59	33	2,078	0	2,078			0	2,078	1,173	1,139	18	630		2,019
7			0	59		59	59	30	2,078	0	2,078			0	2,078	1,066	1,036	15	516		2,019
8			0	59		59	59	28	2,078	0	2,078			0	2,078	969	942	12	423		2,019
9			0	59		59	59	25	2,078	0	2,078			0	2,078	881	856	10	347		2,019
10			0	59		59	59	23	2,078	0	2,078			0	2,078	801	778	8	284		2,019
11			0	59		59	59	21	2,078	0	2,078			0	2,078	728	708	7	233		2,019
12			0	59		59	59	19	2,078	0	2,078			0	2,078	662	643	5	191		2,019
13			0	59		59	59	17	2,078	0	2,078			0	2,078	602	585	4	157		2,019
14			0	59		59	59	16	2,078	0	2,078			0	2,078	547	532	4	128		2,019
15			0	59		59	59	14	2,078	0	2,078			0	2,078	497	483	3	105		2,019
16			0	59		59	59	13	2,078	0	2,078			0	2,078	452	439	2	86		2,019
17			0	59		59	59	12	2,078	0	2,078			0	2,078	411	399	2	71		2,019
18			0	59		59	59	11	2,078	0	2,078			0	2,078	374	363	2	58		2,019
19			0	59		59	59	10	2,078	0	2,078			0	2,078	340	330	1	48		2,019
20			0	59		59	59	9	2,078	0	2,078			0	2,078	309	300	1	39		2,019
21			0	59		59	59	8	2,078	0	2,078			0	2,078	281	273	1	32		2,019
22			0	59		59	59	7	2,078	0	2,078			0	2,078	255	248	1	26		2,019
23			0	59		59	59	7	2,078	0	2,078			0	2,078	232	225	1	21		2,019
24			0	59		59	59	6	2,078	0	2,078			0	2,078	211	205	0	18		2,019
25			0	59		59	59	5	2,078	0	2,078			0	2,078	192	186	0	14		2,019
26			0	59		59	59	5	2,078	0	2,078			0	2,078	174	169	0	12		2,019
27			0	59		59	59	5	2,078	0	2,078			0	2,078	158	154	0	10		2,019
28			0	59		59	59	4	2,078	0	2,078			0	2,078	144	140	0	8		2,019
29			0	59		59	59	4	2,078	0	2,078			0	2,078	131	127	0	7		2,019
30			0	59		59	59	3	2,078	0	2,078			0	2,078	119	116	0	5		2,019
31			0	59		59	59	3	2,078	0	2,078			0	2,078	108	105	0	4		2,019
32			0	59		59	59	3	2,078	0	2,078			0	2,078	98	96	0	4		2,019
33			0	59		59	59	3	2,078	0	2,078			0	2,078	89	87	0	3		2,019
34			0	59		59	59	2	2,078	0	2,078			0	2,078	81	79	0	2		2,019
35			0	59		59	59	2	2,078	0	2,078			0	2,078	74	72	0	2		2,019
36			0	59		59	59	2	2,078	0	2,078			0	2,078	67	65	0	2		2,019
37			0	59		59	59	2	2,078	0	2,078			0	2,078	61	59	0	1		2,019
38			0	59		59	59	2	2,078	0	2,078			0	2,078	56	54	0	1		2,019
39			0	59		59	59	1	2,078	0	2,078			0	2,078	50	49	0	1		2,019
40			0	59		59	59	1	2,078	0	2,078			0	2,078	46	45	0	1		2,019
41			0	59		59	59	1	2,078	0	2,078			0	2,078	42	41	0	1		2,019
42			0	59		59	59	1	2,078	0	2,078			0	2,078	38	37	0	0		2,019
43			0	59		59	59	1	2,078	0	2,078			0	2,078	34	34	0	0		2,019
44			0	59		59	59	1	2,078	0	2,078			0	2,078	31	30	0	0		2,019
45			0	59		59	59	1	2,078	0	2,078			0	2,078	29	28	0	0		2,019
46			0	59		59	59	1	2,078	0	2,078			0	2,078	26	25	0	0		2,019
47			0	59		59	59	1	2,078	0	2,078			0	2,078	24	23	0	0		2,019
48			0	59		59	59	1	2,078	0	2,078			0	2,078	21	21	0	0		2,019
49			0	59		59	59	1	2,078	0	2,078			0	2,078	19	19	0	0		2,019
50			0	59		59	59	1	2,078	0	2,078			0	2,078	18	17	0	0		2,019
	5,906	0					8,564	4,854							93,496	12,724	7,870	3,495	3,494	-0.97	22.00%
		5,906																			

IRR	22.00%
B-C	7,870
B/C	2.62

Table H.4.5 (7) Cost Benefit Stream of Alternative Plan of Case 1 in Kalu River Basin

River:	Kalu	Overall
Case:	1	

(Unit: Million Rs.)

Year	Cost								Benefit								B-C (NPV)
	Costruction Cost			O&M			Grand Total	NPV	Flood Control			Power Generation			Grand Total	NPV	
	Short Term	Long Term	Total	Short Term	Long Term	Total			Short Term	Long Term	Total	Short Term	Long Term	Total			
1	1,121		1,121			0	1,121	1,019	0	0	0			0	0	0	-1,019
2	1,133		1,133			0	1,133	936	0	0	0			0	0	0	-936
3	3,122		3,122			0	3,122	2,346	0	0	0			0	0	0	-2,346
4	2,436		2,436			0	2,436	1,664	0	0	0			0	0	0	-1,664
5	1,848		1,848			0	1,848	1,147	0	0	0			0	0	0	-1,848
6		349	349	97		97	446	252	1601	0	1,601			0	1,601	904	652
7		187	187	97		97	284	146	1601	0	1,601			0	1,601	822	676
8		938	938	97		97	1,035	483	1601	0	1,601			0	1,601	747	264
9		1,024	1,024	97		97	1,121	475	1601	0	1,601			0	1,601	679	204
10		1,118	1,118	97		97	1,215	468	1601	0	1,601			0	1,601	617	149
11		1,222	1,222	97		97	1,319	462	1601	0	1,601			0	1,601	561	99
12		1,337	1,337	97		97	1,434	457	1601	0	1,601			0	1,601	510	53
13		1,464	1,464	97		97	1,561	452	1601	0	1,601			0	1,601	464	12
14		1,166	1,166	97		97	1,263	332	1601	0	1,601			0	1,601	422	89
15		314	314	97		97	411	98	1601	0	1,601			0	1,601	383	285
16			0	97	91	188	188	41	0	1,962	1,962			0	1,962	427	386
17			0	97	91	188	188	37	0	1,962	1,962			0	1,962	388	351
18			0	97	91	188	188	34	0	1,962	1,962			0	1,962	353	319
19			0	97	91	188	188	31	0	1,962	1,962			0	1,962	321	290
20			0	97	91	188	188	28	0	1,962	1,962			0	1,962	292	264
21			0	97	91	188	188	25	0	1,962	1,962			0	1,962	265	240
22			0	97	91	188	188	23	0	1,962	1,962			0	1,962	241	218
23			0	97	91	188	188	21	0	1,962	1,962			0	1,962	219	198
24			0	97	91	188	188	19	0	1,962	1,962			0	1,962	199	180
25			0	97	91	188	188	17	0	1,962	1,962			0	1,962	181	164
26			0	97	91	188	188	16	0	1,962	1,962			0	1,962	165	149
27			0	97	91	188	188	14	0	1,962	1,962			0	1,962	150	135
28			0	97	91	188	188	13	0	1,962	1,962			0	1,962	136	123
29			0	97	91	188	188	12	0	1,962	1,962			0	1,962	124	112
30			0	97	91	188	188	11	0	1,962	1,962			0	1,962	112	102
31			0	97	91	188	188	10	0	1,962	1,962			0	1,962	102	92
32			0	97	91	188	188	9	0	1,962	1,962			0	1,962	93	84
33			0	97	91	188	188	8	0	1,962	1,962			0	1,962	84	76
34			0	97	91	188	188	7	0	1,962	1,962			0	1,962	77	69
35			0	97	91	188	188	7	0	1,962	1,962			0	1,962	70	63
36			0	97	91	188	188	6	0	1,962	1,962			0	1,962	63	57
37			0	97	91	188	188	6	0	1,962	1,962			0	1,962	58	52
38			0	97	91	188	188	5	0	1,962	1,962			0	1,962	52	47
39			0	97	91	188	188	5	0	1,962	1,962			0	1,962	48	43
40			0	97	91	188	188	4	0	1,962	1,962			0	1,962	43	39
41			0	97	91	188	188	4	0	1,962	1,962			0	1,962	39	36
42			0	97	91	188	188	3	0	1,962	1,962			0	1,962	36	32
43			0	97	91	188	188	3	0	1,962	1,962			0	1,962	33	29
44			0	97	91	188	188	3	0	1,962	1,962			0	1,962	30	27
45			0	97	91	188	188	3	0	1,962	1,962			0	1,962	27	24
46			0	97	91	188	188	2	0	1,962	1,962			0	1,962	24	22
47			0	97	91	188	188	2	0	1,962	1,962			0	1,962	22	20
48			0	97	91	188	188	2	0	1,962	1,962			0	1,962	20	18
49			0	97	91	188	188	2	0	1,962	1,962			0	1,962	18	17
50			0	97	91	188	188	2	0	1,962	1,962			0	1,962	17	15
	9,660	9,119					26,318	11,171							84,666	10,638	-533
		18,779															

Cost	Benefit		EIRR
Net Present Value	Net Present Value		Verification
1,024	0		-1,121
946	0		-1,133
2,381	0		-3,122
1,697	0		-2,436
1,176	0		-1,848
259	931		1,156
151	851		1,318
502	777		567
497	710		481
492	649		387
488	593		283
485	541		168
482	495		41
356	452		339
106	413		1,191
44	462		1,774
40	422		1,774
37	386		1,774
34	352		1,774
31	322		1,774
28	294		1,774
26	269		1,774
23	245		1,774
21	224		1,774
20	205		1,774
18	187		1,774
16	171		1,774
15	156		1,774
14	143		1,774
12	130		1,774
11	119		1,774
10	109		1,774
10	99		1,774
9	91		1,774
8	83		1,774
7	76		1,774
7	69		1,774
6	63		1,774
6	58		1,774
5	53		1,774
5	48		1,774
4	44		1,774
4	40		1,774
4	37		1,774
3	34		1,774
3	31		1,774
3	28		1,774
2	26		1,774
2	23		1,774
2	21		1,774
11,531	11,531	0	9.46%

EIRR	9.46%
B-C	-533
B/C	0.95

Table H.4.5 (8) Cost Benefit Stream of Alternative Plan of Case 1 in Kalu River Basin

River:	Kalu	Short
Case:	1	

(Unit: Million Rs.)

Year	Cost								Benefit								B-C (NPV)	Cost Net Present Value	Benefit Net Present Value		EIRR Verification
	Costruction Cost			O&M			Grand Total	NPV	Flood Control			Power Generation			Grand Total	NPV					
	Short Term	Long Term	Total	Short Term	Long Term	Total			Short Term	Long Term	Total	Short Term	Long Term	Total							
1	1,121		1,121			0	1,121	1,019	0	0	0			0	0	0	-1,019	996	0		-1,121
2	1,133		1,133			0	1,133	936	0	0	0			0	0	0	-936	895	0		-1,133
3	3,122		3,122			0	3,122	2,346	0	0	0			0	0	0	-2,346	2,191	0		-3,122
4	2,436		2,436			0	2,436	1,664	0	0	0			0	0	0	-1,664	1,519	0		-2,436
5	1,848		1,848			0	1,848	1,147	0	0	0			0	0	0	-1,147	1,024	0		-1,848
6			0	97		97	97	55	1,601	0	1,601			0	1,601	904	849	48	789		1,505
7			0	97		97	97	50	1,601	0	1,601			0	1,601	822	772	42	701		1,505
8			0	97		97	97	45	1,601	0	1,601			0	1,601	747	702	38	623		1,505
9			0	97		97	97	41	1,601	0	1,601			0	1,601	679	638	33	554		1,505
10			0	97		97	97	37	1,601	0	1,601			0	1,601	617	580	30	492		1,505
11			0	97		97	97	34	1,601	0	1,601			0	1,601	561	527	26	437		1,505
12			0	97		97	97	31	1,601	0	1,601			0	1,601	510	479	23	389		1,505
13			0	97		97	97	28	1,601	0	1,601			0	1,601	464	436	21	345		1,505
14			0	97		97	97	25	1,601	0	1,601			0	1,601	422	396	19	307		1,505
15			0	97		97	97	23	1,601	0	1,601			0	1,601	383	360	16	273		1,505
16			0	97		97	97	21	1,601	0	1,601			0	1,601	348	327	15	242		1,505
17			0	97		97	97	19	1,601	0	1,601			0	1,601	317	298	13	215		1,505
18			0	97		97	97	17	1,601	0	1,601			0	1,601	288	271	12	191		1,505
19			0	97		97	97	16	1,601	0	1,601			0	1,601	262	246	10	170		1,505
20			0	97		97	97	14	1,601	0	1,601			0	1,601	238	224	9	151		1,505
21			0	97		97	97	13	1,601	0	1,601			0	1,601	216	203	8	134		1,505
22			0	97		97	97	12	1,601	0	1,601			0	1,601	197	185	7	119		1,505
23			0	97		97	97	11	1,601	0	1,601			0	1,601	179	168	6	106		1,505
24			0	97		97	97	10	1,601	0	1,601			0	1,601	163	153	6	94		1,505
25			0	97		97	97	9	1,601	0	1,601			0	1,601	148	139	5	84		1,505
26			0	97		97	97	8	1,601	0	1,601			0	1,601	134	126	4	74		1,505
27			0	97		97	97	7	1,601	0	1,601			0	1,601	122	115	4	66		1,505
28			0	97		97	97	7	1,601	0	1,601			0	1,601	111	104	4	59		1,505
29			0	97		97	97	6	1,601	0	1,601			0	1,601	101	95	3	52		1,505
30			0	97		97	97	6	1,601	0	1,601			0	1,601	92	86	3	46		1,505
31			0	97		97	97	5	1,601	0	1,601			0	1,601	83	78	2	41		1,505
32			0	97		97	97	5	1,601	0	1,601			0	1,601	76	71	2	37		1,505
33			0	97		97	97	4	1,601	0	1,601			0	1,601	69	65	2	33		1,505
34			0	97		97	97	4	1,601	0	1,601			0	1,601	63	59	2	29		1,505
35			0	97		97	97	3	1,601	0	1,601			0	1,601	57	54	2	26		1,505
36			0	97		97	97	3	1,601	0	1,601			0	1,601	52	49	1	23		1,505
37			0	97		97	97	3	1,601	0	1,601			0	1,601	47	44	1	20		1,505
38			0	97		97	97	3	1,601	0	1,601			0	1,601	43	40	1	18		1,505
39			0	97		97	97	2	1,601	0	1,601			0	1,601	39	37	1	16		1,505
40			0	97		97	97	2	1,601	0	1,601			0	1,601	35	33	1	14		1,505
41			0	97		97	97	2	1,601	0	1,601			0	1,601	32	30	1	13		1,505
42			0	97		97	97	2	1,601	0	1,601			0	1,601	29	27	1	11		1,505
43			0	97		97	97	2	1,601	0	1,601			0	1,601	27	25	1	10		1,505
44			0	97		97	97	1	1,601	0	1,601			0	1,601	24	23	1	9		1,505
45			0	97		97	97	1	1,601	0	1,601			0	1,601	22	21	0	8		1,505
46			0	97		97	97	1	1,601	0	1,601			0	1,601	20	19	0	7		1,505
47			0	97		97	97	1	1,601	0	1,601			0	1,601	18	17	0	6		1,505
48			0	97		97	97	1	1,601	0	1,601			0	1,601	17	16	0	6		1,505
49			0	97		97	97	1	1,601	0	1,601			0	1,601	15	14	0	5		1,505
50			0	97		97	97	1	1,601	0	1,601			0	1,601	14	13	0	4		1,505
	9,660	0					14,007	7,704							72,059	9,806	2,102	7,051	7,051	0.01	12.53%
		9,660																			

EIRR	12.53%
B-C	2,102
B/C	1.27

Table H.4.5 (9) Cost Benefit Stream of Alternative Plan of Case 2 in Kalu River Basin

River:	Kalu	Overall
Case:	2	

(Unit: Million Rs.)

Year	Cost								Benefit								B-C (NPV)
	Costruction Cost			O&M			Grand Total	NPV	Flood Control			Power Generation			Grand Total	NPV	
	Short Term	Long Term	Total	Short Term	Long Term	Total			Short Term	Long Term	Total	Short Term	Long Term	Total			
1	1,291		1,291			0	1,291	1,174	0	0	0			0	0	0	-1,174
2	1,723		1,723			0	1,723	1,424	0	0	0			0	0	0	-1,424
3	3,255		3,255			0	3,255	2,446	0	0	0			0	0	0	-2,446
4	2,641		2,641			0	2,641	1,804	0	0	0			0	0	0	-1,804
5	2,127		2,127			0	2,127	1,321	0	0	0			0	0	0	-1,321
6		1,287	1,287	110		110	1,397	789	1,399	0	1,399			0	1,399	790	1
7		736	736	110		110	846	434	1,399	0	1,399			0	1,399	718	284
8		2,451	2,451	110		110	2,561	1,195	1,399	0	1,399			0	1,399	653	-542
9		2,604	2,604	110		110	2,714	1,151	1,399	0	1,399			0	1,399	593	-558
10		2,765	2,765	110		110	2,875	1,109	1,399	0	1,399			0	1,399	539	-569
11		3,021	3,021	110		110	3,131	1,098	1,399	0	1,399			0	1,399	490	-607
12		3,303	3,303	110		110	3,413	1,088	1,399	0	1,399			0	1,399	446	-642
13		3,613	3,613	110		110	3,723	1,079	1,399	0	1,399			0	1,399	405	-673
14		2,934	2,934	110		110	3,044	802	1,399	0	1,399			0	1,399	368	-433
15		963	963	110		110	1,073	257	1,399	0	1,399			0	1,399	335	78
16			0	110	237	347	347	76	0	1,962	1,962			0	1,962	427	351
17			0	110	237	347	347	69	0	1,962	1,962			0	1,962	388	319
18			0	110	237	347	347	62	0	1,962	1,962			0	1,962	353	290
19			0	110	237	347	347	57	0	1,962	1,962			0	1,962	321	264
20			0	110	237	347	347	52	0	1,962	1,962			0	1,962	292	240
21			0	110	237	347	347	47	0	1,962	1,962			0	1,962	265	218
22			0	110	237	347	347	43	0	1,962	1,962			0	1,962	241	198
23			0	110	237	347	347	39	0	1,962	1,962			0	1,962	219	180
24			0	110	237	347	347	35	0	1,962	1,962			0	1,962	199	164
25			0	110	237	347	347	32	0	1,962	1,962			0	1,962	181	149
26			0	110	237	347	347	29	0	1,962	1,962			0	1,962	165	135
27			0	110	237	347	347	26	0	1,962	1,962			0	1,962	150	123
28			0	110	237	347	347	24	0	1,962	1,962			0	1,962	136	112
29			0	110	237	347	347	22	0	1,962	1,962			0	1,962	124	102
30			0	110	237	347	347	20	0	1,962	1,962			0	1,962	112	93
31			0	110	237	347	347	18	0	1,962	1,962			0	1,962	102	84
32			0	110	237	347	347	16	0	1,962	1,962			0	1,962	93	76
33			0	110	237	347	347	15	0	1,962	1,962			0	1,962	84	70
34			0	110	237	347	347	14	0	1,962	1,962			0	1,962	77	63
35			0	110	237	347	347	12	0	1,962	1,962			0	1,962	70	57
36			0	110	237	347	347	11	0	1,962	1,962			0	1,962	63	52
37			0	110	237	347	347	10	0	1,962	1,962			0	1,962	58	47
38			0	110	237	347	347	9	0	1,962	1,962			0	1,962	52	43
39			0	110	237	347	347	8	0	1,962	1,962			0	1,962	48	39
40			0	110	237	347	347	8	0	1,962	1,962			0	1,962	43	36
41			0	110	237	347	347	7	0	1,962	1,962			0	1,962	39	32
42			0	110	237	347	347	6	0	1,962	1,962			0	1,962	36	29
43			0	110	237	347	347	6	0	1,962	1,962			0	1,962	33	27
44			0	110	237	347	347	5	0	1,962	1,962			0	1,962	30	24
45			0	110	237	347	347	5	0	1,962	1,962			0	1,962	27	22
46			0	110	237	347	347	4	0	1,962	1,962			0	1,962	24	20
47			0	110	237	347	347	4	0	1,962	1,962			0	1,962	22	18
48			0	110	237	347	347	4	0	1,962	1,962			0	1,962	20	17
49			0	110	237	347	347	3	0	1,962	1,962			0	1,962	18	15
50			0	110	237	347	347	3	0	1,962	1,962			0	1,962	17	14
	11,037	23,676					47,967	17,969							82,646	9,867	-8,102
		34,714															

Cost	Benefit		EIRR
Net Present Value	Net Present Value		Verification
1,241	0		-1,291
1,592	0		-1,723
2,891	0		-3,255
2,255	0		-2,641
1,746	0		-2,127
1,102	1,104		2
642	1,061		553
1,868	1,020		-1,162
1,902	981		-1,315
1,937	943		-1,476
2,028	906		-1,732
2,125	871		-2,014
2,228	837		-2,324
1,751	805		-1,645
594	774		326
185	1,043		1,614
177	1,002		1,614
171	964		1,614
164	926		1,614
158	890		1,614
151	856		1,614
146	823		1,614
140	791		1,614
135	760		1,614
129	731		1,614
124	703		1,614
120	675		1,614
115	649		1,614
110	624		1,614
106	600		1,614
102	577		1,614
98	554		1,614
94	533		1,614
91	512		1,614
87	492		1,614
84	473		1,614
81	455		1,614
77	437		1,614
74	420		1,614
72	404		1,614
69	389		1,614
66	374		1,614
64	359		1,614
61	345		1,614
59	332		1,614
56	319		1,614
54	307		1,614
52	295		1,614
50	283		1,614
48	272		1,614
29,474	29,474	0.08	4.03%

EIRR	4.03%
B-C	-8,102
B/C	0.55

Table H.4.5 (10) Cost Benefit Stream of Alternative Plan of Case 2 in Kalu River Basin

River:	Kalu	Short
Case:	2	

(Unit: Million Rs.)

Year	Cost								Benefit								B-C (NPV)	Cost Net Present Value	Benefit Net Present Value		EIRR Verification
	Costruction Cost			O&M			Grand Total	NPV	Flood Control			Power Generation			Grand Total	NPV					
	Short Term	Long Term	Total	Short Term	Long Term	Total			Short Term	Long Term	Total	Short Term	Long Term	Total							
1	1,291		1,291			0	1,291	1,174	0	0	0			0	0	0	-1,174	1,177	0		-1,291
2	1,723		1,723			0	1,723	1,424	0	0	0			0	0	0	-1,424	1,432	0		-1,723
3	3,255		3,255			0	3,255	2,446	0	0	0			0	0	0	-2,446	2,466	0		-3,255
4	2,641		2,641			0	2,641	1,804	0	0	0			0	0	0	-1,804	1,824	0		-2,641
5	2,127		2,127			0	2,127	1,321	0	0	0			0	0	0	-1,321	1,339	0		-2,127
6			0	110		110	110	62	1,399	0	1,399			0	1,399	790	728	63	803		1,289
7			0	110		110	110	57	1,399	0	1,399			0	1,399	718	661	58	732		1,289
8			0	110		110	110	51	1,399	0	1,399			0	1,399	653	601	53	667		1,289
9			0	110		110	110	47	1,399	0	1,399			0	1,399	593	547	48	608		1,289
10			0	110		110	110	43	1,399	0	1,399			0	1,399	539	497	44	555		1,289
11			0	110		110	110	39	1,399	0	1,399			0	1,399	490	452	40	506		1,289
12			0	110		110	110	35	1,399	0	1,399			0	1,399	446	411	36	461		1,289
13			0	110		110	110	32	1,399	0	1,399			0	1,399	405	373	33	420		1,289
14			0	110		110	110	29	1,399	0	1,399			0	1,399	368	339	30	383		1,289
15			0	110		110	110	26	1,399	0	1,399			0	1,399	335	309	28	349		1,289
16			0	110		110	110	24	1,399	0	1,399			0	1,399	305	281	25	318		1,289
17			0	110		110	110	22	1,399	0	1,399			0	1,399	277	255	23	290		1,289
18			0	110		110	110	20	1,399	0	1,399			0	1,399	252	232	21	264		1,289
19			0	110		110	110	18	1,399	0	1,399			0	1,399	229	211	19	241		1,289
20			0	110		110	110	16	1,399	0	1,399			0	1,399	208	192	17	220		1,289
21			0	110		110	110	15	1,399	0	1,399			0	1,399	189	174	16	200		1,289
22			0	110		110	110	14	1,399	0	1,399			0	1,399	172	158	14	183		1,289
23			0	110		110	110	12	1,399	0	1,399			0	1,399	156	144	13	166		1,289
24			0	110		110	110	11	1,399	0	1,399			0	1,399	142	131	12	152		1,289
25			0	110		110	110	10	1,399	0	1,399			0	1,399	129	119	11	138		1,289
26			0	110		110	110	9	1,399	0	1,399			0	1,399	117	108	10	126		1,289
27			0	110		110	110	8	1,399	0	1,399			0	1,399	107	98	9	115		1,289
28			0	110		110	110	8	1,399	0	1,399			0	1,399	97	89	8	105		1,289
29			0	110		110	110	7	1,399	0	1,399			0	1,399	88	81	8	96		1,289
30			0	110		110	110	6	1,399	0	1,399			0	1,399	80	74	7	87		1,289
31			0	110		110	110	6	1,399	0	1,399			0	1,399	73	67	6	79		1,289
32			0	110		110	110	5	1,399	0	1,399			0	1,399	66	61	6	72		1,289
33			0	110		110	110	5	1,399	0	1,399			0	1,399	60	55	5	66		1,289
34			0	110		110	110	4	1,399	0	1,399			0	1,399	55	50	5	60		1,289
35			0	110		110	110	4	1,399	0	1,399			0	1,399	50	46	4	55		1,289
36			0	110		110	110	4	1,399	0	1,399			0	1,399	45	42	4	50		1,289
37			0	110		110	110	3	1,399	0	1,399			0	1,399	41	38	4	46		1,289
38			0	110		110	110	3	1,399	0	1,399			0	1,399	37	34	3	42		1,289
39			0	110		110	110	3	1,399	0	1,399			0	1,399	34	31	3	38		1,289
40			0	110		110	110	2	1,399	0	1,399			0	1,399	31	28	3	35		1,289
41			0	110		110	110	2	1,399	0	1,399			0	1,399	28	26	2	31		1,289
42			0	110		110	110	2	1,399	0	1,399			0	1,399	26	24	2	29		1,289
43			0	110		110	110	2	1,399	0	1,399			0	1,399	23	21	2	26		1,289
44			0	110		110	110	2	1,399	0	1,399			0	1,399	21	19	2	24		1,289
45			0	110		110	110	2	1,399	0	1,399			0	1,399	19	18	2	22		1,289
46			0	110		110	110	1	1,399	0	1,399			0	1,399	17	16	2	20		1,289
47			0	110		110	110	1	1,399	0	1,399			0	1,399	16	15	1	18		1,289
48			0	110		110	110	1	1,399	0	1,399			0	1,399	14	13	1	16		1,289
49			0	110		110	110	1	1,399	0	1,399			0	1,399	13	12	1	15		1,289
50			0	110		110	110	1	1,399	0	1,399			0	1,399	12	11	1	14		1,289
	11,037	0					16,004	8,844							62,969	8,569	-274	8,943	8,943	-0.01	9.70%
		11,037																			

EIRR	9.70%
B-C	-274
B/C	0.97

Table H.4.5 (11) Cost Benefit Stream of Alternative Plan of Case 3 in Kalu River Basin

River:	Kalu	Overall
Case:	3	

(Unit: Million Rs.)

Year	Cost								Benefit								B-C (NPV)	Cost Net Present Value	Benefit Net Present Value		EIRR Verification
	Costruction Cost			O&M			Grand Total	NPV	Flood Control			Power Generation			Grand Total	NPV					
	Short Term	Long Term	Total	Short Term	Long Term	Total			Short Term	Long Term	Total	Short Term	Long Term	Total							
1	1,168		1,168			0	1,168	1,062	0	0	0			0	0	0	-1,062	1,139	0		-1,168
2	1,427		1,427			0	1,427	1,179	0	0	0			0	0	0	-1,179	1,357	0		-1,427
3	3,121		3,121			0	3,121	2,345	0	0	0			0	0	0	-2,345	2,893	0		-3,121
4	2,501		2,501			0	2,501	1,708	0	0	0			0	0	0	-1,708	2,260	0		-2,501
5	1,980		1,980			0	1,980	1,229	0	0	0			0	0	0	-1,229	1,745	0		-1,980
6		2,332	2,332	102		102	2,434	1,374	1,399	0	1,399			0	1,399	790	-584	2,091	1,202		-1,035
7		1,699	1,699	102		102	1,801	924	1,399	0	1,399			0	1,399	718	-206	1,509	1,172		-402
8		4,735	4,735	102		102	4,837	2,256	1,399	0	1,399			0	1,399	653	-1,604	3,951	1,143		-3,438
9		4,671	4,671	102		102	4,773	2,024	1,399	0	1,399			0	1,399	593	-1,431	3,802	1,115		-3,374
10		4,549	4,549	102		102	4,651	1,793	1,399	0	1,399			0	1,399	539	-1,254	3,612	1,087		-3,252
11		4,988	4,988	102		102	5,090	1,784	1,399	0	1,399			0	1,399	490	-1,294	3,854	1,060		-3,691
12		5,471	5,471	102		102	5,573	1,776	1,399	0	1,399			0	1,399	446	-1,330	4,115	1,033		-4,174
13		6,003	6,003	102		102	6,105	1,768	1,399	0	1,399			0	1,399	405	-1,363	4,395	1,007		-4,706
14		6,588	6,588	102		102	6,690	1,762	1,399	0	1,399			0	1,399	368	-1,393	4,696	982		-5,291
15		7,231	7,231	102		102	7,333	1,755	1,399	0	1,399			0	1,399	335	-1,420	5,019	958		-5,934
16			0	102	483	585	585	127	0	2,858	2,858			0	2,858	622	495	390	1,907		2,273
17			0	102	483	585	585	116	0	2,858	2,858			0	2,858	565	450	380	1,859		2,273
18			0	102	483	585	585	105	0	2,858	2,858			0	2,858	514	409	371	1,813		2,273
19			0	102	483	585	585	96	0	2,858	2,858			0	2,858	467	372	362	1,768		2,273
20			0	102	483	585	585	87	0	2,858	2,858			0	2,858	425	338	353	1,724		2,273
21			0	102	483	585	585	79	0	2,858	2,858			0	2,858	386	307	344	1,680		2,273
22			0	102	483	585	585	72	0	2,858	2,858			0	2,858	351	279	335	1,639		2,273
23			0	102	483	585	585	65	0	2,858	2,858			0	2,858	319	254	327	1,598		2,273
24			0	102	483	585	585	59	0	2,858	2,858			0	2,858	290	231	319	1,558		2,273
25			0	102	483	585	585	54	0	2,858	2,858			0	2,858	264	210	311	1,519		2,273
26			0	102	483	585	585	49	0	2,858	2,858			0	2,858	240	191	303	1,481		2,273
27			0	102	483	585	585	45	0	2,858	2,858			0	2,858	218	173	295	1,444		2,273
28			0	102	483	585	585	41	0	2,858	2,858			0	2,858	198	158	288	1,408		2,273
29			0	102	483	585	585	37	0	2,858	2,858			0	2,858	180	143	281	1,373		2,273
30			0	102	483	585	585	34	0	2,858	2,858			0	2,858	164	130	274	1,338		2,273
31			0	102	483	585	585	30	0	2,858	2,858			0	2,858	149	118	267	1,305		2,273
32			0	102	483	585	585	28	0	2,858	2,858			0	2,858	135	108	260	1,272		2,273
33			0	102	483	585	585	25	0	2,858	2,858			0	2,858	123	98	254	1,241		2,273
34			0	102	483	585	585	23	0	2,858	2,858			0	2,858	112	89	247	1,210		2,273
35			0	102	483	585	585	21	0	2,858	2,858			0	2,858	102	81	241	1,180		2,273
36			0	102	483	585	585	19	0	2,858	2,858			0	2,858	92	74	235	1,150		2,273
37			0	102	483	585	585	17	0	2,858	2,858			0	2,858	84	67	229	1,121		2,273
38			0	102	483	585	585	16	0	2,858	2,858			0	2,858	76	61	224	1,093		2,273
39			0	102	483	585	585	14	0	2,858	2,858			0	2,858	69	55	218	1,066		2,273
40			0	102	483	585	585	13	0	2,858	2,858			0	2,858	63	50	213	1,039		2,273
41			0	102	483	585	585	12	0	2,858	2,858			0	2,858	57	46	207	1,014		2,273
42			0	102	483	585	585	11	0	2,858	2,858			0	2,858	52	42	202	988		2,273
43			0	102	483	585	585	10	0	2,858	2,858			0	2,858	47	38	197	964		2,273
44			0	102	483	585	585	9	0	2,858	2,858			0	2,858	43	34	192	939		2,273
45			0	102	483	585	585	8	0	2,858	2,858			0	2,858	39	31	187	916		2,273
46			0	102	483	585	585	7	0	2,858	2,858			0	2,858	36	28	183	893		2,273
47			0	102	483	585	585	7	0	2,858	2,858			0	2,858	32	26	178	871		2,273
48			0	102	483	585	585	6	0	2,858	2,858			0	2,858	29	23	174	849		2,273
49			0	102	483	585	585	5	0	2,858	2,858			0	2,858	27	21	169	828		2,273
50			0	102	483	585	585	5	0	2,858	2,858			0	2,858	24	19	165	807		2,273
	10,197	48,267					79,946	26,091							114,013	11,936	-14,154	55,613	55,613	0.00	2.56%
		58,464																			

EIRR	2.56%
B-C	-14,154
B/C	0.46

Table H.4.5 (12) Cost Benefit Stream of Alternative Plan of Case 3 in Kalu River Basin

River:	Kalu	Short
Case:	3	

(Unit: Million Rs.)

Year	Cost								Benefit								B-C (NPV)	Cost Net Present Value	Benefit Net Present Value		EIRR Verification
	Costruction Cost			O&M			Grand Total	NPV	Flood Control			Power Generation			Grand Total	NPV					
	Short Term	Long Term	Total	Short Term	Long Term	Total			Short Term	Long Term	Total	Short Term	Long Term	Total							
1	1,168		1,168			0	1,168	1,062	0	0	0			0	0	0	-1,062	1,057	0		-1,168
2	1,427		1,427			0	1,427	1,179	0	0	0			0	0	0	-1,179	1,169	0		-1,427
3	3,121		3,121			0	3,121	2,345	0	0	0			0	0	0	-2,345	2,313	0		-3,121
4	2,501		2,501			0	2,501	1,708	0	0	0			0	0	0	-1,708	1,678	0		-2,501
5	1,980		1,980			0	1,980	1,229	0	0	0			0	0	0	-1,229	1,202	0		-1,980
6			0	102		102	102	58	1,399	0	1,399			0	1,399	790	732	56	769		1,297
7			0	102		102	102	52	1,399	0	1,399			0	1,399	718	666	51	696		1,297
8			0	102		102	102	48	1,399	0	1,399			0	1,399	653	605	46	630		1,297
9			0	102		102	102	43	1,399	0	1,399			0	1,399	593	550	42	570		1,297
10			0	102		102	102	39	1,399	0	1,399			0	1,399	539	500	38	516		1,297
11			0	102		102	102	36	1,399	0	1,399			0	1,399	490	455	34	467		1,297
12			0	102		102	102	32	1,399	0	1,399			0	1,399	446	413	31	422		1,297
13			0	102		102	102	30	1,399	0	1,399			0	1,399	405	376	28	382		1,297
14			0	102		102	102	27	1,399	0	1,399			0	1,399	368	342	25	346		1,297
15			0	102		102	102	24	1,399	0	1,399			0	1,399	335	311	23	313		1,297
16			0	102		102	102	22	1,399	0	1,399			0	1,399	305	282	21	283		1,297
17			0	102		102	102	20	1,399	0	1,399			0	1,399	277	257	19	256		1,297
18			0	102		102	102	18	1,399	0	1,399			0	1,399	252	233	17	232		1,297
19			0	102		102	102	17	1,399	0	1,399			0	1,399	229	212	15	210		1,297
20			0	102		102	102	15	1,399	0	1,399			0	1,399	208	193	14	190		1,297
21			0	102		102	102	14	1,399	0	1,399			0	1,399	189	175	13	172		1,297
22			0	102		102	102	13	1,399	0	1,399			0	1,399	172	159	11	156		1,297
23			0	102		102	102	11	1,399	0	1,399			0	1,399	156	145	10	141		1,297
24			0	102		102	102	10	1,399	0	1,399			0	1,399	142	132	9	127		1,297
25			0	102		102	102	9	1,399	0	1,399			0	1,399	129	120	8	115		1,297
26			0	102		102	102	9	1,399	0	1,399			0	1,399	117	109	8	104		1,297
27			0	102		102	102	8	1,399	0	1,399			0	1,399	107	99	7	95		1,297
28			0	102		102	102	7	1,399	0	1,399			0	1,399	97	90	6	86		1,297
29			0	102		102	102	6	1,399	0	1,399			0	1,399	88	82	6	77		1,297
30			0	102		102	102	6	1,399	0	1,399			0	1,399	80	74	5	70		1,297
31			0	102		102	102	5	1,399	0	1,399			0	1,399	73	68	5	63		1,297
32			0	102		102	102	5	1,399	0	1,399			0	1,399	66	61	4	57		1,297
33			0	102		102	102	4	1,399	0	1,399			0	1,399	60	56	4	52		1,297
34			0	102		102	102	4	1,399	0	1,399			0	1,399	55	51	3	47		1,297
35			0	102		102	102	4	1,399	0	1,399			0	1,399	50	46	3	43		1,297
36			0	102		102	102	3	1,399	0	1,399			0	1,399	45	42	3	38		1,297
37			0	102		102	102	3	1,399	0	1,399			0	1,399	41	38	3	35		1,297
38			0	102		102	102	3	1,399	0	1,399			0	1,399	37	35	2	32		1,297
39			0	102		102	102	2	1,399	0	1,399			0	1,399	34	32	2	29		1,297
40			0	102		102	102	2	1,399	0	1,399			0	1,399	31	29	2	26		1,297
41			0	102		102	102	2	1,399	0	1,399			0	1,399	28	26	2	23		1,297
42			0	102		102	102	2	1,399	0	1,399			0	1,399	26	24	2	21		1,297
43			0	102		102	102	2	1,399	0	1,399			0	1,399	23	22	1	19		1,297
44			0	102		102	102	2	1,399	0	1,399			0	1,399	21	20	1	17		1,297
45			0	102		102	102	1	1,399	0	1,399			0	1,399	19	18	1	16		1,297
46			0	102		102	102	1	1,399	0	1,399			0	1,399	17	16	1	14		1,297
47			0	102		102	102	1	1,399	0	1,399			0	1,399	16	15	1	13		1,297
48			0	102		102	102	1	1,399	0	1,399			0	1,399	14	13	1	12		1,297
49			0	102		102	102	1	1,399	0	1,399			0	1,399	13	12	1	11		1,297
50			0	102		102	102	1	1399	0	1399			0	1,399	12	11	1	10		1,297
	10,197	0					14,786	8,148							62,969	8,569	421	8,002	8,002	0.00	10.50%
		10,197																			

EIRR	10.50%
B-C	421
B/C	1.05

Table H.4.5 (13) Cost Benefit Stream of Alternative Plan of Case 4 in Kalu River Basin

River:	Kalu	Overall
Case:	4	

(Unit: Million Rs.)

Year	Cost								Benefit								B-C (NPV)	Cost Net Present Value	Benefit Net Present Value		EIRR Verification
	Costruction Cost			O&M			Grand Total	NPV	Flood Control			Power Generation			Grand Total	NPV					
	Short Term	Long Term	Total	Short Term	Long Term	Total			Short Term	Long Term	Total	Short Term	Long Term	Total							
1	326		326			0	326	296	0	0	0			0	0	0	-296	314	0		-326
2	605		605			0	605	500	0	0	0			0	0	0	-500	561	0		-605
3	829		829			0	829	623	0	0	0			0	0	0	-623	740	0		-829
4	722		722			0	722	493	0	0	0			0	0	0	-493	620	0		-722
5	645		645			0	645	400	0	0	0			0	0	0	-400	533	0		-645
6		2,119	2,119	31		31	2,150	1,214	1,017	0	1,017			0	1,017	574	-640	1,712	809		-1,133
7		1,583	1,583	31		31	1,614	828	1,017	0	1,017			0	1,017	522	-307	1,237	779		-597
8		4,328	4,328	31		31	4,359	2,034	1,017	0	1,017			0	1,017	474	-1,559	3,216	750		-3,342
9		4,228	4,228	31		31	4,259	1,806	1,017	0	1,017			0	1,017	431	-1,375	3,025	722		-3,242
10		4,066	4,066	31		31	4,097	1,580	1,017	0	1,017			0	1,017	392	-1,188	2,801	695		-3,080
11		4,462	4,462	31		31	4,493	1,575	1,017	0	1,017			0	1,017	356	-1,218	2,957	669		-3,476
12		4,898	4,898	31		31	4,929	1,571	1,017	0	1,017			0	1,017	324	-1,247	3,123	644		-3,912
13		5,377	5,377	31		31	5,408	1,567	1,017	0	1,017			0	1,017	295	-1,272	3,299	620		-4,391
14		5,904	5,904	31		31	5,935	1,563	1,017	0	1,017			0	1,017	268	-1,295	3,485	597		-4,918
15		6,483	6,483	31		31	6,514	1,559	1,017	0	1,017			0	1,017	243	-1,316	3,682	575		-5,497
16			0	31	434	466	466	101	0	2,744	2,744			0	2,744	597	496	253	1,493		2,278
17			0	31	434	466	466	92	0	2,744	2,744			0	2,744	543	451	244	1,437		2,278
18			0	31	434	466	466	84	0	2,744	2,744			0	2,744	493	410	235	1,384		2,278
19			0	31	434	466	466	76	0	2,744	2,744			0	2,744	449	372	226	1,332		2,278
20			0	31	434	466	466	69	0	2,744	2,744			0	2,744	408	339	218	1,282		2,278
21			0	31	434	466	466	63	0	2,744	2,744			0	2,744	371	308	210	1,235		2,278
22			0	31	434	466	466	57	0	2,744	2,744			0	2,744	337	280	202	1,188		2,278
23			0	31	434	466	466	52	0	2,744	2,744			0	2,744	306	254	194	1,144		2,278
24			0	31	434	466	466	47	0	2,744	2,744			0	2,744	279	231	187	1,101		2,278
25			0	31	434	466	466	43	0	2,744	2,744			0	2,744	253	210	180	1,060		2,278
26			0	31	434	466	466	39	0	2,744	2,744			0	2,744	230	191	173	1,021		2,278
27			0	31	434	466	466	36	0	2,744	2,744			0	2,744	209	174	167	983		2,278
28			0	31	434	466	466	32	0	2,744	2,744			0	2,744	190	158	161	946		2,278
29			0	31	434	466	466	29	0	2,744	2,744			0	2,744	173	144	155	911		2,278
30			0	31	434	466	466	27	0	2,744	2,744			0	2,744	157	131	149	877		2,278
31			0	31	434	466	466	24	0	2,744	2,744			0	2,744	143	119	143	844		2,278
32			0	31	434	466	466	22	0	2,744	2,744			0	2,744	130	108	138	813		2,278
33			0	31	434	466	466	20	0	2,744	2,744			0	2,744	118	98	133	782		2,278
34			0	31	434	466	466	18	0	2,744	2,744			0	2,744	107	89	128	753		2,278
35			0	31	434	466	466	17	0	2,744	2,744			0	2,744	98	81	123	725		2,278
36			0	31	434	466	466	15	0	2,744	2,744			0	2,744	89	74	118	698		2,278
37			0	31	434	466	466	14	0	2,744	2,744			0	2,744	81	67	114	672		2,278
38			0	31	434	466	466	12	0	2,744	2,744			0	2,744	73	61	110	647		2,278
39			0	31	434	466	466	11	0	2,744	2,744			0	2,744	67	55	106	623		2,278
40			0	31	434	466	466	10	0	2,744	2,744			0	2,744	61	50	102	599		2,278
41			0	31	434	466	466	9	0	2,744	2,744			0	2,744	55	46	98	577		2,278
42			0	31	434	466	466	9	0	2,744	2,744			0	2,744	50	42	94	556		2,278
43			0	31	434	466	466	8	0	2,744	2,744			0	2,744	46	38	91	535		2,278
44			0	31	434	466	466	7	0	2,744	2,744			0	2,744	41	34	87	515		2,278
45			0	31	434	466	466	6	0	2,744	2,744			0	2,744	38	31	84	496		2,278
46			0	31	434	466	466	6	0	2,744	2,744			0	2,744	34	28	81	477		2,278
47			0	31	434	466	466	5	0	2,744	2,744			0	2,744	31	26	78	459		2,278
48			0	31	434	466	466	5	0	2,744	2,744			0	2,744	28	23	75	442		2,278
49			0	31	434	466	466	4	0	2,744	2,744			0	2,744	26	21	72	426		2,278
50			0	31	434	466	466	4	0	2,744	2,744			0	2,744	23	19	70	410		2,278
	3,127	43,448					63,189	18,684							106,194	10,214	-8,471	36,303	36,303	0.02	3.88%
		46,575																			

EIRR	3.88%
B-C	-8,471
B/C	0.55

Table H.4.5 (14) Cost Benefit Stream of Alternative Plan of Case 4 in Kalu River Basin

River:	Kalu	Short
Case:	4	

(Unit: Million Rs.)

Year	Cost								Benefit								B-C (NPV)	Cost Net Present Value	Benefit Net Present Value		EIRR Verification
	Costruction Cost			O&M			Grand Total	NPV	Flood Control			Power Generation			Grand Total	NPV					
	Short Term	Long Term	Total	Short Term	Long Term	Total			Short Term	Long Term	Total	Short Term	Long Term	Total							
1	326		326			0	326	296	0	0	0			0	0	0	-296	268	0		-326
2	605		605			0	605	500	0	0	0			0	0	0	-500	409	0		-605
3	829		829			0	829	623	0	0	0			0	0	0	-623	461	0		-829
4	722		722			0	722	493	0	0	0			0	0	0	-493	330	0		-722
5	645		645			0	645	400	0	0	0			0	0	0	-400	242	0		-645
6			0	31		31	31	18	1,017	0	1,017			0	1,017	574	556	10	314		986
7			0	31		31	31	16	1,017	0	1,017			0	1,017	522	506	8	258		986
8			0	31		31	31	15	1,017	0	1,017			0	1,017	474	460	7	212		986
9			0	31		31	31	13	1,017	0	1,017			0	1,017	431	418	5	174		986
10			0	31		31	31	12	1,017	0	1,017			0	1,017	392	380	4	143		986
11			0	31		31	31	11	1,017	0	1,017			0	1,017	356	345	4	118		986
12			0	31		31	31	10	1,017	0	1,017			0	1,017	324	314	3	97		986
13			0	31		31	31	9	1,017	0	1,017			0	1,017	295	285	2	80		986
14			0	31		31	31	8	1,017	0	1,017			0	1,017	268	260	2	65		986
15			0	31		31	31	7	1,017	0	1,017			0	1,017	243	236	2	54		986
16			0	31		31	31	7	1,017	0	1,017			0	1,017	221	214	1	44		986
17			0	31		31	31	6	1,017	0	1,017			0	1,017	201	195	1	36		986
18			0	31		31	31	6	1,017	0	1,017			0	1,017	183	177	1	30		986
19			0	31		31	31	5	1,017	0	1,017			0	1,017	166	161	1	25		986
20			0	31		31	31	5	1,017	0	1,017			0	1,017	151	146	1	20		986
21			0	31		31	31	4	1,017	0	1,017			0	1,017	137	133	1	17		986
22			0	31		31	31	4	1,017	0	1,017			0	1,017	125	121	0	14		986
23			0	31		31	31	3	1,017	0	1,017			0	1,017	114	110	0	11		986
24			0	31		31	31	3	1,017	0	1,017			0	1,017	103	100	0	9		986
25			0	31		31	31	3	1,017	0	1,017			0	1,017	94	91	0	8		986
26			0	31		31	31	3	1,017	0	1,017			0	1,017	85	83	0	6		986
27			0	31		31	31	2	1,017	0	1,017			0	1,017	78	75	0	5		986
28			0	31		31	31	2	1,017	0	1,017			0	1,017	71	68	0	4		986
29			0	31		31	31	2	1,017	0	1,017			0	1,017	64	62	0	3		986
30			0	31		31	31	2	1,017	0	1,017			0	1,017	58	56	0	3		986
31			0	31		31	31	2	1,017	0	1,017			0	1,017	53	51	0	2		986
32			0	31		31	31	1	1,017	0	1,017			0	1,017	48	47	0	2		986
33			0	31		31	31	1	1,017	0	1,017			0	1,017	44	42	0	2		986
34			0	31		31	31	1	1,017	0	1,017			0	1,017	40	39	0	1		986
35			0	31		31	31	1	1,017	0	1,017			0	1,017	36	35	0	1		986
36			0	31		31	31	1	1,017	0	1,017			0	1,017	33	32	0	1		986
37			0	31		31	31	1	1,017	0	1,017			0	1,017	30	29	0	1		986
38			0	31		31	31	1	1,017	0	1,017			0	1,017	27	26	0	1		986
39			0	31		31	31	1	1,017	0	1,017			0	1,017	25	24	0	0		986
40			0	31		31	31	1	1,017	0	1,017			0	1,017	22	22	0	0		986
41			0	31		31	31	1	1,017	0	1,017			0	1,017	20	20	0	0		986
42			0	31		31	31	1	1,017	0	1,017			0	1,017	19	18	0	0		986
43			0	31		31	31	1	1,017	0	1,017			0	1,017	17	16	0	0		986
44			0	31		31	31	0	1,017	0	1,017			0	1,017	15	15	0	0		986
45			0	31		31	31	0	1,017	0	1,017			0	1,017	14	14	0	0		986
46			0	31		31	31	0	1,017	0	1,017			0	1,017	13	12	0	0		986
47			0	31		31	31	0	1,017	0	1,017			0	1,017	12	11	0	0		986
48			0	31		31	31	0	1,017	0	1,017			0	1,017	10	10	0	0		986
49			0	31		31	31	0	1,017	0	1,017			0	1,017	10	9	0	0		986
50			0	31		31	31	0	1,017	0	1,017			0	1,017	9	8	0	0		986
	3,127	0					4,534	2,504							45,756	6,227	3,723	1,764	1,764	0.00	21.64%
		3,127																			

EIRR	21.64%
B-C	3,723
B/C	2.49

Table H.4.5 (15) Cost Benefit Stream of Alternative Plan of Case 1 in Gin River Basin

River:	GIN	Overall
Case:	1	

(Unit: Million Rs.)

Year	Cost								Benefit								B-C (NPV)	Cost Net Present Value	Benefit Net Present Pvalue		EIRR Verification
	Costruction Cost			O&M			Grand Total	NPV	Flood Control			Power Generation			Grand Total	NPV					
	Short Term	Long Term	Total	Short Term	Long Term	Total			Short Term	Long Term	Total	Short Term	Long Term	Total							
1	437		437			0	437	397	0	0	0			0	0	0	-397	436	0		-437
2	778		778			0	778	643	0	0	0			0	0	0	-643	774	0		-778
3	2,794		2,794			0	2,794	2,099	0	0	0			0	0	0	-2,099	2,773	0		-2,794
4	2,938		2,938			0	2,938	2,007	0	0	0			0	0	0	-2,007	2,909	0		-2,938
5	3,170		3,170			0	3,170	1,968	0	0	0			0	0	0	-1,968	3,131	0		-3,170
6		4,976	4,976	101		101	5,077	2,866	220	0	220			0	220	124	-2,742	5,003	216		-4,858
7		6,112	6,112	101		101	6,213	3,188	220	0	220			0	220	113	-3,076	6,107	216		-5,994
8		5,415	5,415	101		101	5,516	2,573	220	0	220			0	220	102	-2,471	5,409	215		-5,297
9		4,520	4,520	101		101	4,621	1,960	220	0	220			0	220	93	-1,867	4,520	215		-4,401
10		3,392	3,392	101		101	3,493	1,347	220	0	220			0	220	85	-1,262	3,409	214		-3,274
11		3,716	3,716	101		101	3,817	1,338	220	0	220			0	220	77	-1,261	3,715	214		-3,597
12		4,072	4,072	101		101	4,173	1,330	220	0	220			0	220	70	-1,260	4,051	213		-3,953
13		3,162	3,162	101		101	3,263	945	220	0	220			0	220	64	-882	3,161	213		-3,044
14		601	601	101		101	702	185	220	0	220			0	220	58	-127	679	212		-483
15		646	646	101		101	747	179	220	0	220			0	220	53	-126	720	212		-527
16			0	101	366	467	467	102	0	1,851	1,851			0	1,851	403	301	449	1,779		1,383
17			0	101	366	467	467	92	0	1,851	1,851			0	1,851	366	274	448	1,775		1,383
18			0	101	366	467	467	84	0	1,851	1,851			0	1,851	333	249	447	1,770		1,383
19			0	101	366	467	467	76	0	1,851	1,851			0	1,851	303	226	446	1,766		1,383
20			0	101	366	467	467	69	0	1,851	1,851			0	1,851	275	206	445	1,762		1,383
21			0	101	366	467	467	63	0	1,851	1,851			0	1,851	250	187	444	1,757		1,383
22			0	101	366	467	467	57	0	1,851	1,851			0	1,851	227	170	443	1,753		1,383
23			0	101	366	467	467	52	0	1,851	1,851			0	1,851	207	154	442	1,749		1,383
24			0	101	366	467	467	47	0	1,851	1,851			0	1,851	188	140	440	1,745		1,383
25			0	101	366	467	467	43	0	1,851	1,851			0	1,851	171	128	439	1,740		1,383
26			0	101	366	467	467	39	0	1,851	1,851			0	1,851	155	116	438	1,736		1,383
27			0	101	366	467	467	36	0	1,851	1,851			0	1,851	141	106	437	1,732		1,383
28			0	101	366	467	467	32	0	1,851	1,851			0	1,851	128	96	436	1,727		1,383
29			0	101	366	467	467	29	0	1,851	1,851			0	1,851	117	87	435	1,723		1,383
30			0	101	366	467	467	27	0	1,851	1,851			0	1,851	106	79	434	1,719		1,383
31			0	101	366	467	467	24	0	1,851	1,851			0	1,851	96	72	433	1,715		1,383
32			0	101	366	467	467	22	0	1,851	1,851			0	1,851	88	66	432	1,711		1,383
33			0	101	366	467	467	20	0	1,851	1,851			0	1,851	80	60	431	1,706		1,383
34			0	101	366	467	467	18	0	1,851	1,851			0	1,851	72	54	430	1,702		1,383
35			0	101	366	467	467	17	0	1,851	1,851			0	1,851	66	49	429	1,698		1,383
36			0	101	366	467	467	15	0	1,851	1,851			0	1,851	60	45	428	1,694		1,383
37			0	101	366	467	467	14	0	1,851	1,851			0	1,851	54	41	427	1,690		1,383
38			0	101	366	467	467	12	0	1,851	1,851			0	1,851	49	37	426	1,686		1,383
39			0	101	366	467	467	11	0	1,851	1,851			0	1,851	45	34	425	1,681		1,383
40			0	101	366	467	467	10	0	1,851	1,851			0	1,851	41	31	424	1,677		1,383
41			0	101	366	467	467	9	0	1,851	1,851			0	1,851	37	28	422	1,673		1,383
42			0	101	366	467	467	9	0	1,851	1,851			0	1,851	34	25	421	1,669		1,383
43			0	101	366	467	467	8	0	1,851	1,851			0	1,851	31	23	420	1,665		1,383
44			0	101	366	467	467	7	0	1,851	1,851			0	1,851	28	21	419	1,661		1,383
45			0	101	366	467	467	6	0	1,851	1,851			0	1,851	25	19	418	1,657		1,383
46			0	101	366	467	467	6	0	1,851	1,851			0	1,851	23	17	417	1,653		1,383
47			0	101	366	467	467	5	0	1,851	1,851			0	1,851	21	16	416	1,649		1,383
48			0	101	366	467	467	5	0	1,851	1,851			0	1,851	19	14	415	1,645		1,383
49			0	101	366	467	467	4	0	1,851	1,851			0	1,851	17	13	414	1,641		1,383
50			0	101	366	467	467	4	0	1,851	1,851			0	1,851	16	12	413	1,637		1,383
	10,116	36,612					64,094	24,103							66,966	5,110	-18,993	61,880	61,880	0.14	0.25%
		46,727																			

EIRR	0.25%
B-C	-18,993
B/C	0.21

Table H.4.5 (16) Cost Benefit Stream of Alternative Plan of Case 1 in Gin River Basin

River:	GIN	Short
Case:	1	

(Unit: Million Rs.)

Year	Cost								Benefit								B-C (NPV)	Cost Net Present Value	Benefit Net Present Pvalue		EIRR Verification
	Costruction Cost			O&M			Grand Total	NPV	Flood Control			Power Generation			Grand Total	NPV					
	Short Term	Long Term	Total	Short Term	Long Term	Total			Short Term	Long Term	Total	Short Term	Long Term	Total							
1	437		437			0	437	397	0	0	0			0	0	0	-397	447	0		-437
2	778		778			0	778	643	0	0	0			0	0	0	-643	816	0		-778
3	2,794		2,794			0	2,794	2,099	0	0	0			0	0	0	-2,099	3,006	0		-2,794
4	2,938		2,938			0	2,938	2,007	0	0	0			0	0	0	-2,007	3,240	0		-2,938
5	3,170		3,170			0	3,170	1,968	0	0	0			0	0	0	-1,968	3,581	0		-3,170
6			0	101		101	101	57	220	0	220			0	220	124	67	117	254		118
7			0	101		101	101	52	220	0	220			0	220	113	61	120	260		118
8			0	101		101	101	47	220	0	220			0	220	102	55	123	267		118
9			0	101		101	101	43	220	0	220			0	220	93	50	126	273		118
10			0	101		101	101	39	220	0	220			0	220	85	46	129	280		118
11			0	101		101	101	35	220	0	220			0	220	77	41	132	287		118
12			0	101		101	101	32	220	0	220			0	220	70	38	136	294		118
13			0	101		101	101	29	220	0	220			0	220	64	34	139	302		118
14			0	101		101	101	27	220	0	220			0	220	58	31	142	309		118
15			0	101		101	101	24	220	0	220			0	220	53	28	146	317		118
16			0	101		101	101	22	220	0	220			0	220	48	26	150	324		118
17			0	101		101	101	20	220	0	220			0	220	43	23	153	332		118
18			0	101		101	101	18	220	0	220			0	220	39	21	157	341		118
19			0	101		101	101	17	220	0	220			0	220	36	19	161	349		118
20			0	101		101	101	15	220	0	220			0	220	33	18	165	358		118
21			0	101		101	101	14	220	0	220			0	220	30	16	169	367		118
22			0	101		101	101	12	220	0	220			0	220	27	15	173	376		118
23			0	101		101	101	11	220	0	220			0	220	25	13	177	385		118
24			0	101		101	101	10	220	0	220			0	220	22	12	182	394		118
25			0	101		101	101	9	220	0	220			0	220	20	11	186	404		118
26			0	101		101	101	8	220	0	220			0	220	18	10	191	414		118
27			0	101		101	101	8	220	0	220			0	220	17	9	196	424		118
28			0	101		101	101	7	220	0	220			0	220	15	8	200	435		118
29			0	101		101	101	6	220	0	220			0	220	14	7	205	446		118
30			0	101		101	101	6	220	0	220			0	220	13	7	210	457		118
31			0	101		101	101	5	220	0	220			0	220	11	6	216	468		118
32			0	101		101	101	5	220	0	220			0	220	10	6	221	480		118
33			0	101		101	101	4	220	0	220			0	220	9	5	226	491		118
34			0	101		101	101	4	220	0	220			0	220	9	5	232	504		118
35			0	101		101	101	4	220	0	220			0	220	8	4	238	516		118
36			0	101		101	101	3	220	0	220			0	220	7	4	244	529		118
37			0	101		101	101	3	220	0	220			0	220	6	3	250	542		118
38			0	101		101	101	3	220	0	220			0	220	6	3	256	555		118
39			0	101		101	101	2	220	0	220			0	220	5	3	262	569		118
40			0	101		101	101	2	220	0	220			0	220	5	3	269	583		118
41			0	101		101	101	2	220	0	220			0	220	4	2	275	598		118
42			0	101		101	101	2	220	0	220			0	220	4	2	282	612		118
43			0	101		101	101	2	220	0	220			0	220	4	2	289	627		118
44			0	101		101	101	2	220	0	220			0	220	3	2	296	643		118
45			0	101		101	101	1	220	0	220			0	220	3	2	304	659		118
46			0	101		101	101	1	220	0	220			0	220	3	1	311	675		118
47			0	101		101	101	1	220	0	220			0	220	2	1	319	692		118
48			0	101		101	101	1	220	0	220			0	220	2	1	327	709		118
49			0	101		101	101	1	220	0	220			0	220	2	1	335	726		118
50			0	101		101	101	1	220	0	220			0	220	2	1	343	744		118
	10,116	0					14,668	7,733							9,878	1,344	-6,389	20,573	20,573	0.88	-2.41%
		10,116																			

EIRR	-2.41%
B-C	-6,389
B/C	0.17

Table H.4.5 (17) Cost Benefit Stream of Alternative Plan of Case 2 in Gin River Basin

River:	GIN	Overall
Case:	2	

(Unit: Million Rs.)

Year	Cost								Benefit								B-C (NPV)	Cost Net Present Value	Benefit Net Present Pvalue		EIRR Verification
	Costruction Cost			O&M			Grand Total	NPV	Flood Control			Power Generation			Grand Total	NPV					
	Short Term	Long Term	Total	Short Term	Long Term	Total			Short Term	Long Term	Total	Short Term	Long Term	Total							
1	363		363			0	363	330	0	0	0			0	0	0	-330	350	0		-363
2	628		628			0	628	519	0	0	0			0	0	0	-519	584	0		-628
3	3,202		3,202			0	3,202	2,406	0	0	0			0	0	0	-2,406	2,869	0		-3,202
4	3,375		3,375			0	3,375	2,305	0	0	0			0	0	0	-2,305	2,915	0		-3,375
5	3,654		3,654			0	3,654	2,269	0	0	0			0	0	0	-2,269	3,043	0		-3,654
6		3,124	3,124	112		112	3,236	1,827	1,319	0	1,319			0	1,319	745	-1,082	2,598	1,059		-1,917
7		4,863	4,863	112		112	4,975	2,553	1,319	0	1,319			0	1,319	677	-1,876	3,850	1,021		-3,656
8		4,559	4,559	112		112	4,671	2,179	1,319	0	1,319			0	1,319	615	-1,564	3,485	984		-3,352
9		2,712	2,712	112		112	2,824	1,198	1,319	0	1,319			0	1,319	559	-638	2,031	949		-1,505
10		2,029	2,029	112		112	2,141	826	1,319	0	1,319			0	1,319	509	-317	1,485	915		-822
11		378	378	112		112	490	172	1,319	0	1,319			0	1,319	462	290	328	882		829
12		404	404	112		112	516	164	1,319	0	1,319			0	1,319	420	256	333	850		803
13		433	433	112		112	545	158	1,319	0	1,319			0	1,319	382	224	339	819		774
14		464	464	112		112	576	152	1,319	0	1,319			0	1,319	347	196	345	790		743
15		499	499	112		112	611	146	1,319	0	1,319			0	1,319	316	169	353	762		708
16			0	112	195	307	307	67	0	1,726	1,726			0	1,726	376	309	171	961		1,420
17			0	112	195	307	307	61	0	1,726	1,726			0	1,726	342	281	165	926		1,420
18			0	112	195	307	307	55	0	1,726	1,726			0	1,726	311	255	159	893		1,420
19			0	112	195	307	307	50	0	1,726	1,726			0	1,726	282	232	153	861		1,420
20			0	112	195	307	307	46	0	1,726	1,726			0	1,726	257	211	148	830		1,420
21			0	112	195	307	307	41	0	1,726	1,726			0	1,726	233	192	142	800		1,420
22			0	112	195	307	307	38	0	1,726	1,726			0	1,726	212	174	137	771		1,420
23			0	112	195	307	307	34	0	1,726	1,726			0	1,726	193	159	132	744		1,420
24			0	112	195	307	307	31	0	1,726	1,726			0	1,726	175	144	127	717		1,420
25			0	112	195	307	307	28	0	1,726	1,726			0	1,726	159	131	123	691		1,420
26			0	112	195	307	307	26	0	1,726	1,726			0	1,726	145	119	118	666		1,420
27			0	112	195	307	307	23	0	1,726	1,726			0	1,726	132	108	114	642		1,420
28			0	112	195	307	307	21	0	1,726	1,726			0	1,726	120	98	110	619		1,420
29			0	112	195	307	307	19	0	1,726	1,726			0	1,726	109	89	106	597		1,420
30			0	112	195	307	307	18	0	1,726	1,726			0	1,726	99	81	102	576		1,420
31			0	112	195	307	307	16	0	1,726	1,726			0	1,726	90	74	99	555		1,420
32			0	112	195	307	307	15	0	1,726	1,726			0	1,726	82	67	95	535		1,420
33			0	112	195	307	307	13	0	1,726	1,726			0	1,726	74	61	92	516		1,420
34			0	112	195	307	307	12	0	1,726	1,726			0	1,726	68	56	88	497		1,420
35			0	112	195	307	307	11	0	1,726	1,726			0	1,726	61	51	85	479		1,420
36			0	112	195	307	307	10	0	1,726	1,726			0	1,726	56	46	82	462		1,420
37			0	112	195	307	307	9	0	1,726	1,726			0	1,726	51	42	79	445		1,420
38			0	112	195	307	307	8	0	1,726	1,726			0	1,726	46	38	76	429		1,420
39			0	112	195	307	307	7	0	1,726	1,726			0	1,726	42	35	74	414		1,420
40			0	112	195	307	307	7	0	1,726	1,726			0	1,726	38	31	71	399		1,420
41			0	112	195	307	307	6	0	1,726	1,726			0	1,726	35	29	68	385		1,420
42			0	112	195	307	307	6	0	1,726	1,726			0	1,726	32	26	66	371		1,420
43			0	112	195	307	307	5	0	1,726	1,726			0	1,726	29	24	64	358		1,420
44			0	112	195	307	307	5	0	1,726	1,726			0	1,726	26	21	61	345		1,420
45			0	112	195	307	307	4	0	1,726	1,726			0	1,726	24	19	59	332		1,420
46			0	112	195	307	307	4	0	1,726	1,726			0	1,726	22	18	57	320		1,420
47			0	112	195	307	307	3	0	1,726	1,726			0	1,726	20	16	55	309		1,420
48			0	112	195	307	307	3	0	1,726	1,726			0	1,726	18	15	53	298		1,420
49			0	112	195	307	307	3	0	1,726	1,726			0	1,726	16	13	51	287		1,420
50			0	112	195	307	307	3	0	1,726	1,726			0	1,726	15	12	49	277		1,420
	11,222	19,465					42,550	17,912							73,614	9,018	-8,894	28,340	28,340	0.01	3.73%
		30,687																			

EIRR	3.73%
B-C	-8,894
B/C	0.50

Table H.4.5 (18) Cost Benefit Stream of Alternative Plan of Case 2 in Gin River Basin

River:	GIN	Short
Case:	2	

(Unit: Million Rs.)

Year	Cost								Benefit								B-C (NPV)
	Costruction Cost			O&M			Grand Total	NPV	Flood Control			Power Generation			Grand Total	NPV	
	Short Term	Long Term	Total	Short Term	Long Term	Total			Short Term	Long Term	Total	Short Term	Long Term	Total			
1	363		363			0	363	330	0	0	0			0	0	0	-330
2	628		628			0	628	519	0	0	0			0	0	0	-519
3	3,202		3,202			0	3,202	2,406	0	0	0			0	0	0	-2,406
4	3,375		3,375			0	3,375	2,305	0	0	0			0	0	0	-2,305
5	3,654		3,654			0	3,654	2,269	0	0	0			0	0	0	-2,269
6			0	112		112	112	63	1,319	0	1,319			0	1,319	745	681
7			0	112		112	112	58	1,319	0	1,319			0	1,319	677	619
8			0	112		112	112	52	1,319	0	1,319			0	1,319	615	563
9			0	112		112	112	48	1,319	0	1,319			0	1,319	559	512
10			0	112		112	112	43	1,319	0	1,319			0	1,319	509	465
11			0	112		112	112	39	1,319	0	1,319			0	1,319	462	423
12			0	112		112	112	36	1,319	0	1,319			0	1,319	420	385
13			0	112		112	112	33	1,319	0	1,319			0	1,319	382	350
14			0	112		112	112	30	1,319	0	1,319			0	1,319	347	318
15			0	112		112	112	27	1,319	0	1,319			0	1,319	316	289
16			0	112		112	112	24	1,319	0	1,319			0	1,319	287	263
17			0	112		112	112	22	1,319	0	1,319			0	1,319	261	239
18			0	112		112	112	20	1,319	0	1,319			0	1,319	237	217
19			0	112		112	112	18	1,319	0	1,319			0	1,319	216	197
20			0	112		112	112	17	1,319	0	1,319			0	1,319	196	179
21			0	112		112	112	15	1,319	0	1,319			0	1,319	178	163
22			0	112		112	112	14	1,319	0	1,319			0	1,319	162	148
23			0	112		112	112	13	1,319	0	1,319			0	1,319	147	135
24			0	112		112	112	11	1,319	0	1,319			0	1,319	134	123
25			0	112		112	112	10	1,319	0	1,319			0	1,319	122	111
26			0	112		112	112	9	1,319	0	1,319			0	1,319	111	101
27			0	112		112	112	9	1,319	0	1,319			0	1,319	101	92
28			0	112		112	112	8	1,319	0	1,319			0	1,319	91	84
29			0	112		112	112	7	1,319	0	1,319			0	1,319	83	76
30			0	112		112	112	6	1,319	0	1,319			0	1,319	76	69
31			0	112		112	112	6	1,319	0	1,319			0	1,319	69	63
32			0	112		112	112	5	1,319	0	1,319			0	1,319	62	57
33			0	112		112	112	5	1,319	0	1,319			0	1,319	57	52
34			0	112		112	112	4	1,319	0	1,319			0	1,319	52	47
35			0	112		112	112	4	1,319	0	1,319			0	1,319	47	43
36			0	112		112	112	4	1,319	0	1,319			0	1,319	43	39
37			0	112		112	112	3	1,319	0	1,319			0	1,319	39	35
38			0	112		112	112	3	1,319	0	1,319			0	1,319	35	32
39			0	112		112	112	3	1,319	0	1,319			0	1,319	32	29
40			0	112		112	112	2	1,319	0	1,319			0	1,319	29	27
41			0	112		112	112	2	1,319	0	1,319			0	1,319	26	24
42			0	112		112	112	2	1,319	0	1,319			0	1,319	24	22
43			0	112		112	112	2	1,319	0	1,319			0	1,319	22	20
44			0	112		112	112	2	1,319	0	1,319			0	1,319	20	18
45			0	112		112	112	2	1,319	0	1,319			0	1,319	18	17
46			0	112		112	112	1	1,319	0	1,319			0	1,319	16	15
47			0	112		112	112	1	1,319	0	1,319			0	1,319	15	14
48			0	112		112	112	1	1,319	0	1,319			0	1,319	14	12
49			0	112		112	112	1	1,319	0	1,319			0	1,319	12	11
50			0	112		112	112	1	1,319	0	1,319			0	1,319	11	10
	11,222	0					16,272	8,516							59,355	8,078	-438
		11,222															

	Cost	Benefit		EIRR
	Net Present Value	Net Present Pvalue		EIRR Verification
	332	0		-363
	524	0		-628
	2,441	0		-3,202
	2,350	0		-3,375
	2,325	0		-3,654
	65	767		1,207
	60	700		1,207
	54	640		1,207
	50	584		1,207
	45	534		1,207
	41	488		1,207
	38	446		1,207
	35	407		1,207
	32	372		1,207
	29	340		1,207
	26	310		1,207
	24	283		1,207
	22	259		1,207
	20	237		1,207
	18	216		1,207
	17	197		1,207
	15	180		1,207
	14	165		1,207
	13	150		1,207
	12	137		1,207
	11	126		1,207
	10	115		1,207
	9	105		1,207
	8	96		1,207
	7	87		1,207
	7	80		1,207
	6	73		1,207
	6	67		1,207
	5	61		1,207
	5	56		1,207
	4	51		1,207
	4	46		1,207
	4	42		1,207
	3	39		1,207
	3	35		1,207
	3	32		1,207
	3	30		1,207
	2	27		1,207
	2	25		1,207
	2	23		1,207
	2	21		1,207
	2	19		1,207
	1	17		1,207
	1	16		1,207
	1	14		1,207
	8,713	8,713	0.00	9.47%

EIRR	9.47%
B-C	-438
B/C	0.95

Table H.4.5 (19) Cost Benefit Stream of Alternative Plan of Case 3 in Gin River Basin

River:	GIN	Overall
Case:	3	

(Unit: Million Rs.)

Year	Cost								Benefit								B-C (NPV)
	Costruction Cost			O&M			Grand Total	NPV	Flood Control			Power Generation			Grand Total	NPV	
	Short Term	Long Term	Total	Short Term	Long Term	Total			Short Term	Long Term	Total	Short Term	Long Term	Total			
1	180		180			0	180	164	0	0	0			0	0	0	-164
2	396		396			0	396	327	0	0	0			0	0	0	-327
3	2,565		2,565			0	2,565	1,927	0	0	0			0	0	0	-1,927
4	2,729		2,729			0	2,729	1,864	0	0	0			0	0	0	-1,864
5	2,986		2,986			0	2,986	1,854	0	0	0			0	0	0	-1,854
6		564	564	89		89	653	368	587	0	587			0	587	331	-37
7		1,577	1,577	89		89	1,666	855	587	0	587			0	587	301	-554
8		1,677	1,677	89		89	1,766	824	587	0	587			0	587	274	-550
9		1,782	1,782	89		89	1,871	793	587	0	587			0	587	249	-545
10		1,893	1,893	89		89	1,982	764	587	0	587			0	587	226	-538
11		262	262	89		89	351	123	587	0	587			0	587	206	83
12		282	282	89		89	371	118	587	0	587			0	587	187	69
13		303	303	89		89	392	113	587	0	587			0	587	170	56
14		326	326	89		89	415	109	587	0	587			0	587	154	45
15		352	352	89		89	441	105	587	0	587			0	587	140	35
16			0	89	90	179	179	39	0	1,534	1,534			0	1,534	334	295
17			0	89	90	179	179	35	0	1,534	1,534			0	1,534	304	268
18			0	89	90	179	179	32	0	1,534	1,534			0	1,534	276	244
19			0	89	90	179	179	29	0	1,534	1,534			0	1,534	251	222
20			0	89	90	179	179	27	0	1,534	1,534			0	1,534	228	202
21			0	89	90	179	179	24	0	1,534	1,534			0	1,534	207	183
22			0	89	90	179	179	22	0	1,534	1,534			0	1,534	188	167
23			0	89	90	179	179	20	0	1,534	1,534			0	1,534	171	151
24			0	89	90	179	179	18	0	1,534	1,534			0	1,534	156	138
25			0	89	90	179	179	16	0	1,534	1,534			0	1,534	142	125
26			0	89	90	179	179	15	0	1,534	1,534			0	1,534	129	114
27			0	89	90	179	179	14	0	1,534	1,534			0	1,534	117	103
28			0	89	90	179	179	12	0	1,534	1,534			0	1,534	106	94
29			0	89	90	179	179	11	0	1,534	1,534			0	1,534	97	85
30			0	89	90	179	179	10	0	1,534	1,534			0	1,534	88	78
31			0	89	90	179	179	9	0	1,534	1,534			0	1,534	80	71
32			0	89	90	179	179	8	0	1,534	1,534			0	1,534	73	64
33			0	89	90	179	179	8	0	1,534	1,534			0	1,534	66	58
34			0	89	90	179	179	7	0	1,534	1,534			0	1,534	60	53
35			0	89	90	179	179	6	0	1,534	1,534			0	1,534	55	48
36			0	89	90	179	179	6	0	1,534	1,534			0	1,534	50	44
37			0	89	90	179	179	5	0	1,534	1,534			0	1,534	45	40
38			0	89	90	179	179	5	0	1,534	1,534			0	1,534	41	36
39			0	89	90	179	179	4	0	1,534	1,534			0	1,534	37	33
40			0	89	90	179	179	4	0	1,534	1,534			0	1,534	34	30
41			0	89	90	179	179	4	0	1,534	1,534			0	1,534	31	27
42			0	89	90	179	179	3	0	1,534	1,534			0	1,534	28	25
43			0	89	90	179	179	3	0	1,534	1,534			0	1,534	25	23
44			0	89	90	179	179	3	0	1,534	1,534			0	1,534	23	20
45			0	89	90	179	179	2	0	1,534	1,534			0	1,534	21	19
46			0	89	90	179	179	2	0	1,534	1,534			0	1,534	19	17
47			0	89	90	179	179	2	0	1,534	1,534			0	1,534	17	15
48			0	89	90	179	179	2	0	1,534	1,534			0	1,534	16	14
49			0	89	90	179	179	2	0	1,534	1,534			0	1,534	14	13
50			0	89	90	179	179	2	0	1,534	1,534			0	1,534	13	12
	8,856	9,018					25,016	10,722							59,569	5,780	-4,941
		17,874															

Cost	Benefit		EIRR
Net Present Value	Net Present Pvalue		Verification
171	0		-180
358	0		-396
2,200	0		-2,565
2,224	0		-2,729
2,312	0		-2,986
480	432		-66
1,164	410		-1,079
1,173	390		-1,179
1,181	370		-1,284
1,188	352		-1,395
200	334		236
201	318		216
201	302		195
203	287		172
205	272		146
79	677		1,356
75	643		1,356
71	611		1,356
68	581		1,356
64	552		1,356
61	524		1,356
58	498		1,356
55	473		1,356
52	450		1,356
50	427		1,356
47	406		1,356
45	386		1,356
43	367		1,356
41	348		1,356
39	331		1,356
37	314		1,356
35	299		1,356
33	284		1,356
31	270		1,356
30	256		1,356
28	243		1,356
27	231		1,356
26	220		1,356
24	209		1,356
23	198		1,356
22	189		1,356
21	179		1,356
20	170		1,356
19	162		1,356
18	154		1,356
17	146		1,356
16	139		1,356
15	132		1,356
15	125		1,356
14	119		1,356
14,778	14,778	0.01	5.25%

EIRR	5.25%
B-C	-4,941
B/C	0.54

Table H.4.5 (20) Cost Benefit Stream of Alternative Plan of Case 3 in Gin River Basin

River:	GIN	Short
Case:	3	

(Unit: Million Rs.)

Year	Cost								Benefit								B-C (NPV)	Cost Net Present Value	Benefit Net Present Pvalue		EIRR Verification
	Costruction Cost			O&M			Grand Total	NPV	Flood Control			Power Generation			Grand Total	NPV					
	Short Term	Long Term	Total	Short Term	Long Term	Total			Short Term	Long Term	Total	Short Term	Long Term	Total							
1	180		180			0	180	164	0	0	0			0	0	0	-164	172	0		-180
2	396		396			0	396	327	0	0	0			0	0	0	-327	362	0		-396
3	2,565		2,565			0	2,565	1,927	0	0	0			0	0	0	-1,927	2,238	0		-2,565
4	2,729		2,729			0	2,729	1,864	0	0	0			0	0	0	-1,864	2,275	0		-2,729
5	2,986		2,986			0	2,986	1,854	0	0	0			0	0	0	-1,854	2,379	0		-2,986
6			0	89		89	89	50	587	0	587			0	587	331	281	67	446		498
7			0	89		89	89	45	587	0	587			0	587	301	256	64	427		498
8			0	89		89	89	41	587	0	587			0	587	274	232	62	408		498
9			0	89		89	89	38	587	0	587			0	587	249	211	59	390		498
10			0	89		89	89	34	587	0	587			0	587	226	192	56	372		498
11			0	89		89	89	31	587	0	587			0	587	206	175	54	356		498
12			0	89		89	89	28	587	0	587			0	587	187	159	51	340		498
13			0	89		89	89	26	587	0	587			0	587	170	144	49	325		498
14			0	89		89	89	23	587	0	587			0	587	154	131	47	310		498
15			0	89		89	89	21	587	0	587			0	587	140	119	45	297		498
16			0	89		89	89	19	587	0	587			0	587	128	108	43	283		498
17			0	89		89	89	18	587	0	587			0	587	116	99	41	271		498
18			0	89		89	89	16	587	0	587			0	587	105	90	39	259		498
19			0	89		89	89	14	587	0	587			0	587	96	81	37	247		498
20			0	89		89	89	13	587	0	587			0	587	87	74	36	236		498
21			0	89		89	89	12	587	0	587			0	587	79	67	34	226		498
22			0	89		89	89	11	587	0	587			0	587	72	61	33	216		498
23			0	89		89	89	10	587	0	587			0	587	65	56	31	206		498
24			0	89		89	89	9	587	0	587			0	587	60	51	30	197		498
25			0	89		89	89	8	587	0	587			0	587	54	46	28	188		498
26			0	89		89	89	7	587	0	587			0	587	49	42	27	180		498
27			0	89		89	89	7	587	0	587			0	587	45	38	26	172		498
28			0	89		89	89	6	587	0	587			0	587	41	35	25	164		498
29			0	89		89	89	6	587	0	587			0	587	37	31	24	157		498
30			0	89		89	89	5	587	0	587			0	587	34	29	23	150		498
31			0	89		89	89	5	587	0	587			0	587	31	26	22	143		498
32			0	89		89	89	4	587	0	587			0	587	28	24	21	137		498
33			0	89		89	89	4	587	0	587			0	587	25	21	20	131		498
34			0	89		89	89	3	587	0	587			0	587	23	19	19	125		498
35			0	89		89	89	3	587	0	587			0	587	21	18	18	119		498
36			0	89		89	89	3	587	0	587			0	587	19	16	17	114		498
37			0	89		89	89	3	587	0	587			0	587	17	15	16	109		498
38			0	89		89	89	2	587	0	587			0	587	16	13	16	104		498
39			0	89		89	89	2	587	0	587			0	587	14	12	15	100		498
40			0	89		89	89	2	587	0	587			0	587	13	11	14	95		498
41			0	89		89	89	2	587	0	587			0	587	12	10	14	91		498
42			0	89		89	89	2	587	0	587			0	587	11	9	13	87		498
43			0	89		89	89	1	587	0	587			0	587	10	8	13	83		498
44			0	89		89	89	1	587	0	587			0	587	9	8	12	79		498
45			0	89		89	89	1	587	0	587			0	587	8	7	11	76		498
46			0	89		89	89	1	587	0	587			0	587	7	6	11	72		498
47			0	89		89	89	1	587	0	587			0	587	7	6	10	69		498
48			0	89		89	89	1	587	0	587			0	587	6	5	10	66		498
49			0	89		89	89	1	587	0	587			0	587	5	5	10	63		498
50			0	89		89	89	1	587	0	587			0	587	5	4	9	60		498
	8,856	0					12,841	6,678							26,393	3,592	-3,087	8,746	8,746	0.00	4.65%
		8,856																			

EIRR	4.65%
B-C	-3,087
B/C	0.54

Table H.4.5 (21) Cost Benefit Stream of Alternative Plan of Case 4 in Gin River Basin

River:	GIN	Overall
Case:	4	

(Unit: Million Rs.)

Year	Cost								Benefit								B-C (NPV)	Cost Net Present Value	Benefit Net Present Pvalue		EIRR Verification
	Costruction Cost			O&M			Grand Total	NPV	Flood Control			Power Generation			Grand Total	NPV					
	Short Term	Long Term	Total	Short Term	Long Term	Total			Short Term	Long Term	Total	Short Term	Long Term	Total							
1	282		282			0	282	256	0	0	0			0	0	0	-256	262	0		-282
2	478		478			0	478	395	0	0	0			0	0	0	-395	412	0		-478
3	3,059		3,059			0	3,059	2,298	0	0	0			0	0	0	-2,298	2,447	0		-3,059
4	3,224		3,224			0	3,224	2,202	0	0	0			0	0	0	-2,202	2,394	0		-3,224
5	3,493		3,493			0	3,493	2,169	0	0	0			0	0	0	-2,169	2,408	0		-3,493
6		396	396	105		105	501	283	1,319	0	1,319			0	1,319	745	462	321	844		818
7		950	950	105		105	1,055	542	1,319	0	1,319			0	1,319	677	135	627	784		264
8		1,037	1,037	105		105	1,142	533	1,319	0	1,319			0	1,319	615	82	630	728		177
9		1,134	1,134	105		105	1,239	526	1,319	0	1,319			0	1,319	559	34	635	675		80
10		1,240	1,240	105		105	1,345	519	1,319	0	1,319			0	1,319	509	-10	640	627		-26
11		261	261	105		105	366	128	1,319	0	1,319			0	1,319	462	334	162	582		953
12		280	280	105		105	385	123	1,319	0	1,319			0	1,319	420	297	158	540		934
13		301	301	105		105	406	118	1,319	0	1,319			0	1,319	382	264	155	502		913
14		324	324	105		105	429	113	1,319	0	1,319			0	1,319	347	234	152	466		890
15		350	350	105		105	455	109	1,319	0	1,319			0	1,319	316	207	149	432		864
16			0	105	63	168	168	37	0	1,534	1,534			0	1,534	334	297	51	467		1,366
17			0	105	63	168	168	33	0	1,534	1,534			0	1,534	304	270	47	433		1,366
18			0	105	63	168	168	30	0	1,534	1,534			0	1,534	276	246	44	402		1,366
19			0	105	63	168	168	27	0	1,534	1,534			0	1,534	251	223	41	374		1,366
20			0	105	63	168	168	25	0	1,534	1,534			0	1,534	228	203	38	347		1,366
21			0	105	63	168	168	23	0	1,534	1,534			0	1,534	207	185	35	322		1,366
22			0	105	63	168	168	21	0	1,534	1,534			0	1,534	188	168	33	299		1,366
23			0	105	63	168	168	19	0	1,534	1,534			0	1,534	171	153	30	277		1,366
24			0	105	63	168	168	17	0	1,534	1,534			0	1,534	156	139	28	258		1,366
25			0	105	63	168	168	16	0	1,534	1,534			0	1,534	142	126	26	239		1,366
26			0	105	63	168	168	14	0	1,534	1,534			0	1,534	129	115	24	222		1,366
27			0	105	63	168	168	13	0	1,534	1,534			0	1,534	117	104	23	206		1,366
28			0	105	63	168	168	12	0	1,534	1,534			0	1,534	106	95	21	191		1,366
29			0	105	63	168	168	11	0	1,534	1,534			0	1,534	97	86	19	178		1,366
30			0	105	63	168	168	10	0	1,534	1,534			0	1,534	88	78	18	165		1,366
31			0	105	63	168	168	9	0	1,534	1,534			0	1,534	80	71	17	153		1,366
32			0	105	63	168	168	8	0	1,534	1,534			0	1,534	73	65	16	142		1,366
33			0	105	63	168	168	7	0	1,534	1,534			0	1,534	66	59	14	132		1,366
34			0	105	63	168	168	7	0	1,534	1,534			0	1,534	60	53	13	122		1,366
35			0	105	63	168	168	6	0	1,534	1,534			0	1,534	55	49	12	114		1,366
36			0	105	63	168	168	5	0	1,534	1,534			0	1,534	50	44	12	106		1,366
37			0	105	63	168	168	5	0	1,534	1,534			0	1,534	45	40	11	98		1,366
38			0	105	63	168	168	4	0	1,534	1,534			0	1,534	41	37	10	91		1,366
39			0	105	63	168	168	4	0	1,534	1,534			0	1,534	37	33	9	84		1,366
40			0	105	63	168	168	4	0	1,534	1,534			0	1,534	34	30	9	78		1,366
41			0	105	63	168	168	3	0	1,534	1,534			0	1,534	31	27	8	73		1,366
42			0	105	63	168	168	3	0	1,534	1,534			0	1,534	28	25	7	68		1,366
43			0	105	63	168	168	3	0	1,534	1,534			0	1,534	25	23	7	63		1,366
44			0	105	63	168	168	3	0	1,534	1,534			0	1,534	23	21	6	58		1,366
45			0	105	63	168	168	2	0	1,534	1,534			0	1,534	21	19	6	54		1,366
46			0	105	63	168	168	2	0	1,534	1,534			0	1,534	19	17	5	50		1,366
47			0	105	63	168	168	2	0	1,534	1,534			0	1,534	17	15	5	47		1,366
48			0	105	63	168	168	2	0	1,534	1,534			0	1,534	16	14	5	43		1,366
49			0	105	63	168	168	2	0	1,534	1,534			0	1,534	14	13	4	40		1,366
50			0	105	63	168	168	1	0	1,534	1,534			0	1,534	13	12	4	37		1,366
	10,536	6,273					23,746	10,701							66,894	8,575	-2,127	12,212	12,212	0.00	7.72%
		16,809																			

EIRR	7.72%
B-C	-2,127
B/C	0.80

Table H.4.5 (22) Cost Benefit Stream of Alternative Plan of Case 4 in Gin River Basin

River:	GIN	Short
Case:	4	

(Unit: Million Rs.)

Year	Cost								Benefit								B-C (NPV)	Cost Net Present Value	Benefit Net Present Pvalue		EIRR Verification
	Costruction Cost			O&M			Grand Total	NPV	Flood Control			Power Generation			Grand Total	NPV					
	Short Term	Long Term	Total	Short Term	Long Term	Total			Short Term	Long Term	Total	Short Term	Long Term	Total							
1	282		282			0	282	256	0	0	0			0	0	0	-256	256	0		-282
2	478		478			0	478	395	0	0	0			0	0	0	-395	394	0		-478
3	3,059		3,059			0	3,059	2,298	0	0	0			0	0	0	-2,298	2,289	0		-3,059
4	3,224		3,224			0	3,224	2,202	0	0	0			0	0	0	-2,202	2,191	0		-3,224
5	3,493		3,493			0	3,493	2,169	0	0	0			0	0	0	-2,169	2,155	0		-3,493
6			0	105		105	105	59	1,319	0	1,319			0	1,319	745	685	59	739		1,214
7			0	105		105	105	54	1,319	0	1,319			0	1,319	677	623	54	671		1,214
8			0	105		105	105	49	1,319	0	1,319			0	1,319	615	566	49	609		1,214
9			0	105		105	105	45	1,319	0	1,319			0	1,319	559	515	44	553		1,214
10			0	105		105	105	41	1,319	0	1,319			0	1,319	509	468	40	502		1,214
11			0	105		105	105	37	1,319	0	1,319			0	1,319	462	425	36	456		1,214
12			0	105		105	105	34	1,319	0	1,319			0	1,319	420	387	33	414		1,214
13			0	105		105	105	31	1,319	0	1,319			0	1,319	382	352	30	376		1,214
14			0	105		105	105	28	1,319	0	1,319			0	1,319	347	320	27	341		1,214
15			0	105		105	105	25	1,319	0	1,319			0	1,319	316	291	25	310		1,214
16			0	105		105	105	23	1,319	0	1,319			0	1,319	287	264	22	281		1,214
17			0	105		105	105	21	1,319	0	1,319			0	1,319	261	240	20	255		1,214
18			0	105		105	105	19	1,319	0	1,319			0	1,319	237	218	19	232		1,214
19			0	105		105	105	17	1,319	0	1,319			0	1,319	216	198	17	210		1,214
20			0	105		105	105	16	1,319	0	1,319			0	1,319	196	180	15	191		1,214
21			0	105		105	105	14	1,319	0	1,319			0	1,319	178	164	14	173		1,214
22			0	105		105	105	13	1,319	0	1,319			0	1,319	162	149	13	157		1,214
23			0	105		105	105	12	1,319	0	1,319			0	1,319	147	136	11	143		1,214
24			0	105		105	105	11	1,319	0	1,319			0	1,319	134	123	10	130		1,214
25			0	105		105	105	10	1,319	0	1,319			0	1,319	122	112	9	118		1,214
26			0	105		105	105	9	1,319	0	1,319			0	1,319	111	102	9	107		1,214
27			0	105		105	105	8	1,319	0	1,319			0	1,319	101	93	8	97		1,214
28			0	105		105	105	7	1,319	0	1,319			0	1,319	91	84	7	88		1,214
29			0	105		105	105	7	1,319	0	1,319			0	1,319	83	77	6	80		1,214
30			0	105		105	105	6	1,319	0	1,319			0	1,319	76	70	6	73		1,214
31			0	105		105	105	5	1,319	0	1,319			0	1,319	69	63	5	66		1,214
32			0	105		105	105	5	1,319	0	1,319			0	1,319	62	57	5	60		1,214
33			0	105		105	105	5	1,319	0	1,319			0	1,319	57	52	4	54		1,214
34			0	105		105	105	4	1,319	0	1,319			0	1,319	52	48	4	49		1,214
35			0	105		105	105	4	1,319	0	1,319			0	1,319	47	43	4	45		1,214
36			0	105		105	105	3	1,319	0	1,319			0	1,319	43	39	3	41		1,214
37			0	105		105	105	3	1,319	0	1,319			0	1,319	39	36	3	37		1,214
38			0	105		105	105	3	1,319	0	1,319			0	1,319	35	32	3	34		1,214
39			0	105		105	105	3	1,319	0	1,319			0	1,319	32	29	2	30		1,214
40			0	105		105	105	2	1,319	0	1,319			0	1,319	29	27	2	28		1,214
41			0	105		105	105	2	1,319	0	1,319			0	1,319	26	24	2	25		1,214
42			0	105		105	105	2	1,319	0	1,319			0	1,319	24	22	2	23		1,214
43			0	105		105	105	2	1,319	0	1,319			0	1,319	22	20	2	21		1,214
44			0	105		105	105	2	1,319	0	1,319			0	1,319	20	18	2	19		1,214
45			0	105		105	105	1	1,319	0	1,319			0	1,319	18	17	1	17		1,214
46			0	105		105	105	1	1,319	0	1,319			0	1,319	16	15	1	15		1,214
47			0	105		105	105	1	1,319	0	1,319			0	1,319	15	14	1	14		1,214
48			0	105		105	105	1	1,319	0	1,319			0	1,319	14	13	1	13		1,214
49			0	105		105	105	1	1,319	0	1,319			0	1,319	12	11	1	12		1,214
50			0	105		105	105	1	1,319	0	1,319			0	1,319	11	10	1	11		1,214
	10,536	0					15,277	7,966							59,355	8,078	112	7,917	7,917	-0.01	10.14%
		10,536																			

EIRR	10.14%
B-C	112
B/C	1.01

Table H.4.5 (23) Cost Benefit Stream of Alternative Plan of Case 1 in Nilwala River Basin

River:	NILWALA	Overall
Case:	1	

(Unit: Million Rs.)

Year	Cost								Benefit								B-C (NPV)	Cost Net Present Value	Benefit Net Present Value		EIRR Verification
	Costruction Cost			O&M			Grand Total	NPV	Flood Control			Power Generation			Grand Total	NPV					
	Short Term	Long Term	Total	Short Term	Long Term	Total			Short Term	Long Term	Total	Short Term	Long Term	Total							
1	434		434			0	434	395	0	0	0			0	0	0	-395	380	0		-434
2	550		550			0	550	455	0	0	0			0	0	0	-455	421	0		-550
3	2,760		2,760			0	2,760	2,074	0	0	0			0	0	0	-2,074	1,847	0		-2,760
4	2,848		2,848			0	2,848	1,945	0	0	0			0	0	0	-1,945	1,667	0		-2,848
5	3,014		3,014			0	3,014	1,871	0	0	0			0	0	0	-1,871	1,543	0		-3,014
6		311	311	96		96	407	230	1,980	0	1,980			0	1,980	1,117	888	182	886		1,572
7		583	583	96		96	679	348	1,980	0	1,980			0	1,980	1,016	667	266	775		1,300
8		621	621	96		96	717	335	1,980	0	1,980			0	1,980	923	589	246	678		1,262
9		678	678	96		96	774	328	1,980	0	1,980			0	1,980	840	511	232	593		1,205
10		194	194	96		96	290	112	1,980	0	1,980			0	1,980	763	651	76	519		1,689
11		208	208	96		96	304	107	1,980	0	1,980			0	1,980	694	587	70	454		1,675
12		223	223	96		96	319	102	1,980	0	1,980			0	1,980	631	529	64	397		1,660
13		239	239	96		96	335	97	1,980	0	1,980			0	1,980	573	476	59	347		1,644
14		257	257	96		96	353	93	1,980	0	1,980			0	1,980	521	428	54	303		1,626
15		277	277	96		96	373	89	1,980	0	1,980			0	1,980	474	385	50	265		1,606
16		0	0	96	36	132	132	29	0	2,223	2,223			0	2,223	484	455	15	261		2,091
17		0	0	96	36	132	132	26	0	2,223	2,223			0	2,223	440	414	14	228		2,091
18		0	0	96	36	132	132	24	0	2,223	2,223			0	2,223	400	376	12	199		2,091
19		0	0	96	36	132	132	22	0	2,223	2,223			0	2,223	363	342	10	174		2,091
20		0	0	96	36	132	132	20	0	2,223	2,223			0	2,223	330	311	9	153		2,091
21		0	0	96	36	132	132	18	0	2,223	2,223			0	2,223	300	283	8	133		2,091
22		0	0	96	36	132	132	16	0	2,223	2,223			0	2,223	273	257	7	117		2,091
23		0	0	96	36	132	132	15	0	2,223	2,223			0	2,223	248	234	6	102		2,091
24		0	0	96	36	132	132	13	0	2,223	2,223			0	2,223	226	212	5	89		2,091
25		0	0	96	36	132	132	12	0	2,223	2,223			0	2,223	205	193	5	78		2,091
26		0	0	96	36	132	132	11	0	2,223	2,223			0	2,223	187	175	4	68		2,091
27		0	0	96	36	132	132	10	0	2,223	2,223			0	2,223	170	159	4	60		2,091
28		0	0	96	36	132	132	9	0	2,223	2,223			0	2,223	154	145	3	52		2,091
29		0	0	96	36	132	132	8	0	2,223	2,223			0	2,223	140	132	3	46		2,091
30		0	0	96	36	132	132	8	0	2,223	2,223			0	2,223	127	120	2	40		2,091
31		0	0	96	36	132	132	7	0	2,223	2,223			0	2,223	116	109	2	35		2,091
32		0	0	96	36	132	132	6	0	2,223	2,223			0	2,223	105	99	2	31		2,091
33		0	0	96	36	132	132	6	0	2,223	2,223			0	2,223	96	90	2	27		2,091
34		0	0	96	36	132	132	5	0	2,223	2,223			0	2,223	87	82	1	23		2,091
35		0	0	96	36	132	132	5	0	2,223	2,223			0	2,223	79	74	1	20		2,091
36		0	0	96	36	132	132	4	0	2,223	2,223			0	2,223	72	68	1	18		2,091
37		0	0	96	36	132	132	4	0	2,223	2,223			0	2,223	65	61	1	16		2,091
38		0	0	96	36	132	132	4	0	2,223	2,223			0	2,223	59	56	1	14		2,091
39		0	0	96	36	132	132	3	0	2,223	2,223			0	2,223	54	51	1	12		2,091
40		0	0	96	36	132	132	3	0	2,223	2,223			0	2,223	49	46	1	10		2,091
41		0	0	96	36	132	132	3	0	2,223	2,223			0	2,223	45	42	1	9		2,091
42		0	0	96	36	132	132	2	0	2,223	2,223			0	2,223	41	38	0	8		2,091
43		0	0	96	36	132	132	2	0	2,223	2,223			0	2,223	37	35	0	7		2,091
44		0	0	96	36	132	132	2	0	2,223	2,223			0	2,223	34	32	0	6		2,091
45		0	0	96	36	132	132	2	0	2,223	2,223			0	2,223	30	29	0	5		2,091
46		0	0	96	36	132	132	2	0	2,223	2,223			0	2,223	28	26	0	5		2,091
47		0	0	96	36	132	132	1	0	2,223	2,223			0	2,223	25	24	0	4		2,091
48		0	0	96	36	132	132	1	0	2,223	2,223			0	2,223	23	22	0	4		2,091
49		0	0	96	36	132	132	1	0	2,223	2,223			0	2,223	21	20	0	3		2,091
50		0	0	96	36	132	132	1	0	2,223	2,223			0	2,223	19	18	0	3		2,091
	9,606	3,591					18,777	8,885							97,596	12,684	3,800	7,276	7,276	0.00	14.33%
		13,197																			

EIRR	14.33%
B-C	3,800
B/C	1.43

Table H.4.5 (24) Cost Benefit Stream of Alternative Plan of Case 1 in Nilwala River Basin

River:	NILWALA	Short
Case:	1	

(Unit: Million Rs.)

Year	Cost								Benefit								B-C (NPV)	Cost Net Present Value	Benefit Net Present Value		EIRR Verification
	Costruction Cost			O&M			Grand Total	NPV	Flood Control			Power Generation			Grand Total	NPV					
	Short Term	Long Term	Total	Short Term	Long Term	Total			Short Term	Long Term	Total	Short Term	Long Term	Total							
1	434		434			0	434	395	0	0	0			0	0	0	-395	374	0		-434
2	550		550			0	550	455	0	0	0			0	0	0	-455	408	0		-550
3	2,760		2,760			0	2,760	2,074	0	0	0			0	0	0	-2,074	1,764	0		-2,760
4	2,848		2,848			0	2,848	1,945	0	0	0			0	0	0	-1,945	1,568	0		-2,848
5	3,014		3,014			0	3,014	1,871	0	0	0			0	0	0	-1,871	1,429	0		-3,014
6			0	96		96	96	54	1,980	0	1,980			0	1,980	1,117	1,063	39	809		1,883
7			0	96		96	96	49	1,980	0	1,980			0	1,980	1,016	967	34	696		1,883
8			0	96		96	96	45	1,980	0	1,980			0	1,980	923	879	29	600		1,883
9			0	96		96	96	41	1,980	0	1,980			0	1,980	840	799	25	517		1,883
10			0	96		96	96	37	1,980	0	1,980			0	1,980	763	726	22	445		1,883
11			0	96		96	96	34	1,980	0	1,980			0	1,980	694	660	19	383		1,883
12			0	96		96	96	31	1,980	0	1,980			0	1,980	631	600	16	330		1,883
13			0	96		96	96	28	1,980	0	1,980			0	1,980	573	546	14	284		1,883
14			0	96		96	96	25	1,980	0	1,980			0	1,980	521	496	12	245		1,883
15			0	96		96	96	23	1,980	0	1,980			0	1,980	474	451	10	211		1,883
16			0	96		96	96	21	1,980	0	1,980			0	1,980	431	410	9	182		1,883
17			0	96		96	96	19	1,980	0	1,980			0	1,980	392	373	8	157		1,883
18			0	96		96	96	17	1,980	0	1,980			0	1,980	356	339	7	135		1,883
19			0	96		96	96	16	1,980	0	1,980			0	1,980	324	308	6	116		1,883
20			0	96		96	96	14	1,980	0	1,980			0	1,980	294	280	5	100		1,883
21			0	96		96	96	13	1,980	0	1,980			0	1,980	267	255	4	86		1,883
22			0	96		96	96	12	1,980	0	1,980			0	1,980	243	231	4	74		1,883
23			0	96		96	96	11	1,980	0	1,980			0	1,980	221	210	3	64		1,883
24			0	96		96	96	10	1,980	0	1,980			0	1,980	201	191	3	55		1,883
25			0	96		96	96	9	1,980	0	1,980			0	1,980	183	174	2	47		1,883
26			0	96		96	96	8	1,980	0	1,980			0	1,980	166	158	2	41		1,883
27			0	96		96	96	7	1,980	0	1,980			0	1,980	151	144	2	35		1,883
28			0	96		96	96	7	1,980	0	1,980			0	1,980	137	131	1	30		1,883
29			0	96		96	96	6	1,980	0	1,980			0	1,980	125	119	1	26		1,883
30			0	96		96	96	6	1,980	0	1,980			0	1,980	113	108	1	23		1,883
31			0	96		96	96	5	1,980	0	1,980			0	1,980	103	98	1	19		1,883
32			0	96		96	96	5	1,980	0	1,980			0	1,980	94	89	1	17		1,883
33			0	96		96	96	4	1,980	0	1,980			0	1,980	85	81	1	14		1,883
34			0	96		96	96	4	1,980	0	1,980			0	1,980	77	74	1	12		1,883
35			0	96		96	96	3	1,980	0	1,980			0	1,980	70	67	1	11		1,883
36			0	96		96	96	3	1,980	0	1,980			0	1,980	64	61	0	9		1,883
37			0	96		96	96	3	1,980	0	1,980			0	1,980	58	55	0	8		1,883
38			0	96		96	96	3	1,980	0	1,980			0	1,980	53	50	0	7		1,883
39			0	96		96	96	2	1,980	0	1,980			0	1,980	48	46	0	6		1,883
40			0	96		96	96	2	1,980	0	1,980			0	1,980	44	42	0	5		1,883
41			0	96		96	96	2	1,980	0	1,980			0	1,980	40	38	0	4		1,883
42			0	96		96	96	2	1,980	0	1,980			0	1,980	36	34	0	4		1,883
43			0	96		96	96	2	1,980	0	1,980			0	1,980	33	31	0	3		1,883
44			0	96		96	96	1	1,980	0	1,980			0	1,980	30	28	0	3		1,883
45			0	96		96	96	1	1,980	0	1,980			0	1,980	27	26	0	2		1,883
46			0	96		96	96	1	1,980	0	1,980			0	1,980	25	23	0	2		1,883
47			0	96		96	96	1	1,980	0	1,980			0	1,980	22	21	0	2		1,883
48			0	96		96	96	1	1,980	0	1,980			0	1,980	20	19	0	2		1,883
49			0	96		96	96	1	1,980	0	1,980			0	1,980	19	18	0	1		1,883
50			0	96		96	96	1	1,980	0	1,980			0	1,980	17	16	0	1		1,883
	9,606	0					13,929	7,328							89,078	12,123	4,795	5,826	5,826	-0.01	16.09%
		9,606																			

EIRR	16.09%
B-C	4,795
B/C	1.65

Table H.4.5 (25) Cost Benefit Stream of Alternative Plan of Case 2 in Nilwala River Basin

River:	NILWALA	Overall
Case:	2	

(Unit: Million Rs.)

Year	Cost								Benefit								B-C (NPV)	Cost Net Present Value	Benefit Net Present Value		EIRR Verification
	Costruction Cost			O&M			Grand Total	NPV	Flood Control			Power Generation			Grand Total	NPV					
	Short Term	Long Term	Total	Short Term	Long Term	Total			Short Term	Long Term	Total	Short Term	Long Term	Total							
1	447		447			0	447	406	0	0	0			0	0	0	-406	398	0		-447
2	593		593			0	593	490	0	0	0			0	0	0	-490	469	0		-593
3	2,779		2,779			0	2,779	2,088	0	0	0			0	0	0	-2,088	1,957	0		-2,779
4	2,871		2,871			0	2,871	1,961	0	0	0			0	0	0	-1,961	1,799	0		-2,871
5	3,040		3,040			0	3,040	1,888	0	0	0			0	0	0	-1,888	1,694	0		-3,040
6		503	503	97		97	600	339	1,980	0	1,980			0	1,980	1,117	779	298	982		1,379
7		1,391	1,391	97		97	1,488	764	1,980	0	1,980			0	1,980	1,016	252	657	873		491
8		1,445	1,445	97		97	1,542	719	1,980	0	1,980			0	1,980	923	204	605	777		437
9		1,536	1,536	97		97	1,633	693	1,980	0	1,980			0	1,980	840	147	570	691		346
10		227	227	97		97	324	125	1,980	0	1,980			0	1,980	763	638	101	615		1,655
11		243	243	97		97	340	119	1,980	0	1,980			0	1,980	694	575	94	547		1,639
12		260	260	97		97	357	114	1,980	0	1,980			0	1,980	631	517	88	487		1,622
13		280	280	97		97	377	109	1,980	0	1,980			0	1,980	573	464	83	433		1,602
14		301	301	97		97	398	105	1,980	0	1,980			0	1,980	521	416	78	385		1,581
15		324	324	97		97	421	101	1,980	0	1,980			0	1,980	474	373	73	343		1,558
16			0	97	65	162	162	35	0	2,223	2,223			0	2,223	484	448	25	342		2,061
17			0	97	65	162	162	32	0	2,223	2,223			0	2,223	440	408	22	305		2,061
18			0	97	65	162	162	29	0	2,223	2,223			0	2,223	400	371	20	271		2,061
19			0	97	65	162	162	27	0	2,223	2,223			0	2,223	363	337	18	241		2,061
20			0	97	65	162	162	24	0	2,223	2,223			0	2,223	330	306	16	215		2,061
21			0	97	65	162	162	22	0	2,223	2,223			0	2,223	300	278	14	191		2,061
22			0	97	65	162	162	20	0	2,223	2,223			0	2,223	273	253	12	170		2,061
23			0	97	65	162	162	18	0	2,223	2,223			0	2,223	248	230	11	151		2,061
24			0	97	65	162	162	16	0	2,223	2,223			0	2,223	226	209	10	134		2,061
25			0	97	65	162	162	15	0	2,223	2,223			0	2,223	205	190	9	120		2,061
26			0	97	65	162	162	14	0	2,223	2,223			0	2,223	187	173	8	106		2,061
27			0	97	65	162	162	12	0	2,223	2,223			0	2,223	170	157	7	95		2,061
28			0	97	65	162	162	11	0	2,223	2,223			0	2,223	154	143	6	84		2,061
29			0	97	65	162	162	10	0	2,223	2,223			0	2,223	140	130	5	75		2,061
30			0	97	65	162	162	9	0	2,223	2,223			0	2,223	127	118	5	67		2,061
31			0	97	65	162	162	8	0	2,223	2,223			0	2,223	116	107	4	59		2,061
32			0	97	65	162	162	8	0	2,223	2,223			0	2,223	105	98	4	53		2,061
33			0	97	65	162	162	7	0	2,223	2,223			0	2,223	96	89	3	47		2,061
34			0	97	65	162	162	6	0	2,223	2,223			0	2,223	87	81	3	42		2,061
35			0	97	65	162	162	6	0	2,223	2,223			0	2,223	79	73	3	37		2,061
36			0	97	65	162	162	5	0	2,223	2,223			0	2,223	72	67	2	33		2,061
37			0	97	65	162	162	5	0	2,223	2,223			0	2,223	65	61	2	29		2,061
38			0	97	65	162	162	4	0	2,223	2,223			0	2,223	59	55	2	26		2,061
39			0	97	65	162	162	4	0	2,223	2,223			0	2,223	54	50	2	23		2,061
40			0	97	65	162	162	4	0	2,223	2,223			0	2,223	49	46	2	21		2,061
41			0	97	65	162	162	3	0	2,223	2,223			0	2,223	45	41	1	18		2,061
42			0	97	65	162	162	3	0	2,223	2,223			0	2,223	41	38	1	16		2,061
43			0	97	65	162	162	3	0	2,223	2,223			0	2,223	37	34	1	15		2,061
44			0	97	65	162	162	2	0	2,223	2,223			0	2,223	34	31	1	13		2,061
45			0	97	65	162	162	2	0	2,223	2,223			0	2,223	30	28	1	12		2,061
46			0	97	65	162	162	2	0	2,223	2,223			0	2,223	28	26	1	10		2,061
47			0	97	65	162	162	2	0	2,223	2,223			0	2,223	25	23	1	9		2,061
48			0	97	65	162	162	2	0	2,223	2,223			0	2,223	23	21	1	8		2,061
49			0	97	65	162	162	2	0	2,223	2,223			0	2,223	21	19	1	7		2,061
50			0	97	65	162	162	1	0	2,223	2,223			0	2,223	19	18	0	6		2,061
	9,730	6,510					22,897	10,396							97,596	12,684	2,289	9,186	9,186	0.00	12.40%
		16,240																			

EIRR	12.40%
B-C	2289
B/C	1.22

Table H.4.5 (26) Cost Benefit Stream of Alternative Plan of Case 2 in Nilwala River Basin

River:	NILWALA	Short
Case:	2	

(Unit: Million Rs.)

Year	Cost								Benefit								B-C (NPV)	Cost Net Present Value	Benefit Net Present Value		EIRR Verification
	Costruction Cost			O&M			Grand Total	NPV	Flood Control			Power Generation			Grand Total	NPV					
	Short Term	Long Term	Total	Short Term	Long Term	Total			Short Term	Long Term	Total	Short Term	Long Term	Total							
1	447		447			0	447	406	0	0	0			0	0	0	-406	386	0		-447
2	593		593			0	593	490	0	0	0			0	0	0	-490	442	0		-593
3	2,779		2,779			0	2,779	2,088	0	0	0			0	0	0	-2,088	1,787	0		-2,779
4	2,871		2,871			0	2,871	1,961	0	0	0			0	0	0	-1,961	1,594	0		-2,871
5	3,070		3,070			0	3,070	1,906	0	0	0			0	0	0	-1,906	1,471	0		-3,070
6			0	98		98	98	55	1,980	0	1,980			0	1,980	1,117	1,062	40	819		1,882
7			0	98		98	98	50	1,980	0	1,980			0	1,980	1,016	966	35	707		1,882
8			0	98		98	98	46	1,980	0	1,980			0	1,980	923	878	30	610		1,882
9			0	98		98	98	41	1,980	0	1,980			0	1,980	840	798	26	526		1,882
10			0	98		98	98	38	1,980	0	1,980			0	1,980	763	726	22	454		1,882
11			0	98		98	98	34	1,980	0	1,980			0	1,980	694	660	19	392		1,882
12			0	98		98	98	31	1,980	0	1,980			0	1,980	631	600	17	339		1,882
13			0	98		98	98	28	1,980	0	1,980			0	1,980	573	545	14	292		1,882
14			0	98		98	98	26	1,980	0	1,980			0	1,980	521	496	12	252		1,882
15			0	98		98	98	23	1,980	0	1,980			0	1,980	474	451	11	218		1,882
16			0	98		98	98	21	1,980	0	1,980			0	1,980	431	410	9	188		1,882
17			0	98		98	98	19	1,980	0	1,980			0	1,980	392	372	8	162		1,882
18			0	98		98	98	18	1,980	0	1,980			0	1,980	356	338	7	140		1,882
19			0	98		98	98	16	1,980	0	1,980			0	1,980	324	308	6	121		1,882
20			0	98		98	98	15	1,980	0	1,980			0	1,980	294	280	5	104		1,882
21			0	98		98	98	13	1,980	0	1,980			0	1,980	267	254	4	90		1,882
22			0	98		98	98	12	1,980	0	1,980			0	1,980	243	231	4	78		1,882
23			0	98		98	98	11	1,980	0	1,980			0	1,980	221	210	3	67		1,882
24			0	98		98	98	10	1,980	0	1,980			0	1,980	201	191	3	58		1,882
25			0	98		98	98	9	1,980	0	1,980			0	1,980	183	174	2	50		1,882
26			0	98		98	98	8	1,980	0	1,980			0	1,980	166	158	2	43		1,882
27			0	98		98	98	7	1,980	0	1,980			0	1,980	151	144	2	37		1,882
28			0	98		98	98	7	1,980	0	1,980			0	1,980	137	130	2	32		1,882
29			0	98		98	98	6	1,980	0	1,980			0	1,980	125	119	1	28		1,882
30			0	98		98	98	6	1,980	0	1,980			0	1,980	113	108	1	24		1,882
31			0	98		98	98	5	1,980	0	1,980			0	1,980	103	98	1	21		1,882
32			0	98		98	98	5	1,980	0	1,980			0	1,980	94	89	1	18		1,882
33			0	98		98	98	4	1,980	0	1,980			0	1,980	85	81	1	15		1,882
34			0	98		98	98	4	1,980	0	1,980			0	1,980	77	74	1	13		1,882
35			0	98		98	98	3	1,980	0	1,980			0	1,980	70	67	1	11		1,882
36			0	98		98	98	3	1,980	0	1,980			0	1,980	64	61	0	10		1,882
37			0	98		98	98	3	1,980	0	1,980			0	1,980	58	55	0	9		1,882
38			0	98		98	98	3	1,980	0	1,980			0	1,980	53	50	0	7		1,882
39			0	98		98	98	2	1,980	0	1,980			0	1,980	48	46	0	6		1,882
40			0	98		98	98	2	1,980	0	1,980			0	1,980	44	42	0	5		1,882
41			0	98		98	98	2	1,980	0	1,980			0	1,980	40	38	0	5		1,882
42			0	98		98	98	2	1,980	0	1,980			0	1,980	36	34	0	4		1,882
43			0	98		98	98	2	1,980	0	1,980			0	1,980	33	31	0	4		1,882
44			0	98		98	98	1	1,980	0	1,980			0	1,980	30	28	0	3		1,882
45			0	98		98	98	1	1,980	0	1,980			0	1,980	27	26	0	3		1,882
46			0	98		98	98	1	1,980	0	1,980			0	1,980	25	23	0	2		1,882
47			0	98		98	98	1	1,980	0	1,980			0	1,980	22	21	0	2		1,882
48			0	98		98	98	1	1,980	0	1,980			0	1,980	20	19	0	2		1,882
49			0	98		98	98	1	1,980	0	1,980			0	1,980	19	18	0	1		1,882
50			0	98		98	98	1	1,980	0	1,980			0	1,980	17	16	0	1		1,882
	9,760	0					14,152	7,449							89,078	12,123	4,673	5,974	5,974	-0.02	15.85%
		9,760																			

EIRR	15.85%
B-C	4,673
B/C	1.63

Table H.4.5 (27) Cost Benefit Stream of Alternative Plan of Case 3 in Nilwala River Basin

River:	NILWALA	Overall
Case:	3	

(Unit: Million Rs.)

Year	Cost								Benefit								B-C (NPV)	Cost Net Present Value	Benefit Net Present Value		EIRR Verification
	Costruction Cost			O&M			Grand Total	NPV	Flood Control			Power Generation			Grand Total	NPV					
	Short Term	Long Term	Total	Short Term	Long Term	Total			Short Term	Long Term	Total	Short Term	Long Term	Total							
1	577		577			0	577	525	0	0	0			0	0	0	-525	549	0		-577
2	989		989			0	989	817	0	0	0			0	0	0	-817	894	0		-989
3	2,879		2,879			0	2,879	2,163	0	0	0			0	0	0	-2,163	2,473	0		-2,879
4	2,992		2,992			0	2,992	2,044	0	0	0			0	0	0	-2,044	2,444	0		-2,992
5	3,185		3,185			0	3,185	1,978	0	0	0			0	0	0	-1,978	2,473	0		-3,185
6		1,580	1,580	106		106	1,686	952	1,673	0	1,673			0	1,673	944	-7	1,245	1,235		-13
7		3,163	3,163	106		106	3,269	1,678	1,673	0	1,673			0	1,673	859	-819	2,294	1,174		-1,596
8		5,566	5,566	106		106	5,672	2,646	1,673	0	1,673			0	1,673	780	-1,866	3,783	1,116		-3,999
9		5,858	5,858	106		106	5,964	2,529	1,673	0	1,673			0	1,673	710	-1,820	3,782	1,061		-4,291
10		3,334	3,334	106		106	3,440	1,326	1,673	0	1,673			0	1,673	645	-681	2,074	1,008		-1,767
11		3,653	3,653	106		106	3,759	1,318	1,673	0	1,673			0	1,673	586	-731	2,154	959		-2,086
12		4,003	4,003	106		106	4,109	1,309	1,673	0	1,673			0	1,673	533	-776	2,238	911		-2,436
13		4,388	4,388	106		106	4,494	1,302	1,673	0	1,673			0	1,673	485	-817	2,327	866		-2,821
14		4,812	4,812	106		106	4,918	1,295	1,673	0	1,673			0	1,673	441	-855	2,421	824		-3,245
15		739	739	106		106	845	202	1,673	0	1,673			0	1,673	401	198	396	783		828
16			0	106	371	477	477	104	0	3,366	3,366			0	3,366	733	629	212	1,497		2,889
17			0	106	371	477	477	94	0	3,366	3,366			0	3,366	666	572	202	1,424		2,889
18			0	106	371	477	477	86	0	3,366	3,366			0	3,366	605	520	192	1,353		2,889
19			0	106	371	477	477	78	0	3,366	3,366			0	3,366	550	472	182	1,286		2,889
20			0	106	371	477	477	71	0	3,366	3,366			0	3,366	500	429	173	1,223		2,889
21			0	106	371	477	477	64	0	3,366	3,366			0	3,366	455	390	165	1,163		2,889
22			0	106	371	477	477	59	0	3,366	3,366			0	3,366	413	355	157	1,105		2,889
23			0	106	371	477	477	53	0	3,366	3,366			0	3,366	376	323	149	1,051		2,889
24			0	106	371	477	477	48	0	3,366	3,366			0	3,366	342	293	142	999		2,889
25			0	106	371	477	477	44	0	3,366	3,366			0	3,366	311	267	135	950		2,889
26			0	106	371	477	477	40	0	3,366	3,366			0	3,366	282	242	128	903		2,889
27			0	106	371	477	477	36	0	3,366	3,366			0	3,366	257	220	122	858		2,889
28			0	106	371	477	477	33	0	3,366	3,366			0	3,366	233	200	116	816		2,889
29			0	106	371	477	477	30	0	3,366	3,366			0	3,366	212	182	110	775		2,889
30			0	106	371	477	477	27	0	3,366	3,366			0	3,366	193	166	105	737		2,889
31			0	106	371	477	477	25	0	3,366	3,366			0	3,366	175	151	99	701		2,889
32			0	106	371	477	477	23	0	3,366	3,366			0	3,366	159	137	94	666		2,889
33			0	106	371	477	477	21	0	3,366	3,366			0	3,366	145	124	90	633		2,889
34			0	106	371	477	477	19	0	3,366	3,366			0	3,366	132	113	85	602		2,889
35			0	106	371	477	477	17	0	3,366	3,366			0	3,366	120	103	81	572		2,889
36			0	106	371	477	477	15	0	3,366	3,366			0	3,366	109	93	77	544		2,889
37			0	106	371	477	477	14	0	3,366	3,366			0	3,366	99	85	73	517		2,889
38			0	106	371	477	477	13	0	3,366	3,366			0	3,366	90	77	70	492		2,889
39			0	106	371	477	477	12	0	3,366	3,366			0	3,366	82	70	66	467		2,889
40			0	106	371	477	477	11	0	3,366	3,366			0	3,366	74	64	63	444		2,889
41			0	106	371	477	477	10	0	3,366	3,366			0	3,366	68	58	60	422		2,889
42			0	106	371	477	477	9	0	3,366	3,366			0	3,366	61	53	57	402		2,889
43			0	106	371	477	477	8	0	3,366	3,366			0	3,366	56	48	54	382		2,889
44			0	106	371	477	477	7	0	3,366	3,366			0	3,366	51	44	51	363		2,889
45			0	106	371	477	477	7	0	3,366	3,366			0	3,366	46	40	49	345		2,889
46			0	106	371	477	477	6	0	3,366	3,366			0	3,366	42	36	46	328		2,889
47			0	106	371	477	477	5	0	3,366	3,366			0	3,366	38	33	44	312		2,889
48			0	106	371	477	477	5	0	3,366	3,366			0	3,366	35	30	42	296		2,889
49			0	106	371	477	477	4	0	3,366	3,366			0	3,366	32	27	40	282		2,889
50			0	106	371	477	477	4	0	3,366	3,366			0	3,366	29	25	38	268		2,889
	10,622	37,096					65,482	23,185							134,540	14,154	-9,031	35,115	35,115	0.01	5.19%
		47,718																			

EIRR	5.19%
B-C	-9,031
B/C	0.61

Table H.4.5 (28) Cost Benefit Stream of Alternative Plan of Case 3 in Nilwala River Basin

River:	NILWALA	Short
Case:	3	

(Unit: Million Rs.)

Year	Cost								Benefit								B-C (NPV)	Cost Net Present Value	Benefit Net Present Value		EIRR Verification
	Costruction Cost			O&M			Grand Total	NPV	Flood Control			Power Generation			Grand Total	NPV					
	Short Term	Long Term	Total	Short Term	Long Term	Total			Short Term	Long Term	Total	Short Term	Long Term	Total							
1	577		577			0	577	525	0	0	0			0	0	0	-525	513	0		-577
2	989		989			0	989	817	0	0	0			0	0	0	-817	782	0		-989
3	2,879		2,879			0	2,879	2,163	0	0	0			0	0	0	-2,163	2,025	0		-2,879
4	2,992		2,992			0	2,992	2,044	0	0	0			0	0	0	-2,044	1,871	0		-2,992
5	3,185		3,185			0	3,185	1,978	0	0	0			0	0	0	-1,978	1,771	0		-3,185
6			0	106		106	106	60	1,673	0	1,673			0	1,673	944	884	53	827		1,567
7			0	106		106	106	55	1,673	0	1,673			0	1,673	859	804	47	736		1,567
8			0	106		106	106	50	1,673	0	1,673			0	1,673	780	731	42	654		1,567
9			0	106		106	106	45	1,673	0	1,673			0	1,673	710	664	37	582		1,567
10			0	106		106	106	41	1,673	0	1,673			0	1,673	645	604	33	517		1,567
11			0	106		106	106	37	1,673	0	1,673			0	1,673	586	549	29	460		1,567
12			0	106		106	106	34	1,673	0	1,673			0	1,673	533	499	26	409		1,567
13			0	106		106	106	31	1,673	0	1,673			0	1,673	485	454	23	364		1,567
14			0	106		106	106	28	1,673	0	1,673			0	1,673	441	413	21	324		1,567
15			0	106		106	106	25	1,673	0	1,673			0	1,673	401	375	18	288		1,567
16			0	106		106	106	23	1,673	0	1,673			0	1,673	364	341	16	256		1,567
17			0	106		106	106	21	1,673	0	1,673			0	1,673	331	310	14	228		1,567
18			0	106		106	106	19	1,673	0	1,673			0	1,673	301	282	13	202		1,567
19			0	106		106	106	17	1,673	0	1,673			0	1,673	274	256	11	180		1,567
20			0	106		106	106	16	1,673	0	1,673			0	1,673	249	233	10	160		1,567
21			0	106		106	106	14	1,673	0	1,673			0	1,673	226	212	9	142		1,567
22			0	106		106	106	13	1,673	0	1,673			0	1,673	206	192	8	127		1,567
23			0	106		106	106	12	1,673	0	1,673			0	1,673	187	175	7	113		1,567
24			0	106		106	106	11	1,673	0	1,673			0	1,673	170	159	6	100		1,567
25			0	106		106	106	10	1,673	0	1,673			0	1,673	154	145	6	89		1,567
26			0	106		106	106	9	1,673	0	1,673			0	1,673	140	131	5	79		1,567
27			0	106		106	106	8	1,673	0	1,673			0	1,673	128	120	4	70		1,567
28			0	106		106	106	7	1,673	0	1,673			0	1,673	116	109	4	63		1,567
29			0	106		106	106	7	1,673	0	1,673			0	1,673	105	99	4	56		1,567
30			0	106		106	106	6	1,673	0	1,673			0	1,673	96	90	3	49		1,567
31			0	106		106	106	6	1,673	0	1,673			0	1,673	87	82	3	44		1,567
32			0	106		106	106	5	1,673	0	1,673			0	1,673	79	74	2	39		1,567
33			0	106		106	106	5	1,673	0	1,673			0	1,673	72	67	2	35		1,567
34			0	106		106	106	4	1,673	0	1,673			0	1,673	65	61	2	31		1,567
35			0	106		106	106	4	1,673	0	1,673			0	1,673	60	56	2	28		1,567
36			0	106		106	106	3	1,673	0	1,673			0	1,673	54	51	2	24		1,567
37			0	106		106	106	3	1,673	0	1,673			0	1,673	49	46	1	22		1,567
38			0	106		106	106	3	1,673	0	1,673			0	1,673	45	42	1	19		1,567
39			0	106		106	106	3	1,673	0	1,673			0	1,673	41	38	1	17		1,567
40			0	106		106	106	2	1,673	0	1,673			0	1,673	37	35	1	15		1,567
41			0	106		106	106	2	1,673	0	1,673			0	1,673	34	31	1	14		1,567
42			0	106		106	106	2	1,673	0	1,673			0	1,673	31	29	1	12		1,567
43			0	106		106	106	2	1,673	0	1,673			0	1,673	28	26	1	11		1,567
44			0	106		106	106	2	1,673	0	1,673			0	1,673	25	24	1	10		1,567
45			0	106		106	106	1	1,673	0	1,673			0	1,673	23	21	1	9		1,567
46			0	106		106	106	1	1,673	0	1,673			0	1,673	21	20	0	8		1,567
47			0	106		106	106	1	1,673	0	1,673			0	1,673	19	18	0	7		1,567
48			0	106		106	106	1	1,673	0	1,673			0	1,673	17	16	0	6		1,567
49			0	106		106	106	1	1,673	0	1,673			0	1,673	16	15	0	5		1,567
50			0	106		106	106	1	1,673	0	1,673			0	1,673	14	13	0	5		1,567
	10,622	0					15,402	8,177							75,285	10,245	2,069	7,434	7,434	0.00	12.45%
		10,622																			

EIRR	12.45%
B-C	2,069
B/C	1.25

Table H.4.5 (29) Cost Benefit Stream of Alternative Plan of Case 4 in Nilwala River Basin

River:	NILWALA	Overall
Case:	4	

(Unit: Million Rs.)

Year	Cost								Benefit								B-C (NPV)	Cost Net Present Value	Benefit Net Present Value		EIRR Verification
	Costruction Cost			O&M			Grand Total	NPV	Flood Control			Power Generation			Grand Total	NPV					
	Short Term	Long Term	Total	Short Term	Long Term	Total			Short Term	Long Term	Total	Short Term	Long Term	Total							
1	560		560			0	560	509	0	0	0			0	0	0	-509	525	0		-560
2	916		916			0	916	757	0	0	0			0	0	0	-757	806	0		-916
3	2,923		2,923			0	2,923	2,196	0	0	0			0	0	0	-2,196	2,412	0		-2,923
4	3,033		3,033			0	3,033	2,072	0	0	0			0	0	0	-2,072	2,347	0		-3,033
5	3,224		3,224			0	3,224	2,002	0	0	0			0	0	0	-2,002	2,340	0		-3,224
6		1,332	1,332	107		107	1,439	812	1,980	0	1,980			0	1,980	1,117	305	979	1,348		541
7		3,460	3,460	107		107	3,567	1,830	1,980	0	1,980			0	1,980	1,016	-814	2,277	1,264		-1,587
8		4,561	4,561	107		107	4,668	2,177	1,980	0	1,980			0	1,980	923	-1,254	2,795	1,186		-2,688
9		4,805	4,805	107		107	4,912	2,083	1,980	0	1,980			0	1,980	840	-1,243	2,759	1,112		-2,932
10		3,903	3,903	107		107	4,010	1,546	1,980	0	1,980			0	1,980	763	-783	2,113	1,043		-2,030
11		4,280	4,280	107		107	4,387	1,537	1,980	0	1,980			0	1,980	694	-844	2,168	978		-2,407
12		4,695	4,695	107		107	4,802	1,530	1,980	0	1,980			0	1,980	631	-899	2,225	917		-2,822
13		564	564	107		107	671	194	1,980	0	1,980			0	1,980	573	379	292	861		1,309
14		607	607	107		107	714	188	1,980	0	1,980			0	1,980	521	333	291	807		1,266
15		654	654	107		107	761	182	1,980	0	1,980			0	1,980	474	292	291	757		1,219
16			0	107	289	395	395	86	0	3,173	3,173			0	3,173	691	605	142	1,138		2,778
17			0	107	289	395	395	78	0	3,173	3,173			0	3,173	628	550	133	1,067		2,778
18			0	107	289	395	395	71	0	3,173	3,173			0	3,173	571	500	125	1,001		2,778
19			0	107	289	395	395	65	0	3,173	3,173			0	3,173	519	454	117	939		2,778
20			0	107	289	395	395	59	0	3,173	3,173			0	3,173	472	413	110	881		2,778
21			0	107	289	395	395	53	0	3,173	3,173			0	3,173	429	375	103	826		2,778
22			0	107	289	395	395	49	0	3,173	3,173			0	3,173	390	341	97	775		2,778
23			0	107	289	395	395	44	0	3,173	3,173			0	3,173	354	310	91	727		2,778
24			0	107	289	395	395	40	0	3,173	3,173			0	3,173	322	282	85	682		2,778
25			0	107	289	395	395	36	0	3,173	3,173			0	3,173	293	256	80	639		2,778
26			0	107	289	395	395	33	0	3,173	3,173			0	3,173	266	233	75	600		2,778
27			0	107	289	395	395	30	0	3,173	3,173			0	3,173	242	212	70	562		2,778
28			0	107	289	395	395	27	0	3,173	3,173			0	3,173	220	193	66	528		2,778
29			0	107	289	395	395	25	0	3,173	3,173			0	3,173	200	175	62	495		2,778
30			0	107	289	395	395	23	0	3,173	3,173			0	3,173	182	159	58	464		2,778
31			0	107	289	395	395	21	0	3,173	3,173			0	3,173	165	145	54	435		2,778
32			0	107	289	395	395	19	0	3,173	3,173			0	3,173	150	132	51	408		2,778
33			0	107	289	395	395	17	0	3,173	3,173			0	3,173	137	120	48	383		2,778
34			0	107	289	395	395	15	0	3,173	3,173			0	3,173	124	109	45	359		2,778
35			0	107	289	395	395	14	0	3,173	3,173			0	3,173	113	99	42	337		2,778
36			0	107	289	395	395	13	0	3,173	3,173			0	3,173	103	90	39	316		2,778
37			0	107	289	395	395	12	0	3,173	3,173			0	3,173	93	82	37	296		2,778
38			0	107	289	395	395	11	0	3,173	3,173			0	3,173	85	74	35	278		2,778
39			0	107	289	395	395	10	0	3,173	3,173			0	3,173	77	68	32	261		2,778
40			0	107	289	395	395	9	0	3,173	3,173			0	3,173	70	61	30	244		2,778
41			0	107	289	395	395	8	0	3,173	3,173			0	3,173	64	56	29	229		2,778
42			0	107	289	395	395	7	0	3,173	3,173			0	3,173	58	51	27	215		2,778
43			0	107	289	395	395	7	0	3,173	3,173			0	3,173	53	46	25	202		2,778
44			0	107	289	395	395	6	0	3,173	3,173			0	3,173	48	42	24	189		2,778
45			0	107	289	395	395	5	0	3,173	3,173			0	3,173	44	38	22	177		2,778
46			0	107	289	395	395	5	0	3,173	3,173			0	3,173	40	35	21	166		2,778
47			0	107	289	395	395	4	0	3,173	3,173			0	3,173	36	31	19	156		2,778
48			0	107	289	395	395	4	0	3,173	3,173			0	3,173	33	29	18	146		2,778
49			0	107	289	395	395	4	0	3,173	3,173			0	3,173	30	26	17	137		2,778
50			0	107	289	395	395	3	0	3,173	3,173			0	3,173	27	24	16	129		2,778
	10,656	28,861					54,414	20,528							130,847	14,878	-5,650	26,662	26,662	0.00	6.62%
		39,517																			

EIRR	6.62%
B-C	-5,650
B/C	0.72

Supporting Report I

Established Systems in Pilot Project

Supporting Report I Established Systems in Pilot Project

I.1 Hydrological Information System

Systems established in Pilot Project are mainly composed of Hydrological Information System and Intra-Governmental Network.

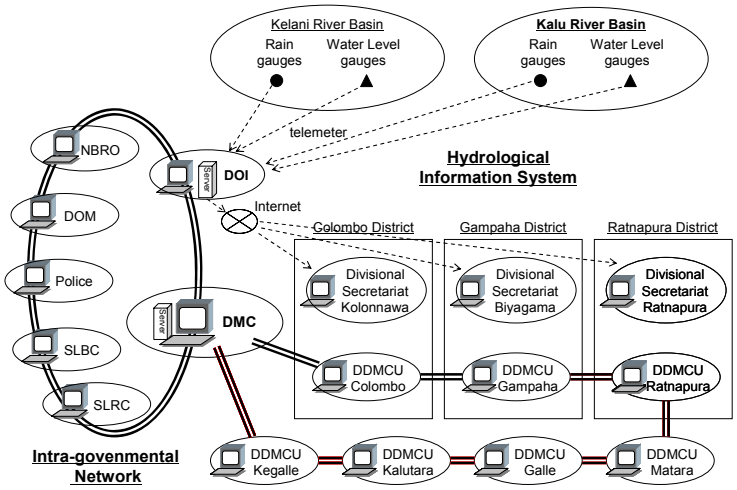


Figure I.1.1 Relation of Hydrological Information System and Intra-Governmental Network

I.1.1 General

The Hydrological Information System is consisted of the following two systems: 1) Monitoring Equipment and Data Collecting System, and 2) Database and Data Display System.

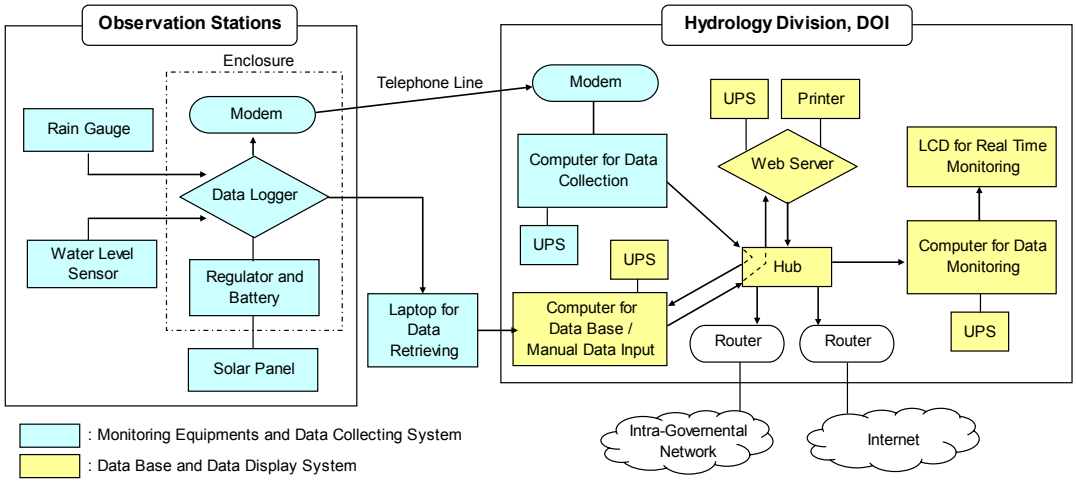


Figure I.1.2 System Diagram of Hydrological Information System

I.1.2 Monitoring Equipment and Data Collecting System

The pilot project automated the following observation stations in Kelani and Kalu river basin and the observed data at some of the most important stations are transferred to the hydrology division by telemeter system.

Table I.1.1 Selected Gauging Stations

River Basin	Name of gauging station	Rain gauge	Water level gauge	Telemeter
Kelani	Nagalagam St.	—	○	○
	Hanwella	○	○	○
	Glencourse	△	○	—
	Kitulgala	○	△	—
	Dompe	○	—	—
	Meegoda	○	—	○
	Holombuwa	○	○	○
	Deraniyagala	○*	○	○
Kalu	Putupaula	—	○	○
	Ellagawa	—	○	○
	Ratnapura	—	△	○
	Dela	—	○	—
	Malwala	—	○	—
	Hapugastenna	○	—	○

○: installed by Pilot Project, △: existing, —: not installed, *: will be installed (location is not decided)

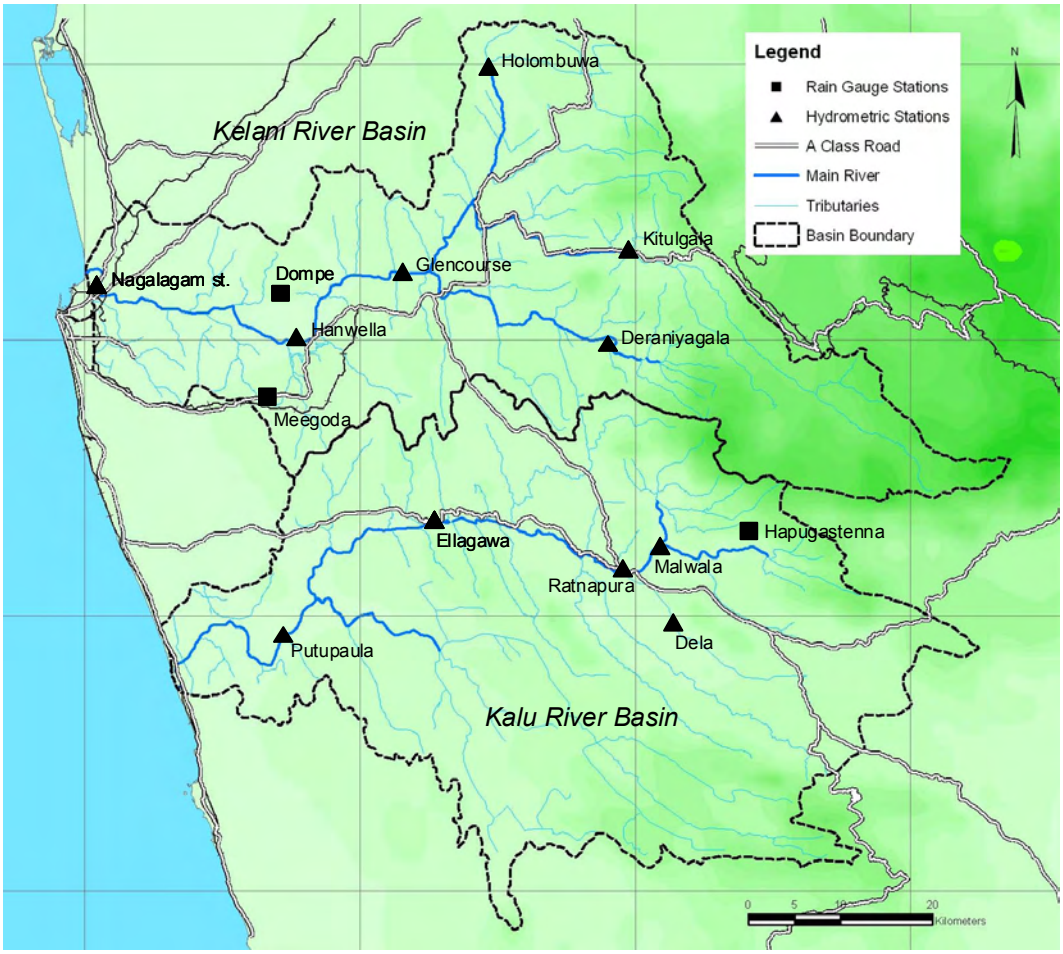
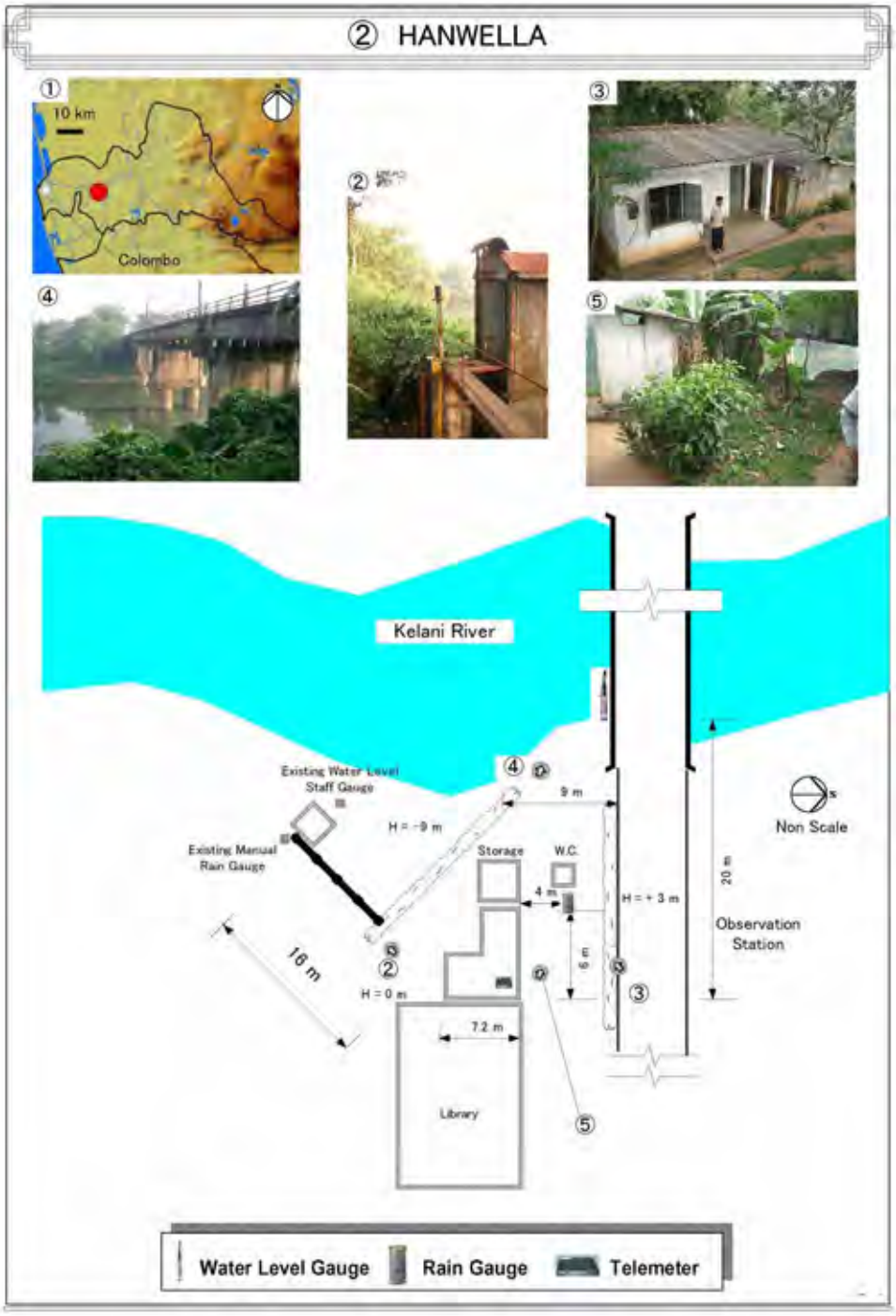


Figure I.1.3 Location of Observation Stations

(1) Nagalagam st.

(2) Hanwella

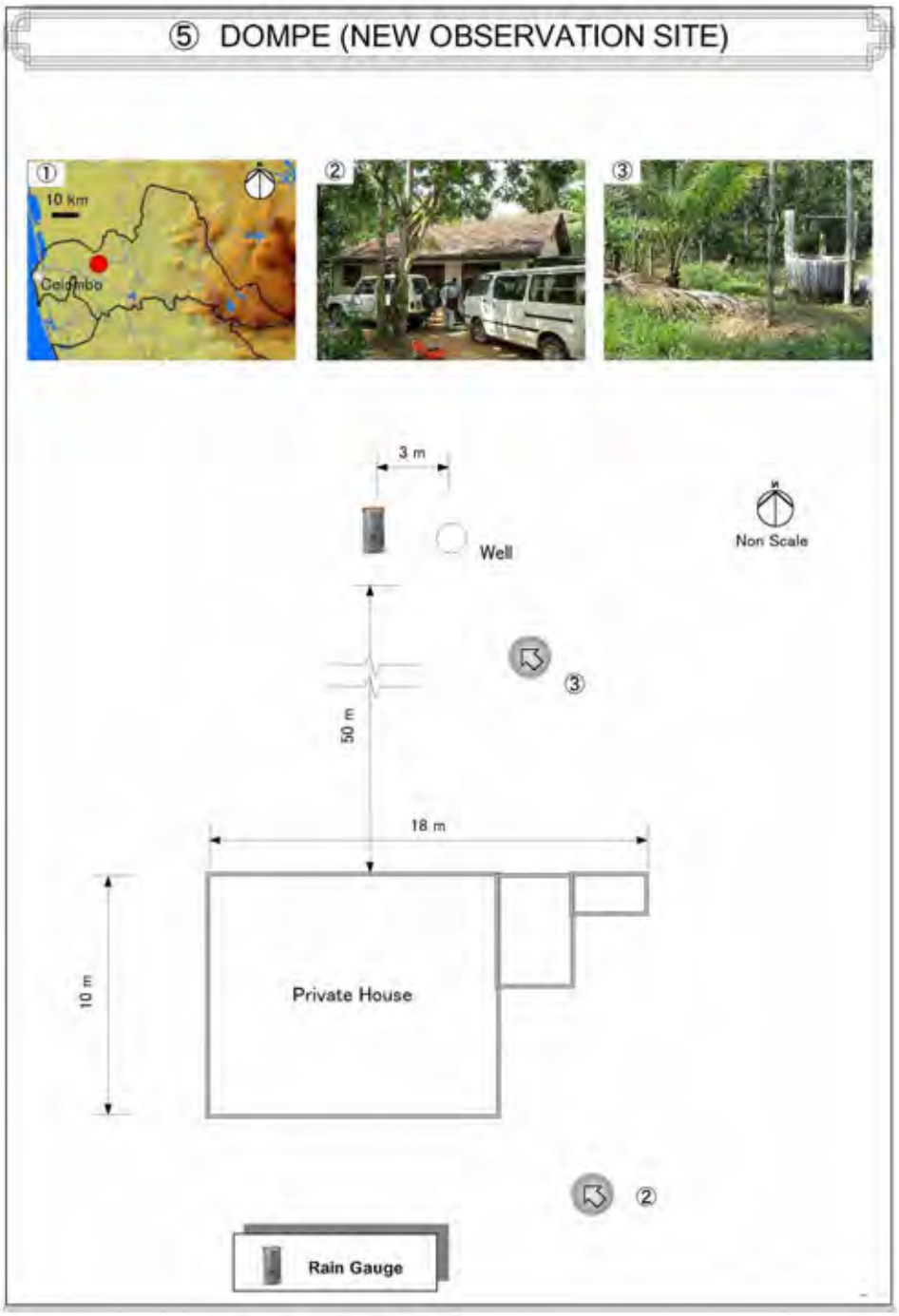

② HANWELLA
①
10 km
Colombo
②
③
④
⑤
Kelani River
Existing Water Level Staff Gauge
Existing Manual Rain Gauge
H = -9 m
9 m
Storage
W.C.
4 m
H = + 3 m
20 m
Observation Station
Non Scale
16 m
H = 0 m
7.2 m
Library
Water Level Gauge
Rain Gauge
Telemeter

(3) Glencourse

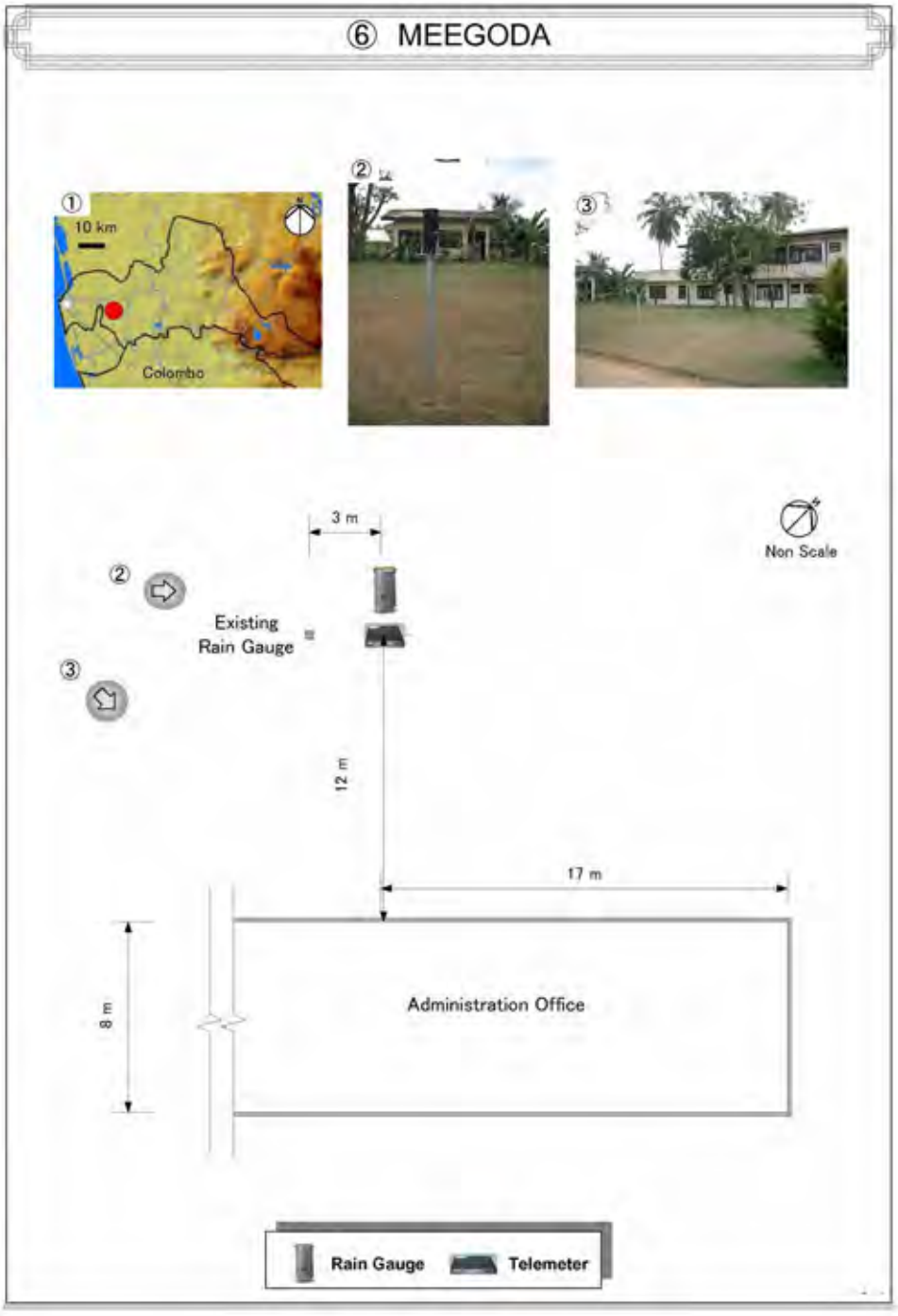
(4) Kitulgala


④ KITULGALA
① 10 km
Colombo
②
③
④
⑤
⑥
Kelani River
Non Scale
Suspension Bridge
⑥
Existing Water Level Staff Gauge
②
Existing Automatic Water Level Gauge
⑤
Water Flow Observation Station
Existing Manual Rain Gauge
12 m
④ Observation Station
Existing Self-recording Rain Gauge
Storage
③
25 m
Rain Gauge
Observation Site
Existing Manual Rain Gauge
8m
4.5m
Existing Self recording Rain Gauge
2 m
4.5 m

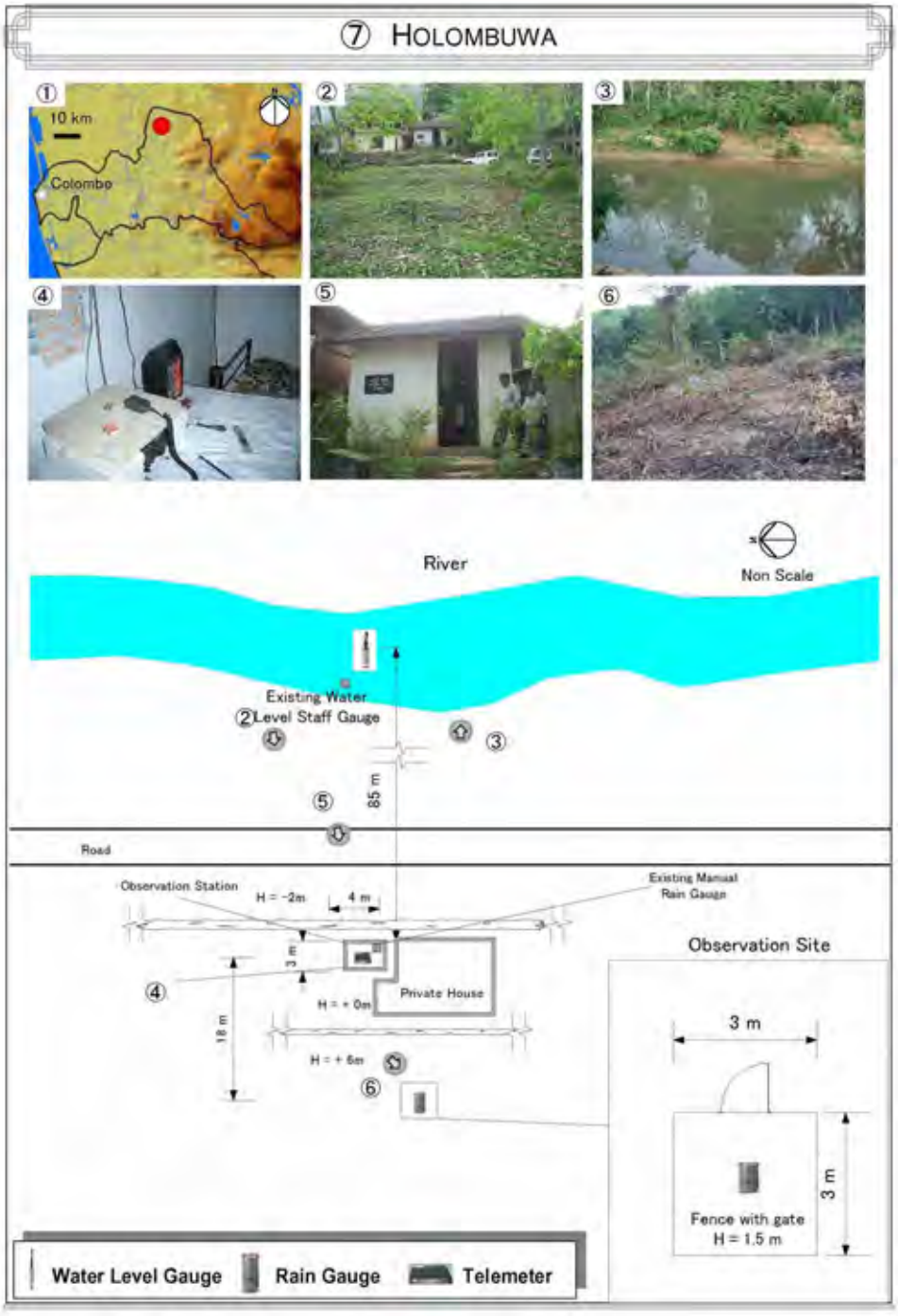
(5) Dompe


⑤ DOMPE (NEW OBSERVATION SITE)
①
10 km
Colombo
②
③
3 m
Well
Non Scale
③
50 m
18 m
10 m
Private House
②
Rain Gauge

(6) Meegoda

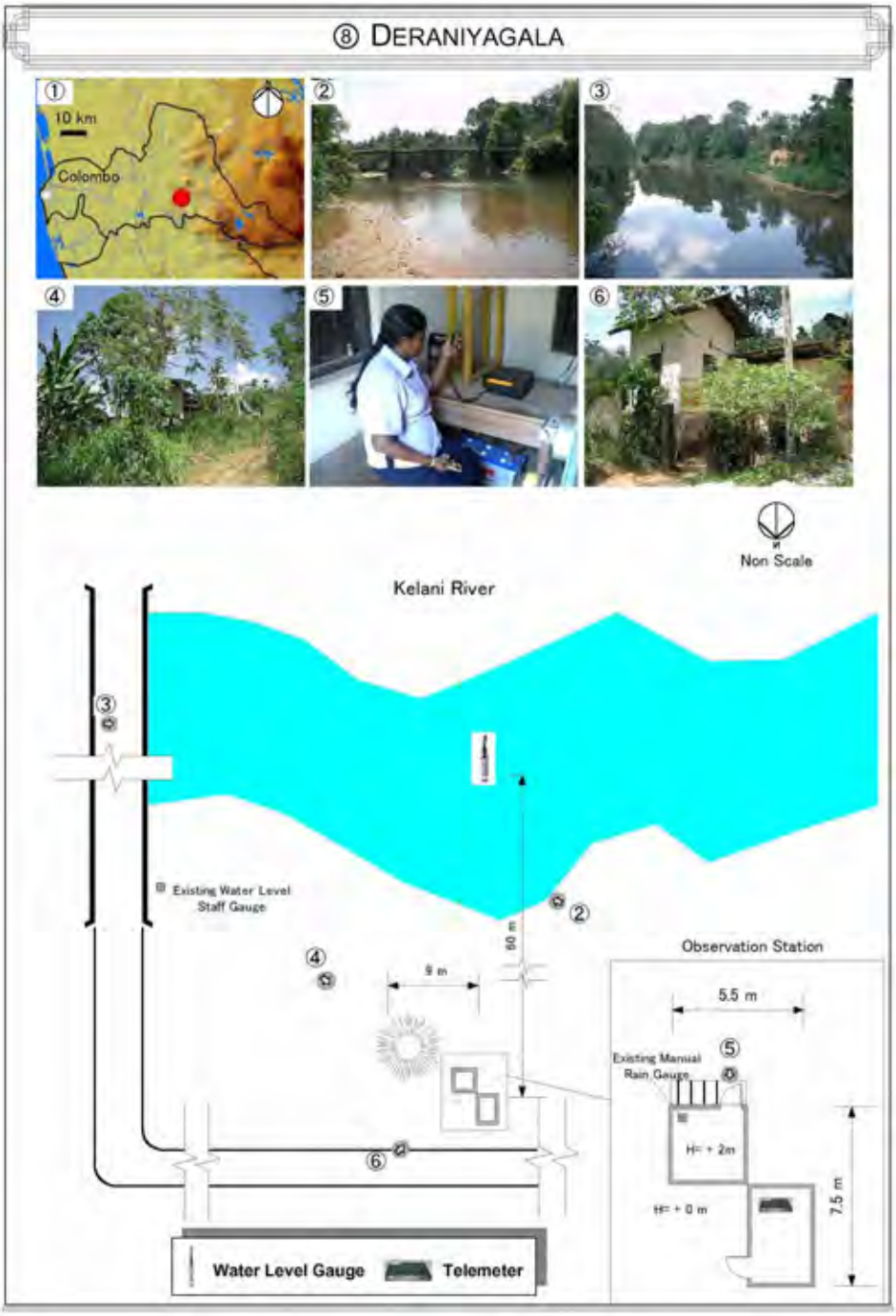

⑥ MEEGODA
①
10 km
Colombo
②
③
3 m
Non Scale
②
Existing
Rain Gauge
③
12 m
17 m
8 m
Administration Office
Rain Gauge
Telemeter

(7) Holombuwa


⑦ HOLOMBUWA
①
10 km
Colombo
②
③
④
⑤
⑥
River
Non Scale
Existing Water
②Level Staff Gauge
③
⑤
85 m
Road
Observation Station
H = -2m
4 m
Existing Manual
Rain Gauge
Observation Site
E
m
④
Private House
H = + 0m
18 m
H = + 6m
⑥
3 m
3 m
Fence with gate
H = 1.5 m
Water Level Gauge
Rain Gauge
Telemeter


JAPAN

(8) Deraniyagala



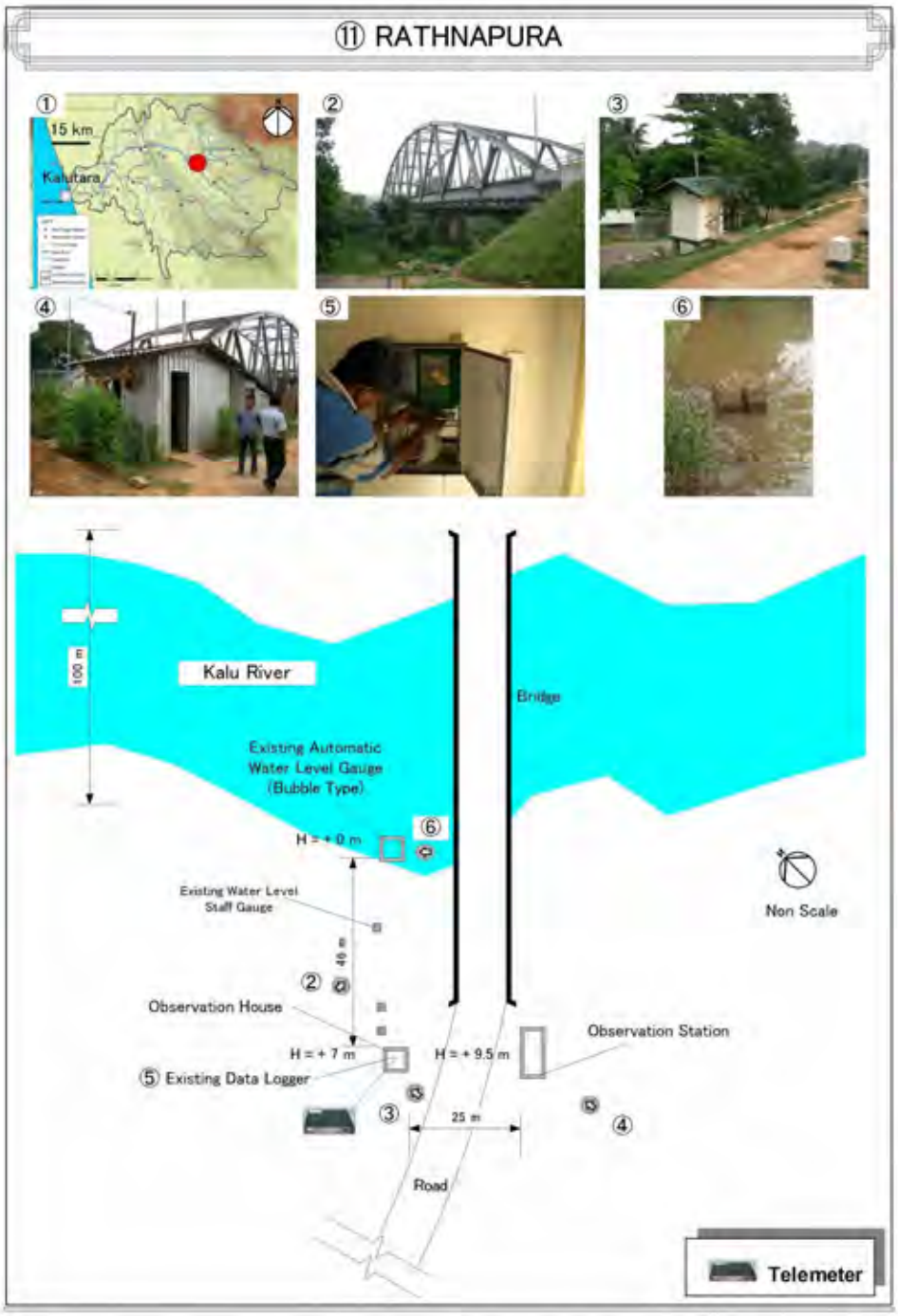
(9) Putupaula


⑨ PUTUPAULA
15 km
Kalutara
Kalu River
90 m
25 m
10 m
Existing Water
Level Staff Gauge
Existing Water
Level Gauge
(Float Type)
Well
Non Scale
Private House
Road
Water Level
Gauge
Telemeter

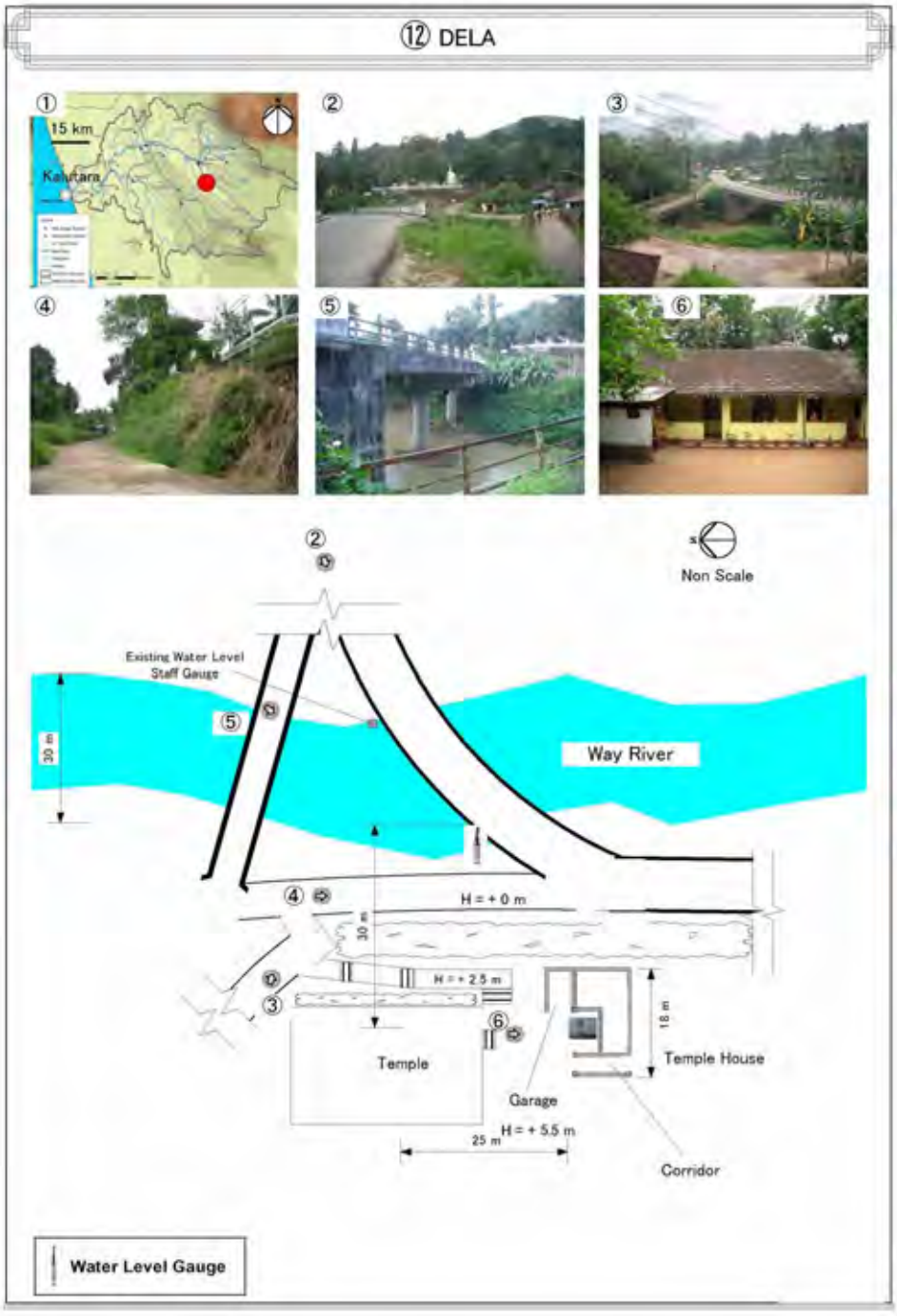
(10) Ellagawa


⑩ ELLAGAWA
①
15 km
Kalutara
②
③
④
⑤
⑥
Kalu River
55 m
Existing Water Level
Staff Gauge
H = + 0 m
Non Scale
30 m
Observation Station
6 m
3 m
3 m
H = + 9.5 m
7.5 m
Water Level Gauge
Telemeter

(11) Ratnapura



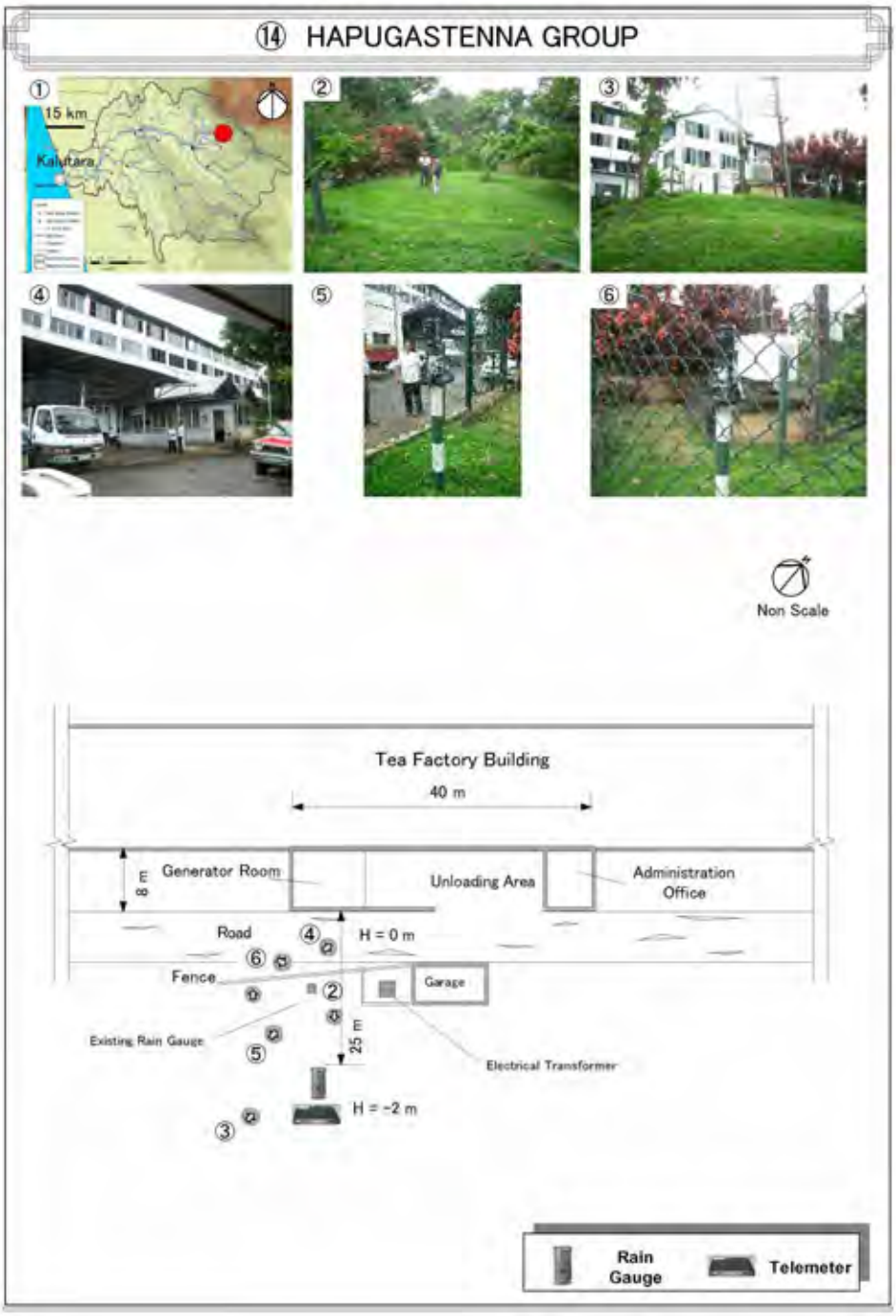
(12) Dela


⑫ DELA
①
15 km
Kalutara
②
③
④
⑤
⑥
Non Scale
Existing Water Level
Staff Gauge
30 m
Way River
H = + 0 m
H = + 2.5 m
Temple
18 m
Temple House
Garage
H = + 5.5 m
25 m
Corridor
Water Level Gauge

(13) Malwala


⑬ MALWALA
①
15 km
Kalutara
②
③
④
⑤
⑥
Kalu River
50 m
15 m
H = + 0 m
Existing Water Level
Staff Gauge
Non Scale
90 m
Private Station
H = + 15 m
9.5 m
Water Level
Gauge

(14) Hapugastenna



I.1.3 Database and Data Display System

In the pilot project, collected data by telemeter system is saved in the database, and tables and graphs are created and shown on the screen. The tables and graphs are also shown on the wide screen so that all the officers in the hydrology division can monitor the current situation.

Figure I.1.4 Installed Equipments at Hydrology Division, DOI

Figure I.1.5 Monitoring Screen of Hydrological Information System

I.2 Intra-Governmental Network

I.2.1 Summary of Intra-Governmental Network

Intra-Governmental Network was installed to connect relevant 14 organizations through a dedicated line so that government officers of the concerned organizations can easily communicate whenever necessary. The connected organizations are; DMC, DOI, DOM, NBRO, Police, Media (SLBC and SLRC),and DDMCU (Colombo, Gampaha, Kegalle, Ratnapura, Kalutara, Galle and Matara).

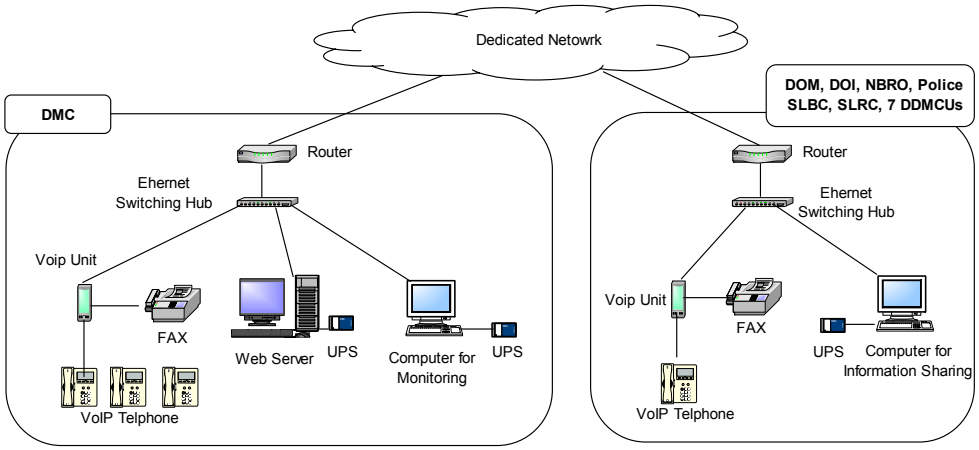
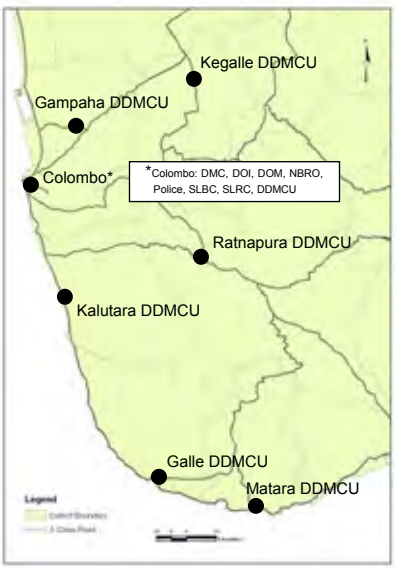


Figure I.2.1 System Diagram of Intra-Governmental Network

Each organization was provided a personal computer, telephone and fax to be linked to this network. Normal communication using telephone and fax, and information sharing through a web server at the DMC is made possible by this network. Commercial dedicated communication line by radio system called "Wimax" was selected for Intra-Governmental Network.



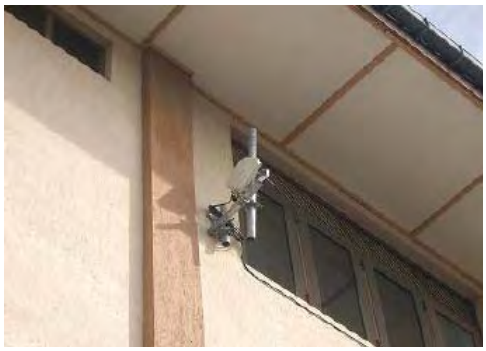
Organization	Telephone	Fax
DMC	101,102,103	201
DOI	201	202
DOM	301	302
NBRO	401	402
Police	501	502
SLRC	601	602
SLBC	701	702
DDMCU Colombo	801	802
DDMCU Gampaha	901	902
DDMCU Kegalle	931	932
DDMCU Ratnapura	941	942
DDMCU Kalutara	921	922
DDMCU Galle	951	952
DDMCU Matara	911	912

Figure I.2.2 Location Map and Telephone/Fax Number

(1) DMC

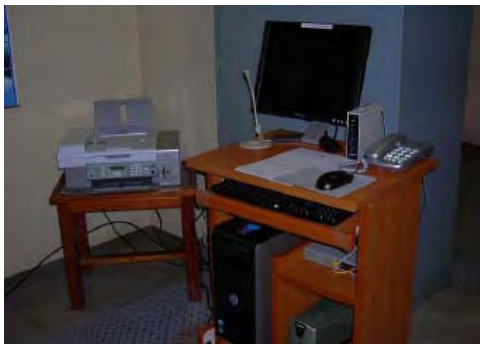

(2) DOI


(3) DOM




(4) NBRO

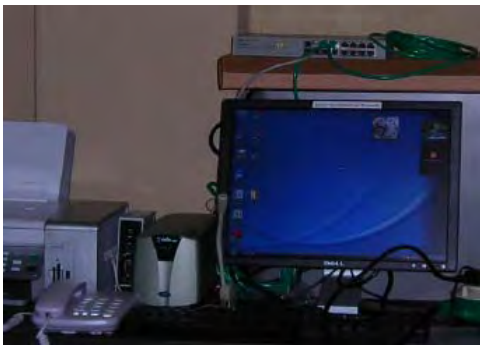

(5) SLRC




(6) SLBC


(7) DDMCU Colombo

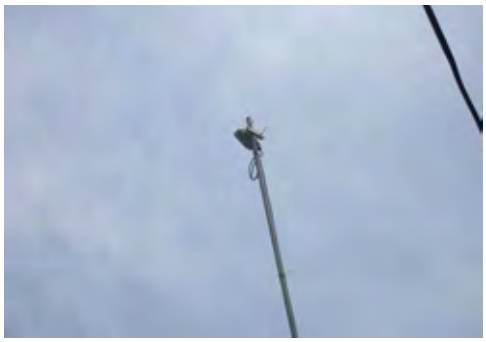

(8) DDMCU Gampaha

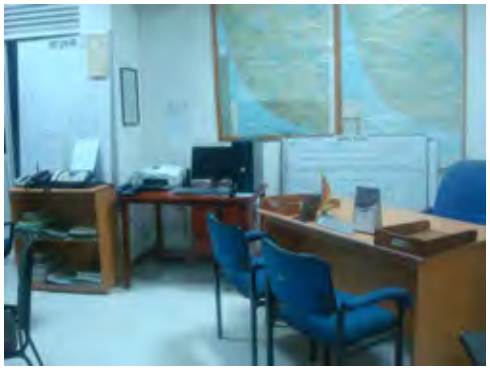
(9) DDMCU Kegalle


(10) DDMCU Ratnapura


(11) DDMCU Kalutara




(12) DDMCU Galle




(13) DDMCU Matara

(14) Police (Taking photo is not allowed)

I.2.2 Utilization of Intra-Governmental Network

It is possible to communicate each other during emergency period without congestion because of dedicated line. This is the best advantage of Intra-Governmental Network. Another advantage is that because of the fixed price contract with communication company, stable budget planning is possible. And information can be shared easily among related organizations by utilizing "notice board" or "share folder". If warning message or evacuation instruction is uploaded to the notice board, this message can be shared by all the organizations at once. Large size files such as photo of disaster or inundation condition can be shared smoothly and easily by utilizing share folder.

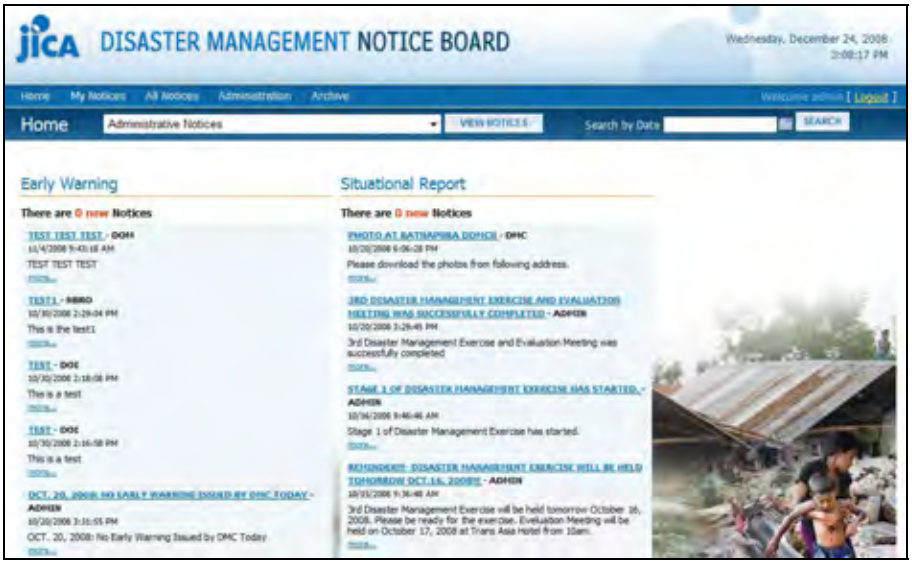


Figure I.2.3 First Page of Notice Board

And, Hydrological Information System can be monitored through Intra-Governmental Network. It serves many uses for provision of information by each organization.

I.3 Recommendation of Methods to Disseminate Information to People

I.3.1 Information Dissemination by Internet

Anybody can monitor the data by uploading the Hydrological Information System to web site. PC and ADSL line were provided to DS office to monitor the system through internet. Because DS office has an important role to disseminate information to GN and people.

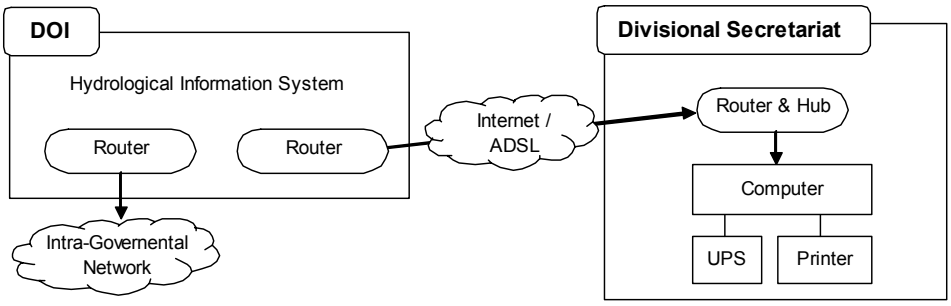


Figure I.3.1 System Diagram of Information Transfer through Internet

PC and ADSL line were provided to 3 DS offices such as Kollonawa and Biyagama (Kelani river basin), and Ratnapura (Kalu river basin).

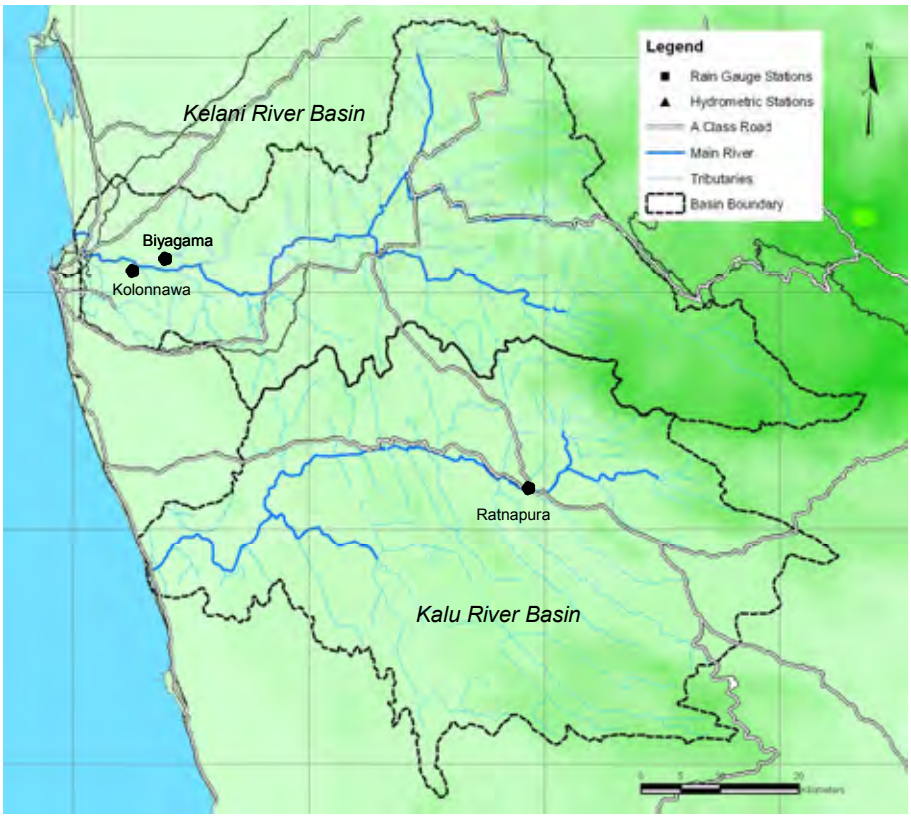


Figure I.3.2 Location Map of Selected DS Office

I.3.2 Information Dissemination by Car Mount Type Loud Speaker

DS office has a role to disseminate information, that is obtained through DDMCU or Internet, to people through GN. In addition to this, car mount type loud speaker is provided as a tool to disseminate information directly to people.

I.3.3 Photos at DS Offices

(1) Kolonnawa DS


(2) Biyagama DS


(3) Ratnapura DS


Supporting Report J

Warning Criteria and Warning Message

Supporting Report J Warning Criteria and Content of Warning Message

J.1 General

In the main report, the methods to define the warning criteria for slow flood, fast flood and landslide are briefly explained. Concrete methods to define the warning criteria for flood in Kelani as the example of slow flood and for flood in Ratnapura as the example of fast flood are explained as follows. Explanation of method for sediment disaster is also shown.

Regarding the contents of warning message, although the necessary items are shown in the main report, sample messages for flood, landslide and tsunami are shown in this chapter.

J.2 Warning Criteria for Downstream of Kelani River

J.2.1 General

It is considered necessary that the technical benchmark for alert, warning and evacuation instruction should be objective and understandable. In particular, the technical benchmark for evacuation instruction should be easily understood by the local government officers as well as local residents since they have the responsibility for the issuance of evacuation instruction. There are many cases in Japan that the local government hesitates to issue evacuation instruction in advance or issues it after disaster happens, because the local government is afraid of making a mistake. This is because the benchmark is not clear.

Based on the "Standing Order" in Kelani River, when a 24-hour rainfall exceeds 125mm, DOI discusses the possibility of minor flood by checking the water level in the basin. And in case the DOI is convinced of the imminent minor flood situation, warning is issued to the people living in the low-lying areas immediately, with the least possible delay, through the media, police and local government. Although it may be possible to respond in time since the flood concentration time is long in Kelani river, it is very important to set up several technical benchmarks and to define the activities depending on the benchmarks from the point of risk management. In this report, the Study Team has studied what kind of the warning level can be defined for Kelani River.

J.2.2 Correlation Analysis

(1) Target Water Level

Location of main monitoring stations in Kelani is shown below. The correlation analysis of three monitoring stations, Glencourse, Hanwella and Nagalagam St., those are at the downstream of confluence of main river and two tributaries, was conducted. The target water level for flood forecasting is the water level by that level the inundation occurs around Colombo at first. This water level is 5 feet at Nagalagam St. gauging station. (Regarding the water level 5 feet, there is a report saying that inundation occurs below this water level in the actual situation. Therefore, target water level can be modified according to further study.)

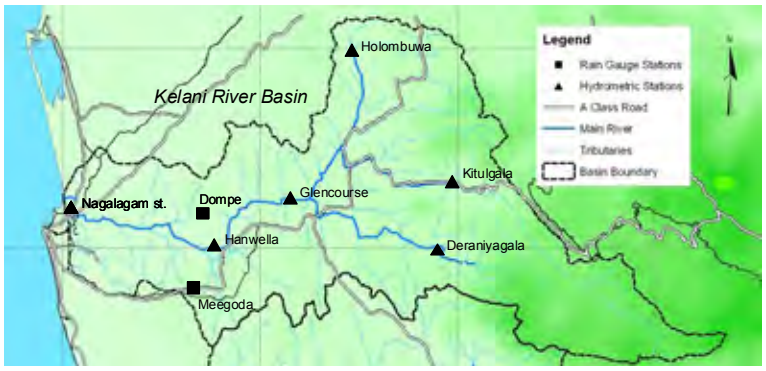


Figure J.2.1 Location of Gauging Stations in Kelani River Basin

(2) Correlation Analysis

The table below shows the annual maximum water level after 1985. No major flood occurred except for the devastating flooding in 1989, with recorded water level of 9.20 feet at Nagalagam St. gauging station, while minor flooding were recorded seven times.

These 8 floods are selected as representative floods to compare the hourly water level at Glencourse, Hanwella and Nagalagam St. gauging stations.

Table J.2.1 Annual Maximum Water Level

Year.Month	Waterlevel at Nagalagam st. (feet)	Flood Level	Year.Month	Waterlevel at Nagalagam st. (feet)	Flood Level
1985.6	4.60		1996.9	5.00	Minor
1986.4	2.60		1997.9	5.50	Minor
1987.6	3.10		1998.7	4.90	
1988.9	4.10		1999.4	6.60	Minor
1989.6	9.20	Dangerous	2000.9	5.00	Minor
1990.5	3.90		2001.6	3.90	
1991.6	4.90		2002.6	4.05	
1992.6	5.10	Minor	2003.7	3.95	
1993.10	5.00	Minor	2004.11	5.00	Minor
1994.5	4.60		2005.9	4.75	
1995.5	4.20				

The example of peak water level comparison is shown in the following Figure.

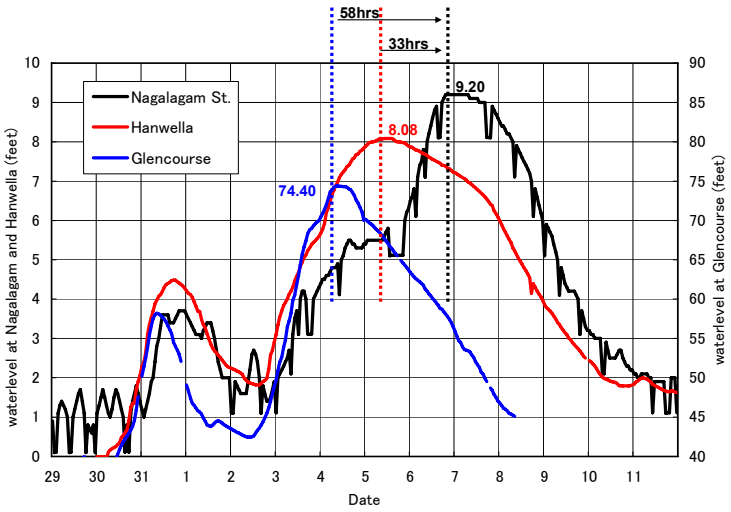


Figure J.2.2 Example of Comparison of Peak Water Level

To carry out the correlation analysis of the water level at three gauging stations, water levels of 8 representative floods observed at 3 gauging stations are compared. Since the number of representative floods are small and not enough for correlation analysis if only peak water levels are compared, other water level combinations which correspond to the water level among three gauging stations are identified by applying the method shown below.

Other water level combinations are selected by assuming that upstream water level at t_1 is corresponding to downstream water level at t_3, where $(t_3-t_1) = (t_4-t_2)$, it means $\Delta t_a = \Delta t_b$.

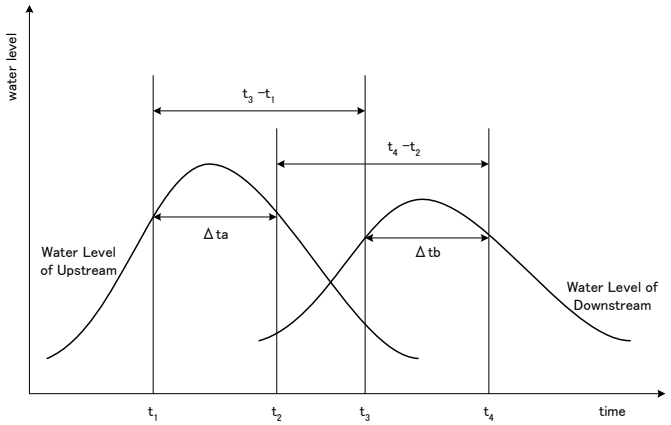
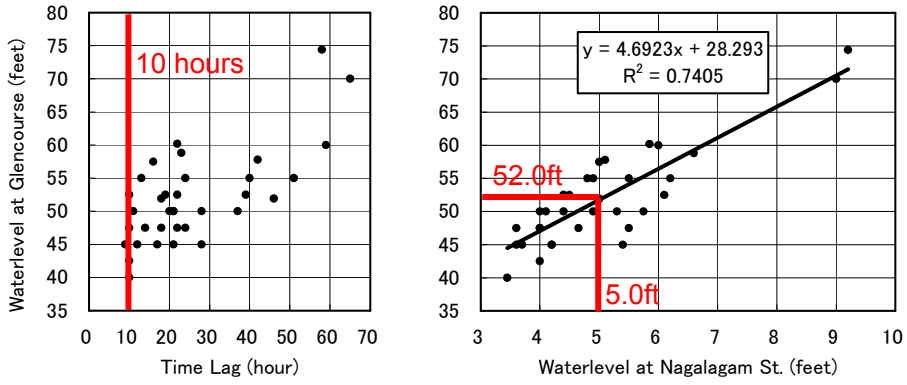
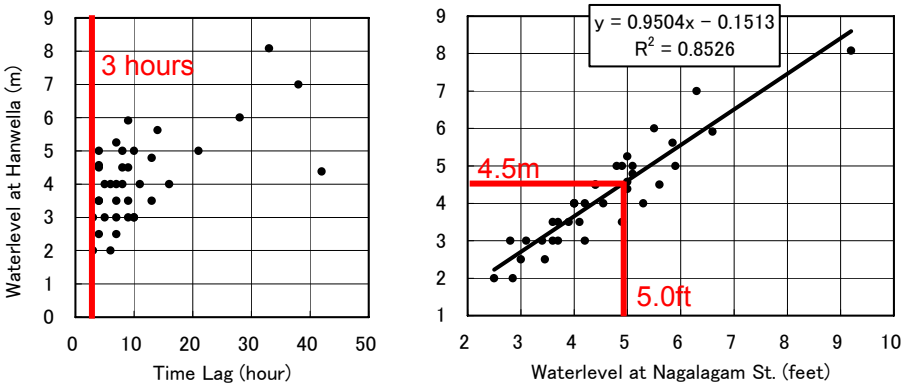


Figure J.2.3 Procedure for Finding Corresponding Water Levels

Five different Δt_a was set for all eight representative floods to get the corresponding water levels, and correlation analysis was carried out using all water level combinations. Result of correlation analysis is shown below.



Correlation Analysis of Glencourse and Nagalagam St.



Correlation Analysis of Hanwella and Nagalagam St.

Figure J.2.4 Result of Correlation Analysis

Water level at Glencourse gauging station is about 52.0 ft., corresponding to 5.0 ft. at Nagalagam St. gauging station according to the correlation analysis. This represents that if the water level reaches 52.0 ft. at Glencourse, there is a possibility that the water level at Nagalagam St. will reach to minor flood level of 5.0 ft. after certain hours. Regarding the time lag (flood travel time) between Glencourse and Nagalagam St., there is at least 10 hours, although there seems no correlation between the water level of Glencourse and travel time to Nagalagam St. Therefore, the warning that can be issued is as follows: "There is a possibility of Minor Flood after 10 hours in case the water level at Glencourse reaches 52.0 ft."

In the same way, based on the result of the correlation analysis, the warning that can be issued may be as follows: "There is a possibility of Minor Flood after three hours in case the water level at Hanwella reaches 4.5 m."

(3) Warning Criteria

Based on the analysis, there are two opportunities to issue the warning in terms of time frame. One is 10 hours and the other one is 3 hours before the flood comes. The warning can be understandable if the meaning is given by describing the activities to be taken at 10 hours and three hours before flooding.

Three hours before flooding, the residents can afford to plan their action. They have time to assess whether it would be better to move their furniture upstairs or to move everything out, depending on

the forecast by DOI or evacuation instruction by GA before evacuation. Therefore, the warning issued at three hours before flooding is the "Warning" which means that people should evacuate smoothly after preparation. GA shall issue "Evacuation Instruction" based on the discussion of district level DM committee meeting after receiving warning from DOI.

DOI is trying to give a more accurate forecast by checking the rainfall amount around the basin and the water level of upstream at 10 hours before flooding. The "Standing Order" says the Flood Committee is convened in case of the Minor Flood, but it is recommended to have a meeting or to coordinate closely with related organizations by using intra-governmental network to prepare for the coming flood at 10 hours before flooding. For local people, it is also a time to watch for signs of the coming flood. Therefore, the warning issued at 10 hours before flooding is the "Alert" that makes people and the related organizations recognize the coming flood.

Warning Criteria to forecast Minor Flood (5 feet at Nagalagam St.) in downstream of Kelani River can be defined as follows.

Table J.2.2 Warning Criteria for Minor Flood in Kelani River

Level	Station	Water Level	Available Time
Advisory	Glencourse	52 feet	10 hours
Warning	Hanwella	4.5 m	3 hours

Although the above study is only for the Minor Flood, the same method can be used for higher flood level by checking the water level at the upstream and modifying the water level forecasting at the downstream.

(4) Comparison with Actual Events

Validity of above warning criteria was studied using the data of actual flood on April/May flood and May/June flood.

Regarding April/May flood, the duration from the time when the water level of Glencourse exceeds its warning level 52 feet to the time when the water level of Nagalagam St. exceeds 5 feet, and the duration from the time when the water level of Hanwella exceeds its warning level 4.5 m to the time when the water level of Nagalagam St. exceeds 5 feet, are shown below. It is found that there are 10 hours from Glencourse to Nagalagam St., and 7 hours from Hanwella to Nagalagam St.

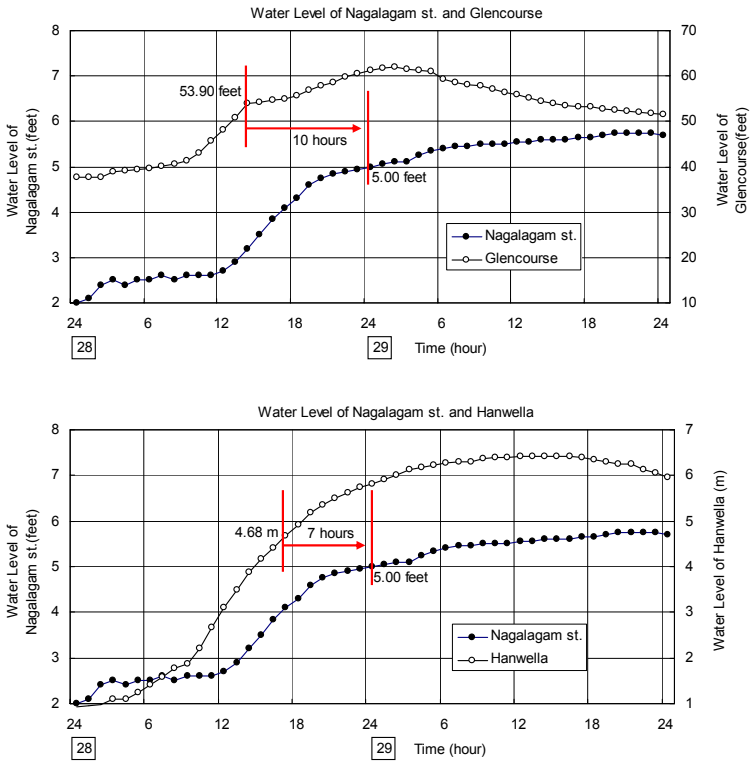


Figure J.2.5 Travel Time (April / May Flood)

Regarding May/June flood, it is found that there are 14 hours from Glencourse to Nagalagam St., and 11 hours from Hanwella to Nagalagam St.

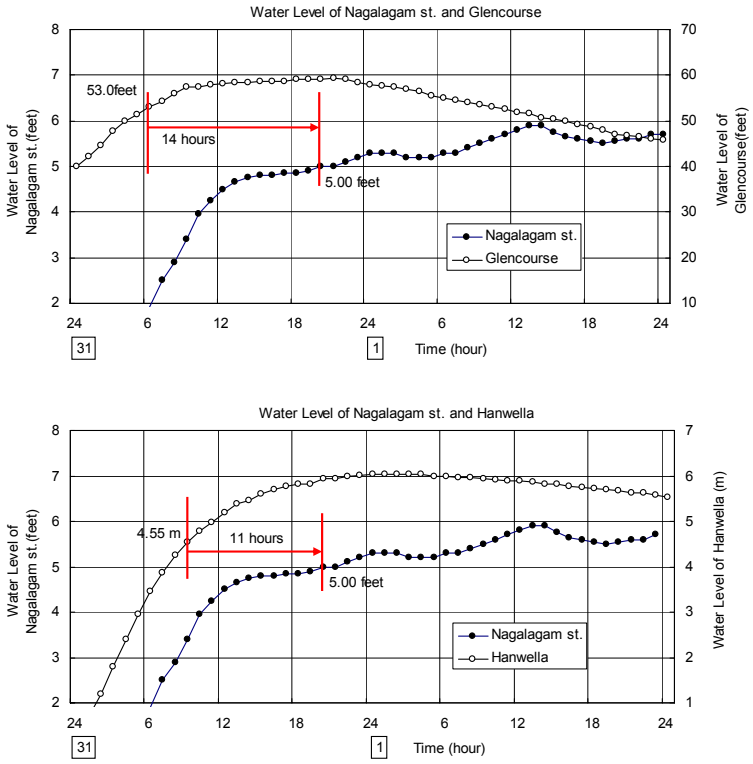


Figure J.2.6 Travel Time (May / June Flood)

If DOI issues flood warning according to the above defined warning criteria, related organization can have enough time for taking their actions in the case for two floods in 2008. Therefore, it can be said that the defined warning criteria is appropriate.

(5) Comparison with Simulation Result

Hydraulic Simulation was conducted by using the MIKE11 model prepared in Component 1 against the result of correlation analysis of three water level gauging stations. The condition of the model was used for this simulation that was calibrated to fit to the actual flood to reflect the present geographical conditions and storage effect etc. of the flood basin in the component 1. Actual hydrograph of 1989 flood and 1990 flood was given to Glencourse as the boundary condition, and simulation result at Hanwella and Nagalagam St. was compared to actual hydrograph in the calibration. In this simulation, actual hydrograph of 1989 flood and 1990 flood was scaled to seven different cases in addition to actual two cases, and total nine case hydrographs were given to Glencourse and correlation of peak water level at three stations and its time lag were analyzed. Boundary condition of nine cases of simulation is shown below.

Table J.2.3 Case of Simulation

Case	Boundary Condition at Glencourse
1	1990 actual hydrograph
2	1.2 * 1990 actual hydrograph
3	1.4 * 1990 actual hydrograph
4	2.0 * 1990 actual hydrograph
5	3.0 * 1990 actual hydrograph
6	1989 actual hydrograph
7	0.85 * 1989 actual hydrograph
8	0.75 * 1989 actual hydrograph
9	0.50 * 1989 actual hydrograph

The result of simulation plotted on Figure J.2.7 is shown below. And correlation of peak water level of three stations and its time lag of April/May flood and May/June flood are also shown on the same figure for reference.

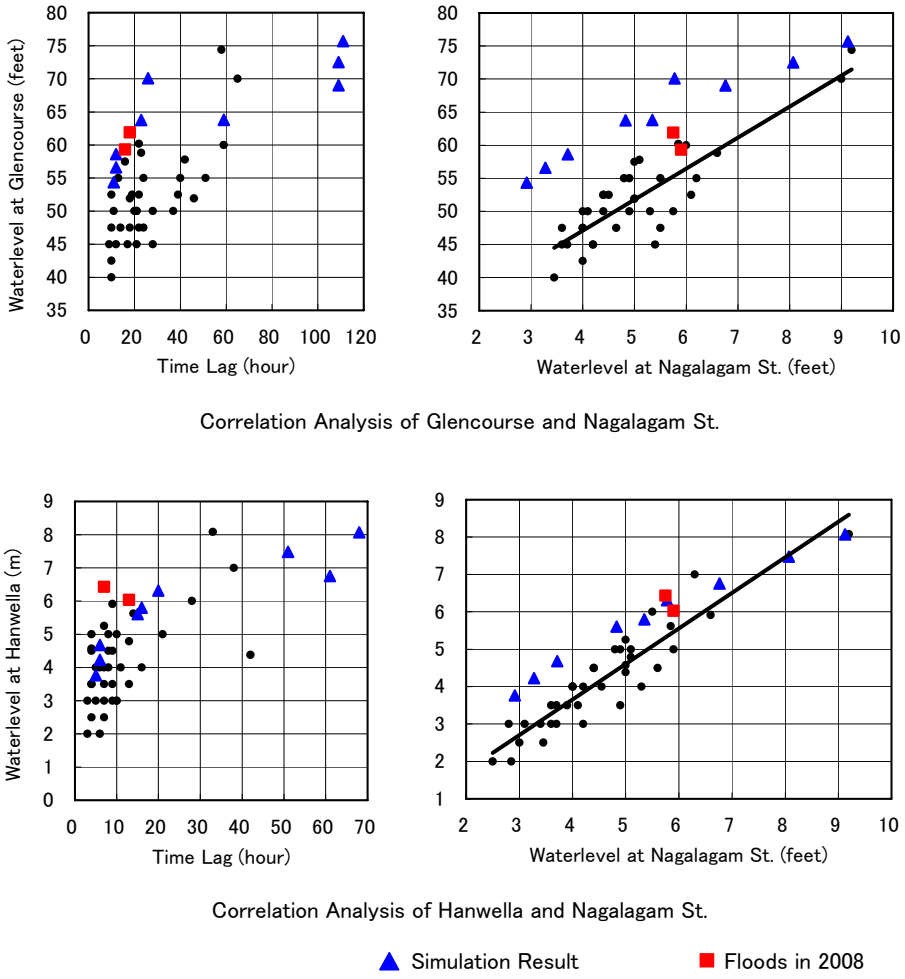


Figure J.2.7 Comparison with Simulation Result

Correlation of peak water level at Glencourse and Nagalagam St. are far above approximated line. One reason is that the storage effect of flood plain is not estimated properly (there is a possibility of overrated.), and inflow from the river basin at downstream of Glencourse is not counted. Correlation of peak water level at Hanwella and Nagalagam St. are also above approximated line, but difference is not so much. It can be said that this is because the distance between two stations is short and the effect of storage and inflow is small.

Although there is an advantage for the simulation to be able to conduct various kind of calculation easily, reliability of the simulation result will be low without preparing the simulation model based on the detailed topographical data, cross section data, and enough hydrological data, etc. If the warning criteria is defined based on the above simulation result, water level at downstream will be underestimated, and this is dangerous. Since a lot of analysis like correlation analysis can be done by using actual data, continuous monitoring of hydrological data is important. Accumulation of monitored data will also help improving the accuracy of simulation model.

J.3 Warning Criteria for Ratnapura

J.3.1 General

Flood in Ratnapura shall be forecasted by correlating the rainfall amount at upstream and water level at downstream. There are several methods for forecasting such flood like in Ratnapura such as using daily rainfall, hourly rainfall, and simulation. Methods shall be selected according to the availability of data.

Warning criteria shall be defined as the rainfall amount at upstream station to forecast the target water level at downstream. And the water level can be also defined as the warning criteria by studying rate of rising of water level.

Location of Ratnapura gauging station and main rainfall stations at upstream of Kalu river basin is shown below. Target water level is Minor Flood level 6m (about 19 feet) at Ratnapura gauging station. (Regarding the water level 6m, there is a report saying that inundation occurs below this water level in the actual situation. Therefore, target water level can be modified according to further study.)

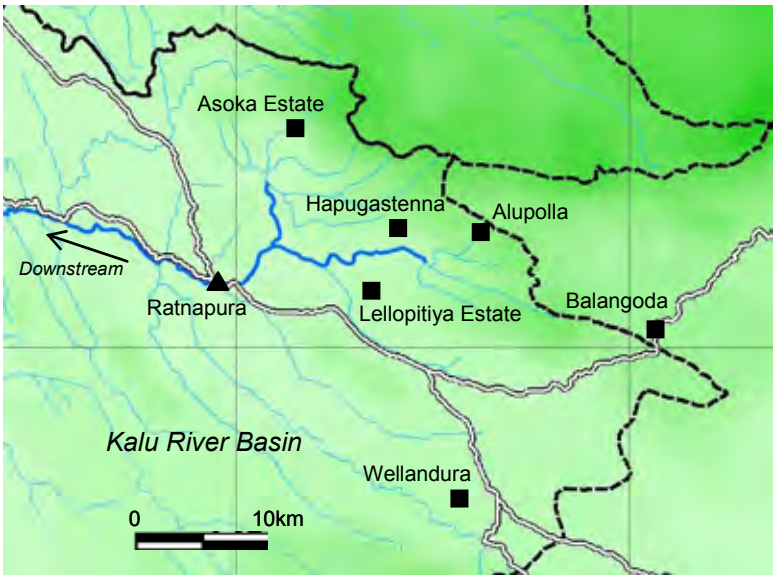


Figure J.3.1 Location of Monitoring Stations at Upstream of Ratnapura

J.3.2 Method by Daily Rainfall

Water level data at Ratnapura gauging station were collected to study warning criteria for Ratnapura. The following Table shows the annual maximum water level from 1981 to 2005. Hourly water level data and daily rainfall data for 17 floods that exceed the water level 6m (19 feet) were collected.

Table J.3.1 Annual Maximum Water Level at Ratnapura gauging station

Year/Month		Water Level (feet)	Year/Month		Water Level (feet)	Year/Month		Water Level (feet)
1981	9	22.0	1991	7	18.8	2001	9	14.3
1982	6	28.3	1992	6	22.0	2002	6	19.8
1983	6	14.0	1993	10	27.8	2003	5	33.2
1984	7	24.9	1994	5	15.6	2004	5	17.8
1985	6	23.3	1995	10	23.5	2005	9	22.6
1986	10	20.0	1996	6	23.0			
1987	6	12.9	1997	8	22.8			
1988	6	26.5	1998	9	20.8			
1989	5	37.0	1999	4	27.0			
1990	5	24.2	2000	6	16.4			

Target rainfall gauging stations are five stations such as Hapugastenna, Lellopitiya, Alupolla, Ratnapura, and Wellandura at the upstream of Ratnapura. One day rainfall amount and two days rainfall amount that will affect the peak water level at Ratnapura for selected 17 floods are shown in the Table below.

Table J.3.2 1 day and 2 days rainfall amount at selected stations

Year	Month	Maximum Waterlevel (feet)	Hapugastenna		Lellopitiya		Alupolla		Ratnapura		Wellandura	
			1day Rainfall	2days Rainfall	1day Rainfall	2days Rainfall	1day Rainfall	2days Rainfall	1day Rainfall	2days Rainfall	1day Rainfall	2days Rainfall
1989	5	37.0	242.6	437.7	119.0	349.0	149.0	457.0	29.1	126.7	59.9	145.5
1989	5	28.0	182.3	298.9	137.0	207.5	140.0	236.0	220.1	323.1	0.0	66.6
2003	5	33.2	156.0	302.5	68.0	257.0	102.0	288.2	99.6	444.8	77.2	343.9
1982	6	20.0	173.0	202.2	120.8	163.9	92.7	158.5	128.8	160.3	–	–
1982	6	28.3	59.7	292.1	56.4	231.1	31.0	205.2	38.3	189.3	–	–
1993	10	27.8	140.7	288.0	68.3	248.3	78.8	182.7	61.2	238.8	59.2	118.1
1999	4	27.0	145.3	244.9	152.5	258.5	94.1	195.3	232.3	353.0	33.5	110.9
1988	6	22.3	181.6	238.5	110.0	228.0	175.0	234.0	34.8	92.0	–	–
1988	6	26.5	165.9	312.7	7.8	11.2	148.0	275.0	243.6	312.5	–	–
1984	7	24.9	185.9	239.0	82.0	132.5	88.4	106.2	91.8	130.2	–	–
1990	5	24.2	7.1	253.7	67.0	248.6	7.2	193.5	23.6	91.5	12.2	79.5
1995	10	23.5	124.5	257.3	91.6	169.6	87.5	175.2	124.5	186.5	18.1	113.4
1985	5	23.3	39.4	184.9	46.8	174.8	15.7	83.8	62.5	177.1	–	–
1985	6	20.9	120.7	181.7	26.5	67.0	52.1	102.9	96.1	135.9	–	–
1996	6	23.0	3.3	3.3	0.0	152.4	1.5	86.9	3.1	395.6	0.0	51.8
1997	8	22.8	12.7	102.9	18.5	48.0	16.1	29.2	2.1	25.8	–	–
2005	9	22.6	59.0	313.0	79.0	180.9	56.0	171.0	64.5	119.1	9.3	52.2
1981	9	22.0	129.5	171.6	141.2	166.6	121.9	153.4	108.5	133.1	–	–
1992	6	22.0	194.3	207.5	133.0	167.1	104.0	119.1	141.8	153.2	61.2	65.3
1998	9	20.8	9.7	50.3	43.1	99.1	26.2	113.2	22.5	69.4	26.7	47.3
1986	10	20.0	105.7	176.3	108.9	168.9	100.8	177.0	95.2	157.8	–	–

The correlation between one day rainfall and two days rainfall, and peak water level at Ratnapura is shown in the figure below.

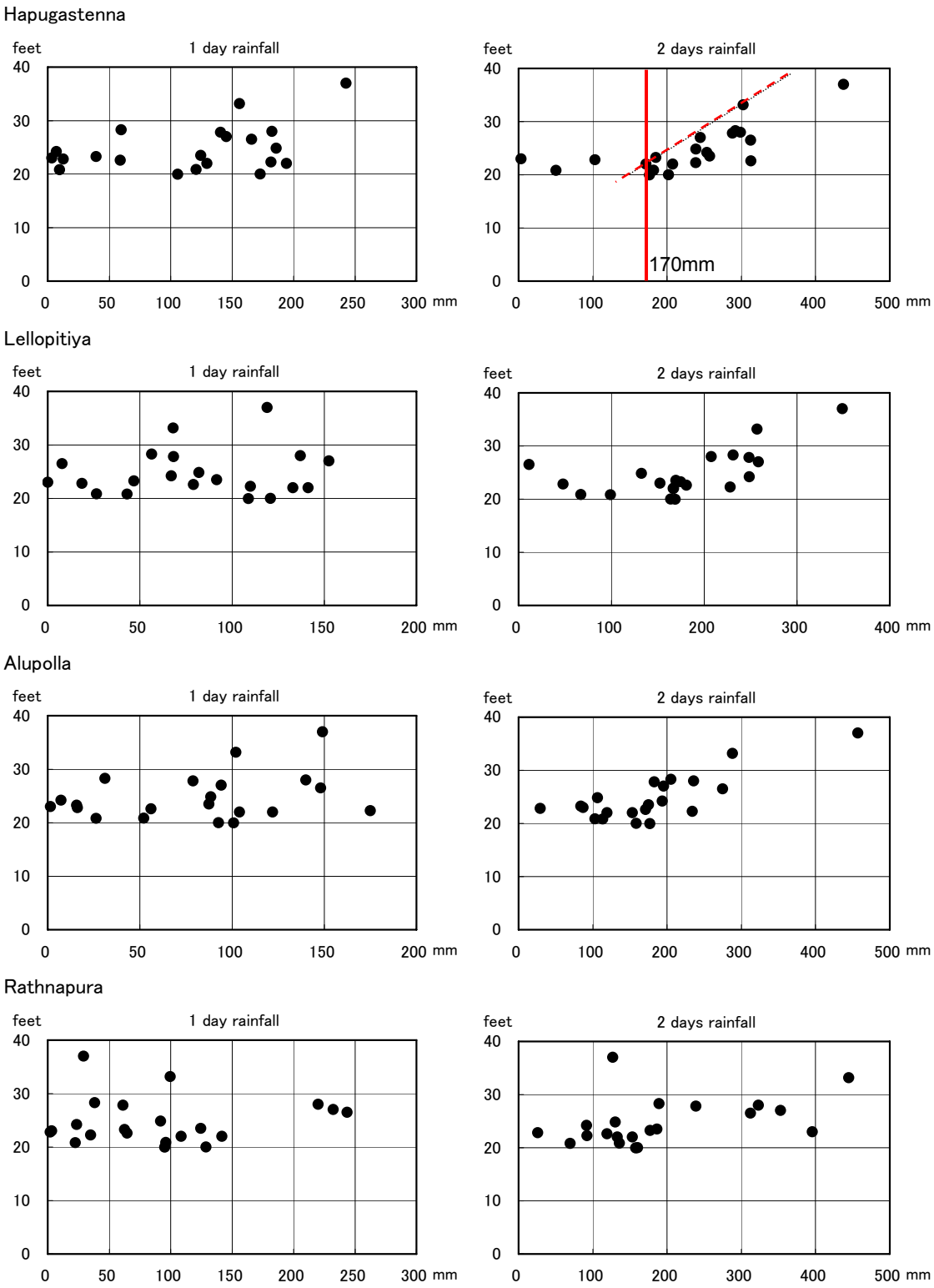


Figure J.3.2 Relation of Rainfall Amount and Water Level in Ratnapura

In case of one day rainfall, the correlation with the water level is not high at any stations. On the other hand, in case of two days rainfall, correlation with the water level is relatively high especially at Hapugastenna station. Three floods that show the low correlation can be eliminated as the exceptional cases. One flood among three is that 400mm/day rainfall amount is monitored at Ratnapura station. The data for other two floods have lack credibility.

According to the result of above study, it can be said as the flood forecasting;

"There is a possibility of Minor Flood (more than 6 m) when the rainfall amount for 2 days exceeds 170mm at Hapugastenna rainfall gauging station."

And it is also possible to predict the water level from rainfall amount by using approximated line even though the accuracy is not high.

The following Table shows the number of rainfall event that exceed the rainfall amount 170 mm /2 days at Hapugastenna.

Table J.3.3 Number of Rainfall event that exceed the rainfall amount 170 mm/2 days

Year	Number of Event	Year	Number of Event	Year	Number of Event
1981	3	1991	0	2001	1
1982	11	1992	8	2002	3
1983	1	1993	10	2003	3
1984	7	1994	1	2004	0
1985	8	1995	4	2005	2
1986	1	1996	0		
1987	0	1997	3	average	3.88
1988	9	1998	3		
1989	9	1999	5		
1990	4	2000	1		

The number of rainfall event that exceed 170 mm/2 days is about 4times/year. This number is appropriate for issuance of early warning. Therefore, warning level by daily rainfall data is defined as follows.

Table J.3.4 Warning Level for Flood in Ratnapura (based on daily rainfall)

Monitoring	Warning Level	Available Time
Rainfall	170 mm / 2 days at Hapugastenna Station	—

J.3.3 Method by Rate of Rising of Hourly Water Level

Next table shows the rate of rising at each stage such as 3 to 6 m (10 to 19 feet), 6 to 8 m (19 to 24 feet), and 8 to 12 m (24 to 36 feet). DOI starts close monitoring at 3m. 6m is the minor flood level, 8m is the medium flood level and 12m is the major flood level. It is shown that it takes at least four hours from 3 to 6 m, three hours from 6 to 8 m, and 11 hours from 8 to 12 m from the actual data for past 25 years.

According to the result of this study, it takes minimum four hours and average 10 hours from 3 to 6 m .

Table J.3.5 Rate of Rising

Year	Month	Maximum Waterlevel (feet)	Rate of Rising															
			10–19feet					19–24feet					24–36feet					
			a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	
			ft	ft	hrs	ft/hr	hrs	ft	ft	hrs	ft/hr	hrs	ft	ft	hrs	ft/hr	hrs	
1989	5	37.0	10.6	19.4	13	0.7	13	19.4	24.2	4	1.2	4	24.2	36.0	16	0.7	16	
1989	5	28.0	11.1	19.9	12	0.7	12	19.9	24.7	4	1.2	4	24.7	28.0	3	1.1	11	
2003	5	33.2	10.5	19.0	7	1.2	7	19.0	24.7	10	0.6	9	24.7	32.5	24	0.3	37	
1982	6	28.3	10.2	19.5	7	1.3	7	–	–	–	–	–	–	–	–	–	–	
1993	10	27.8	10.1	19.5	13	0.7	12	19.5	24.0	13	0.3	14	24.0	27.8	14	0.3	44	
1999	4	27.0	10.1	19.8	8	1.2	7	19.8	24.7	5	1.0	5	24.7	27.0	5	0.5	26	
1988	6	26.5	10.0	19.3	9	1.0	9	19.3	22.3	12	0.2	20	–	–	–	–	–	
1984	7	24.9	10.8	16.6	5	1.2	8	20.0	24.0	7	0.6	9	–	–	–	–	–	
1990	5	24.2	13.8	19.8	4	1.5	6	19.8	24.2	6	0.7	7	–	–	–	–	–	
1995	10	13.4	10.7	13.4	6	0.5	20	19.1	23.5	19	0.2	22	–	–	–	–	–	
1995	10	23.5	11.8	19.1	18	0.4	22	19.1	23.5	19	0.2	22	–	–	–	–	–	
1985	6	23.3	10.8	19.5	9	1.0	9	19.5	23.3	9	0.4	12	–	–	–	–	–	
1996	6	23.0	12.1	19.3	3	2.4	4	19.3	23.0	6	0.6	8	–	–	–	–	–	
1997	8	22.8	10.3	19.3	6	1.5	6	19.3	22.8	3	1.2	4	–	–	–	–	–	
2005	9	22.6	10.0	19.2	18	0.5	18	19.2	22.6	6	0.6	9	–	–	–	–	–	
1981	9	22.0	10.5	19.6	6	1.5	6	–	–	–	–	–	–	–	–	–	–	
1992	6	22.0	10.2	19.5	7	1.3	7	19.5	22.0	5	0.5	10	–	–	–	–	–	
1998	9	20.8	10.3	19.3	8	1.1	8	19.3	20.8	1	1.5	3	–	–	–	–	–	
1986	10	20.0	10.7	18.2	7	1.1	8	–	–	–	–	–	–	–	–	–	–	

a: water level from, b: water level to, c: actual duration from a to b, d: rate of rising, e: calculated duration
: minimum time

Therefore, warning level by rate of rising of water level is defined as follows.

Table J.3.6 Warning Level for Flood in Ratnapura (based on rate of rising)

Monitoring	Warning Level	Available Time
Water level	3.0m at Ratnapura Station	4 – 10 hours

J.3.4 Method by Hourly Rainfall

In the case for April/May flood in 2008, rainfall amount at Asoka Estate for two hours from 7:00am to 9:00am recorded 116 mm and the water level at Ratnapura increased from 2.9 m at 8:00am to 6.0 m at 10:00am. It took only two hours from 3 to 6 m and this is the minimum time in past 28 years. Manual monitoring of daily rainfall is conducted at every morning once a day, and daily rainfall means the 24 hours rainfall from 9:00am to 9:00am next day. (8:30am to 8:30am for DOM) Therefore, if such a torrential rainfall occurs during midnight, this rainfall event can not be known and flood can not be forecasted.

At present, there are only two rainfall gauge stations at the upstream of Ratnapura where the hourly rainfall is monitored, Ratnpaura station operated by DOM and Asoka Estate station consigned by DOI. Relation of cumulative rainfall and water level is analyzed in the following Figure. “24 hours” is selected as the duration for accumulation, because the flood in Ratnapura is depending on the rainfall amount for about 24 hours according to the size of watershed of upstream of Ratnapura.

Horizontal line shows the 24 hours cumulative rainfall amount at Ratnapura and Asoka Estate that changes every hour, and vertical line shows the water level at Ratnapura.

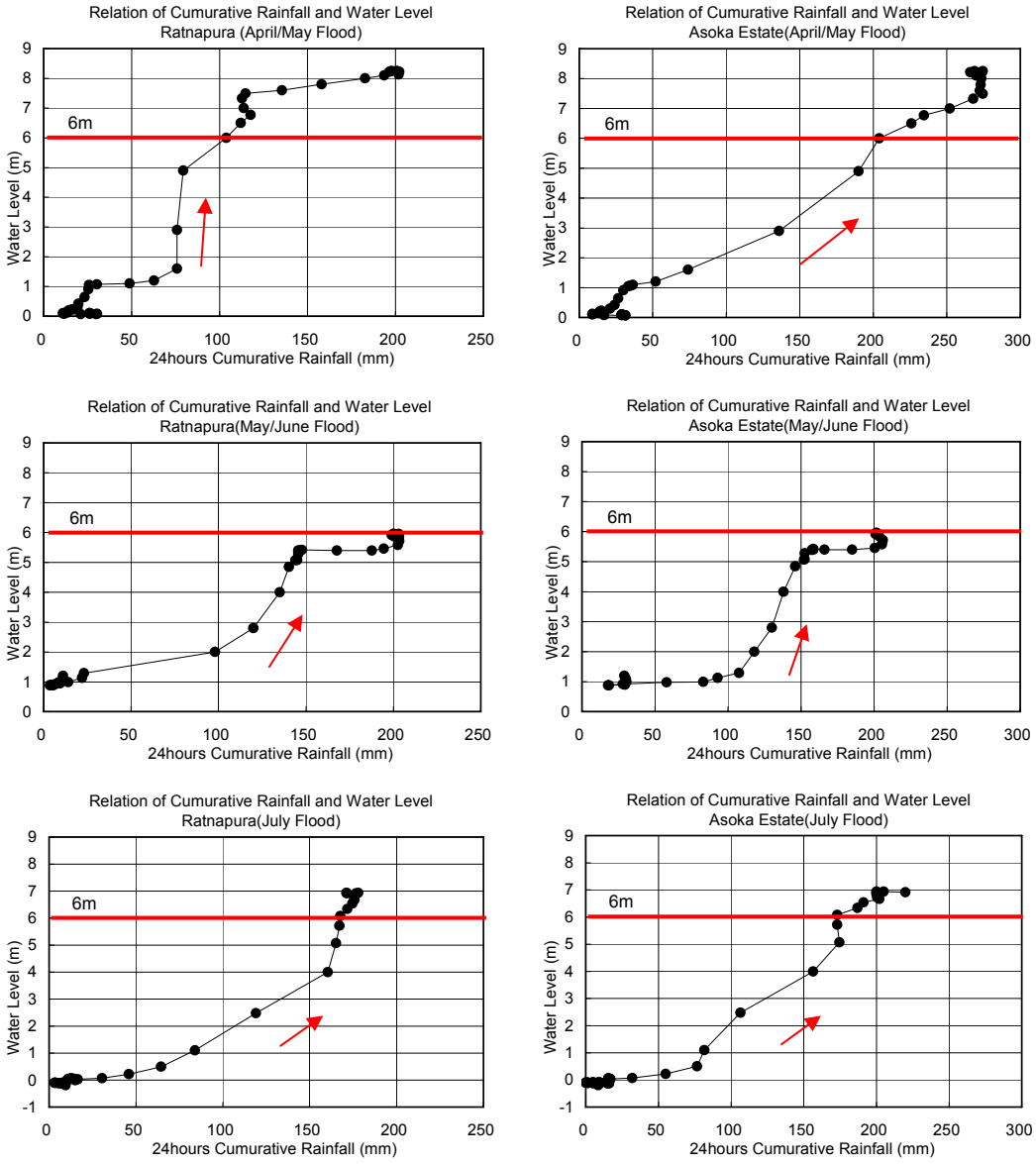


Figure J.3.3 Result of Simulation

24 hours cumulative rainfall when the water level at Ratnapura gauging station reached 6 m is summarized below.

Table J.3.7 24 Hours Cumulative Rainfall at Flood Time

Flood	24 hours cumulative rainfall (mm)	
	Ratnapura	Asoka Estate
April to May	100 mm	200 mm
May to June	200 mm	200 mm
July	170 mm	175 mm

100 mm rainfall for 24 hours at Ratnapura station seems small compared from other rainfall amounts, therefore the warning level by the analysis of the hourly rainfall is defined two levels as follows. However the accuracy will not be high since the number of samples is not enough.

Table J.3.8 Warning Level for Flood in Ratnapura (based on hourly rainfall)

Monitoring	Warning Level	Available Time
Rainfall	Advisory level: 100 mm / 24 hours at any station	—
Rainfall	Warning level: 170 mm / 24 hours at any station	—

J.3.5 Method by Simulation

24 hours rainfall amount by which the water level at Ratnapura station will exceeds 6m was analyzed by using MIKE 11 run-off simulation model prepared in component 1.

24 hours rainfall amount at Hapugastenna station, where automatic rainfall gauge with telemeter system was installed by pilot project, was changed from 100 to 200 mm (five cases per 25 mm), and averaged rainfall amount in the upstream basin of Ratnapura is calculated. The water level at Ratnapura was calculated from this averaged rainfall amount. Result is shown below.

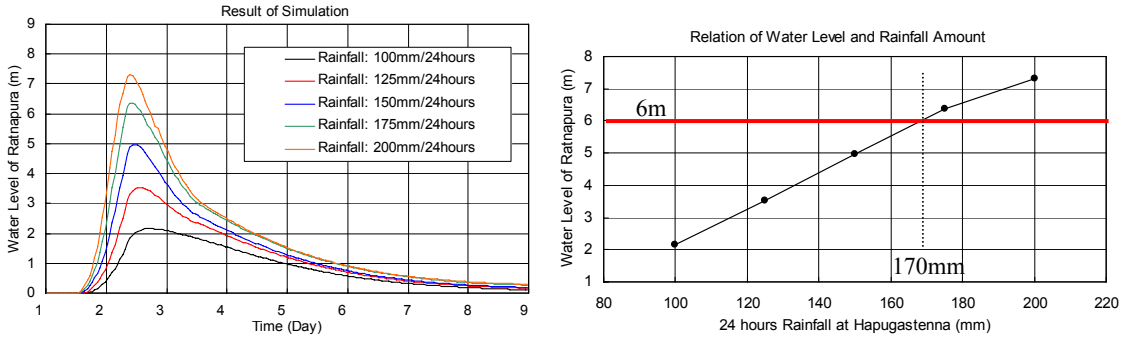


Figure J.3.4 Result of Simulation

It can be said that if 24 hours rainfall amount exceeds 170mm at Hapugatstenna station, water level at Ratnapura will exceed 6 m.

Additionally, regarding the case for 24 hours rainfall amount: 175 mm, the difference of rate of rising of water level was analyzed between the case if it rains 17 5mm for 24 hours uniformly, and the case if it rains 175 mm in three hours.

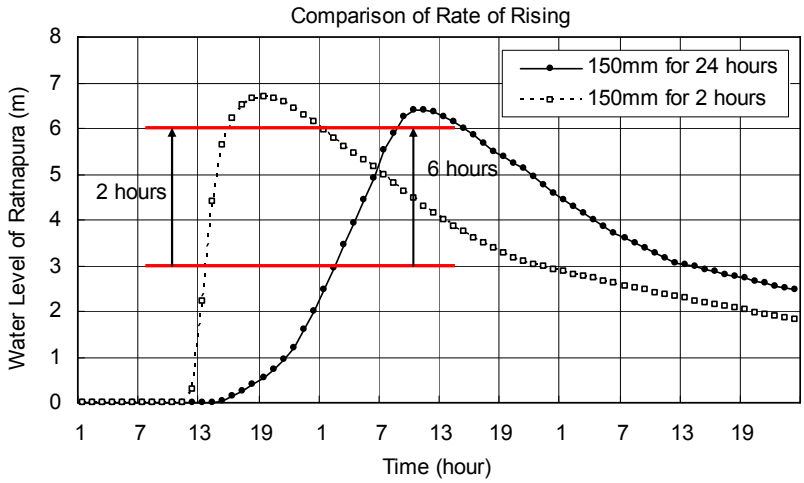


Figure J.3.5 Comparison of Rate of Rising

Therefore, warning level by simulation is defined as follows.

Table J.3.9 Warning Level for Flood in Ratnapura (based on simulation)

Monitoring	Warning Level	Available Time
Rainfall	170mm / 24hours at Hapugastenna station	2 – 6 hours

J.3.6 Warning Criteria for Flood in Ratnapura

Warning criteria shall be defined by taking the above results into consideration in a comprehensive manner. Here, 24 hours cumulative rainfall amount: 150 mm at any stations in upstream basin of Ratnapura is defined as the warning criteria for flood in Ratnapura. This is because 170 mm/24 hours is too critical to issue warning from the experience of 2008 flood. And, since the water level at Ratnapura increases from 3m to 6m in two hours by the simulation as well as in the April /May flood, warning issuance is necessary when the water level reaches 3m, despite of cumulative rainfall amount.

Therefore, "Advisory" shall be issued when the 24 hours cumulative rainfall amount exceeds 100 mm at any stations, and "Warning" shall be issued when the water level reaches 3 m, or the 24 hours cumulative rainfall amount exceeds 150 mm at any stations.

Table J.3.10 Warning Criteria for Minor Flood at Ratnapura

Level	Criteria
Advisory	Rainfall amount is 100 mm within 24 hours at any stations
Warning	Rainfall amount is 150 mm within 24 hours at any stations **or** Water Level is 3.0 m at Ratnapura gauging station

If these warning criteria are applied to the three actual floods in 2008, timing of issuing warning will be estimated as follows.

Table J.3.11 Timing of Issuing Flood Warning based on Warning Criteria and the Time of Minor Flood Occurrence

Level	April/May	May/June	July
Advisory	8:00am	23:00pm	19:00pm
Warning (water level)	9:00am	2:00am	20:00pm
Warning (rainfall)	9:00am	4:00am	20:00pm
Occurrence of Flood	10:00am	18:00pm	23:00pm

It can be said that all three floods can be forecasted by using proposed warning criteria. However only one hour is available for the case of April/May flood, therefore more collection of hourly rainfall data and analysis on the relation between the hourly rainfall and water level at Ratnapura is necessary to upgrade the warning criteria.

J.4 Warning Criteria for Sediment Disaster

In Japan there are several methods to determine the critical rainfall for sediment disaster at present. Among them, Guideline Method called Method "A" is the most simple method based on the past disaster records and rainfall amount at the time of disaster. Basically, the method "A" is applied only for the debris flow, since the landslide can not be forecasted only by the rainfall amount. However, only rainfall amount can be the bench mark for forecasting landslide in Sri Lanka at present, and local people can manage this method

by themselves if properly instructed, the method "A" can be utilized for defining one of the warning criteria for landslide in Sri Lanka.

The following Figure is a schematic image of the critical line. The rainfall index is expressed by a combination of the rainfall intensity and the total rainfall (cumulative rainfall). As shown in the figure, the rainfall intensity is shown in the ordinate (Y-axis) and the total rainfall in the abscissa (X-axis). Debris flow causing rainfall and non-causing rainfall are plotted in the figure by the different symbols. Then, those two rainfall groups are separated with a linear line or a curved line descending to the right. This boundary line is called the Critical Line (CL) which distinguishes the occurrence and non-occurrence of a debris flow. The lower left side of this line is the safe zone where a debris flow may not be caused. The upper right side of this line is the unsafe zone where a debris flow may be caused. The definitions of plotted rainfall values are explained in the Table below.

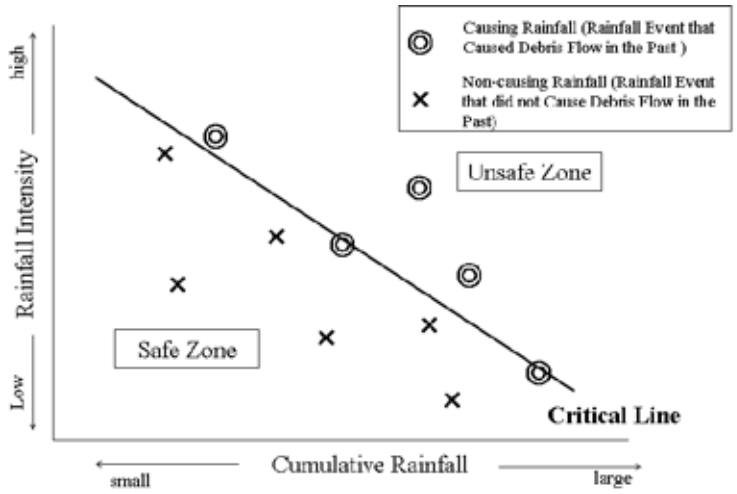


Figure J.4.1 Concept of Critical Line

Table J.4.1 Definitions of Rainfall Indexes

	X axis (abscissa)	Y axis (ordinate)
Causing Rainfall	Cumulative rainfall up to 1 hour before the occurrence of debris flow	1 hour rainfall immediately before the occurrence of debris flow
Non-causing Rainfall	Cumulative rainfall up to before the start of a maximum hourly rainfall	Maximum hourly rainfall in a series of rain

Methods for setting the rainfall criteria for issuing warning and evacuation instruction are explained below. The line indicating the rainfall criteria for warning is called "Warning Line (WL)" and the line indicating the rainfall criteria for evacuation is called "Evacuation Line (EL)".

Before setting the WL and the EL, it is necessary to determine the timing to give warning and evacuation instruction. It means that how many hours before the forecasted occurrence time warning or evacuation instruction should be given, so that people as well as the related organizations can take necessary actions for safety. After that the WL and EL are set in consideration of an estimated rainfall during the leading time. Table shown below shows the conditions used in the "Method A" in Japan.

Table J.4.2 Definitions of Timing for Warning and Evacuation

	Timing	Forecasted Rainfall during leading time
Warning Issuance	2 hours before reaching the CL	Past maximum 2 hours rainfall (R_{H2M})
Evacuation Instruction	1 hours before reaching the CL	Past maximum 1 hour rainfall (R_{H1M})

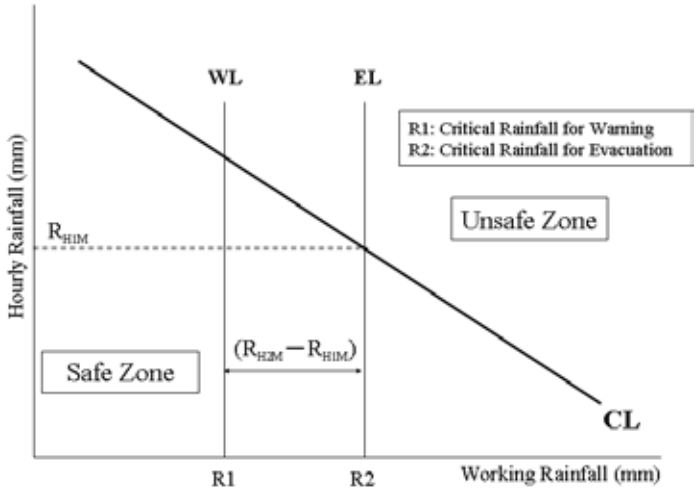


Figure J.4.2 Concept of Warning Level and Evacuation Level

J.5 Samples of Warning Message

Regarding the contents of warning message, the timing of issuance and necessary contents are recommended in the Main Report as follows.

Table J.5.1 Timing of Issuance and Contents of Warning（Flood）

Category	Timing of Issuance	Necessary Contents
Advisory	- Issued by DOI when rainfall amount or water level exceeds the warning criteria (advisory)	- List of Areas to be inundated, estimated time and inundation depth - “wait for next information”
Warning	- Issued by DOI when rainfall amount or water level exceeds the warning criteria (warning) - Warning shall be updated according to new information	- List of Areas to be inundated, estimated time and inundation depth - “follow the instruction by GA”
Evacuation Instruction / Order	- Issued by GA based on the result of District DM Committee Meeting.	- List of Areas to be inundated, estimated time and inundation depth - Evacuation instruction / order
Cancellation of warning	- Issued by DOI when the water level decreases below flood level and water level of upstream decreases below warning criteria.	- Cancellation of warning
Cancellation of evacuation instruction / order	- Issued by GA based on the result of District DM Committee Meeting.	- Cancellation of evacuation instruction / order

Table J.5.2 Timing of Issuance and Contents of Warning（Landslide）

Category	Timing of Issuance	Necessary Contents
Advisory	- Issued by NBRO when rainfall amount exceeds 100mm/24hours	- List of DS covered by rain gauge station exceeds warning criteria - “wait for next information”
Warning	- Issued by NBRO when rainfall amount exceeds 150mm/24hours - Warning shall be updated according to new information	- List of DS covered by rain gauge station exceeds warning criteria - “follow the instruction by GA”
Evacuation Instruction / Order	- Issued by GA based on the result of District DM Committee Meeting.	- List of DS and GN covered by rain gauge station exceeds warning criteria - Evacuation instruction / order
Cancellation of warning	- Issued by NBRO when the rainfall stopped for certain time.	- Cancellation of warning
Cancellation of evacuation instruction / order	- Issued by GA based on the result of District DM Committee Meeting.	- Cancellation of evacuation instruction / order

Table J.5.3 Timing of Issuance and Contents of Warning (Tsunami)

Category	Timing of Issuance	Necessary Contents
Advisory	- Issued by DOM when earthquake occurs which can generate Tsunami	- Time, place and magnitude of earthquake - “wait for next information”
Warning	- Issued by DOM when coast of Sri Lanka is forecasted to be affected by tsunami - Warning shall be updated according to new information such as actual monitoring of tsunami at other countries	- Estimated arrival time of tsunami - “follow the instruction by GA”
Evacuation Instruction / Order	- Issued by GA when “Tsunami Warning” is issued by DOM	- Estimated arrival time of tsunami - Evacuation instruction / order
Cancellation of warning, evacuation instruction / order	- Issued by DOM and GA when PTWC and JMA cancelled their warnings	- Cancellation of warning, evacuation instruction / order

In this Chapter, the samples of warning message for each disaster are shown below. The message shall be simple and easily understandable for people to avoid any misunderstanding. Necessary actions shall be also indicated. The message shall be prepared by Sinahara and Tamil.

Flood Warning for Kelani River

Issued by DOI at 17:15 on April 28th

1. Present Water Level at 17:00 on April 28th

Station	Water level	Situation
Glencourse	54.9 ft	below minor flood but increasing
Hanwella	4.7m	below minor flood but increasing
Nagalagam St.	4.1ft	below minor flood but increasing

2. Flood Forecasting

Minor Flood at Nagalagam St. (5.0ft) is expected at 20:00 on April 28th.

3. Expected Inundation Area

Warning: Biyagama DS, Hanwella DS
Alert: Colombo DS, Kolonnawa DS, Kelaniya DS

4. Instruction

Warning: Please follow the instruction by GA.
Alert: Please wait for next information

Figure J.5.1 Sample of Message (Flood Warning)

Landslide Warning

Issued by NBRO at 9:30 on April 29th

1. Present Rainfall Amount at 9:00 on April 29th

Station	27th	28th
Kitulgala	102.2mm	160.1mm
Ratnapura	71.8mm	159.9mm
Hapugastenna	147.0mm	182.0mm

2. Weather Forecasting

More rainfall is expected around Sabaragamuwa Province next several hours according to DOM.

3. Vulnerable Area for Landslide

Warning: Aaaa DS, Bbbb DS, Cccc DS
Alert: Dddd DS, Eeee DS, Ffff DS

4. Instruction

Warning: Please follow the instruction by GA.
Rainfall amount for Aaaa DS is exceeding critical level
Alert: Please wait for next information

Figure J.5.2 Sample of Message (Landslide Warning)

Tsunami Warning

Issued by DOM at 17:00 on September 12th

1. Information from PTWC at 16:45 on September 12th

- Earthquake occurred at 16:40 at South Sumatra, Indonesia
- Magnitude is 8.2
- Tsunami can be generated
- Estimated tsunami arrival time is as follows.

Dondra Head	20:17
Trincomalee	20:32
Colombo	20:45
Jaffna	21:55

2. Instruction

There is enough time for evacuation. Please follow the instruction by GA.

Figure J.5.3 Sample of Message (Tsunami Warning)

Supporting Report K

Result of Interview Survey

Supporting Report K Results of Interview Survey

K.1 General

An actual "Tsunami warning" was issued due to earthquake at Indonesia and an actual flood disaster occurred due to heavy rainfall during this Study. These actual events were reviewed from the point of EWE system and issues and lessons were raised for system development in the main report. To obtain data for the review of the activities conducted by local people, interview surveys for both events were conducted. The results of these interview surveys are discussed in this chapter.

K.2 Tsunami Warning on 12th and 13th September 2007

K.2.1 Background

Due to an earthquake occurred in South Sumatra, Indonesia, the tsunami warning was issued in Sri Lanka on September 12 and 13, 2007. The questionnaire survey was designed and conducted to understand the information dissemination process from the government level to the people's level after this occasion.

Timeline of Tsunami Warning

Information related to tsunami watch was issued by PTWC (Pacific Tsunami Warning Center) and the information was informed to DOM. Based on this information, DOM issued Tsunami Warning/Evacuation Instruction in Sri Lanka.

On September 12, the earthquake of M.8.2 occurred in South Sumatra, Indonesia at 16:40[1)]. PTWC issued the tsunami watch at 16:45, estimated there is a possibility of tsunami in Sri Lanka around 20:00 to 21:00 (at 20:17 in Dondra Head in Matara, 20:32 in Trincomalee, 20:45 in Colombo and 21:55 in Jaffna). Based on the tsunami watch, DOM issued the tsunami warning at 17:20 and evacuation instruction at 18:30. Before issuing the tsunami warning officially by DOM, the local media broadcasted the tsunami information based on the PTWC's tsunami watch. DMC and Police officially received the evacuation instruction by Fax at 18:38. At 20:30, DOM cancelled evacuation instruction and DMC and police received a cancellation of tsunami warning at 20:40.

On September 13, an earthquake of M.7.8 occurred in South Sumatra, Indonesia at 05:19. DOM issued the tsunami warning at 06:10 and police received a Fax at 06:11. DOM cancelled tsunami warning at 9:00 and police received a cancellation of tsunami warning at 09:50. There was no media broadcasting regarding tsunami information.

Table K.2.1 shows the situation of tsunami warning in chronological order, which was issued from the occurrence of earthquake to cancellation of tsunami warning.

Table K.2.1 Information Related to Tsunami Warning on 12th and 13th September

Time	Situation
12th Sep. 16:40	Occurrence of Earthquake in South Sumatra, Indonesia (M8.2)
16:54	PTWC issued Tsunami Watch (Tsunami Bulletin No.1)
17:01	DOM received Tsunami Bulletin No.1 from PTWC by e-mail, FAX, and GTS
17:09	DOM informed to MDMHR and DMC by telephone and made discussion for next action

1) : All the time mentioned in this section are local time in Sri Lanka.

Time	Situation
17:20	DOM issued Tsunami Warning
17:21	DMC and Police Command Centre received Tsunami Warning by Fax. Police started to take actions assuming the Tsunami Waning as Evacuation Instruction
18:30	DOM issued Evacuation Instruction
18:38	DMC and Police Command Centre received Evacuation Instruction by FAX
20:30	DOM cancelled Evacuation Instruction
20:35	Tsunami Bulletin Final by PTWC: Tsunami Watch was cancelled
20:41	DMC and Police Command Centre received the cancellation of Evacuation Instruction by FAX. But Evacuated people had started to return home before this issuance
13th Sep. 5:19	Occurrence of Earthquake in South Sumatra, Indonesia (M7.8)
5:31	PTWC issued Tsunami Watch. Sri Lanka is out of the issued area
6:10	DOM issued Tsunami Warning
6:11	Police received FAX
8:32	Tsunami Bulletin Final by PTWC: Cancellation of Tsunami Watch
9:00	DOM cancelled Tsunami Warning
9:50	Police received FAX

K.2.2 Questionnaire Survey on Tsunami Warning

(1) Survey Method

Questionnaire sheet was distributed to DDMCU in 5 districts (Galle, Hambantotha Kalthara, Mathara and Ampara) through Mrs. Inburana of DMC. Each district was asked to select total of 40 persons from two divisions (20 person from each division) to answer the questionnaire.

Total number of samples collected was 150. Ampara district did not return any questionnaire. Among 150 samples, there were two questionnaires sheets without name of division. Since the analysis is based on the district level, these questionnaire sheets are counted as a part of total samples in belonging district.

The officers in district conducted the questionnaire using face-to-face interview method.

(2) Survey Duration

The survey was conducted from 28th September to 31st December 2007.

(3) Location and Sample Number

The details of sampling location and number are shown below.

Table K.2.2 Location and Number of Samples Collected in Each District

District/ Total Sample	Galle	40	Hambantotha	40	Kalthara	20	Mathara	50
Division (Sample No.)	Deweta	8	Hambantotha	18	Beruwala	9	Gandara-Devinuwara	23
	Hikkaduwa	20	Hambantotha-E	2	Kalthara	10	Paburana	2
	Katugoda	8	Kudawella-S	7			Paramulla	4
	Siybalagohawaththa	1	Kudawella-W	7			Thotamana	21
	Vijitharama	1	Madaketiya	6				
	No answer	1			No answer	1		

E=Eastern, S=Southern, W=Western

(1) Contents of Questionnaire

The questionnaire has seven sections with 50 questions in which consists of multiple choices and write in type questions. Major questionnaire items are shown below. The original text of questionnaire is attached in the end of the text.

1. General Information of Interviewee Sex, age, occupation, address 2. Tsunami Warning on September 12 Time of tsunami warning, Source of Tsunami warning Contents of tsunami warning 3. Evacuation Location of evacuation Means of transportation Information about evacuation place Reason of evacuation 4. Cancellation of Tsunami Warning Time of cancellation of tsunami warning Source of cancellation of tsunami warning Contents of cancellation of tsunami warning	5. Hazard Map and Evacuation Exercise Recognition of hazard map Usefulness of hazard map Participation to evacuation exercise Usefulness of hazard map 6. Other Information about Tsunami Warning Number of tsunami warning received Time and information source of tsunami warning Reaction to tsunami warning 7. Other Line availability of mobile phone Confusion in evacuation

K.2.3 Result of Questionnaire Survey

(1) Basic information about interviewee

Among the total of 150 samples, gender distribution was “male (85 samples)”, “female (50 samples)” and “no answer (15 samples)”.

About age distribution, interviewees age was concentrated in “30s (27 samples)”, “40s (41 samples)”, “50s (30 samples)” with small number of “below 20s (3 samples)”, “20s (14 samples)”, “60s (11 samples)” and “no answer (24 samples)”.

Current occupation of interviewees were “fishery (37 samples)”, “housewife (26 samples)”, “merchant (24 samples)”, “company employee (14 samples)” and “civil officer (8 samples)” are the major answer.

The distance from the coastal line to current residence was asked. Among 150 samples, interviewees answered that about 43% live in “0 to 100 m” and 46% live in “100-500 m” (Q1.6). This result shows that about 90% of interviewees live in less than 500 m from the coastal line at present. Many interviewees live in close to coastal line after the tsunami experience in 2004.

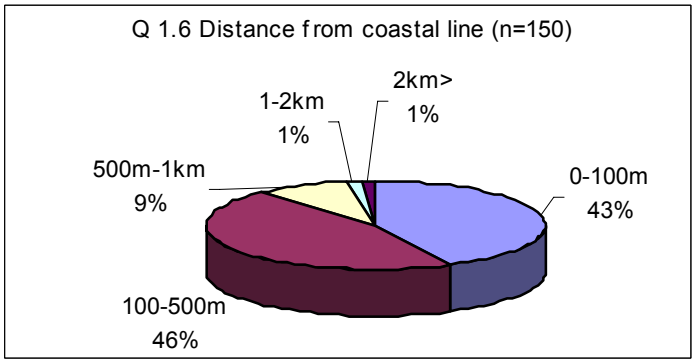


Figure K.2.1 Distance from Coastal Line to House

Among 150 samples, about 93% (138 samples) of interviewees were affected by the tsunami in 2004 (Q1.7). Among whose were affected, the house damage was "totally destroyed (39%)", "half destroyed (36%)", "partially destroyed (9%)" as shown in Figure (continue Q1.7).

(2) Time and Tools of Tsunami Warning on September 12, 2007

PTWC issued 1st tsunami watch at 16:54 and DOM at 17:20. All the interviewees received tsunami warning and 87% of interviewees received tsunami warning before 18:00, about 60 mints after the tsunami watch by PTWC and 30 to 40 minutes after DOM's tsunami warning. On the other hand, 13% of interviewees answered that they received the information after 18:00.

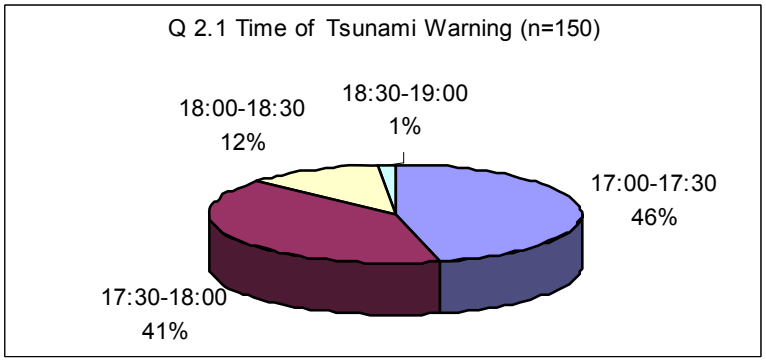


Figure K.2.2 Time of Receiving the Tsunami Warning

Since the expected time of tsunami arrival in the coast of Sri Lanka is around 20:00 to 21:00, it is considered that people in the community had enough time to evacuate with current situation.

The source of tsunami warning was asked in Q 2.2 and interviewees could give multiple answers, and the result is shown below.

Table K.2.3 Source of Tsunami Warning

Item	Answer	Percentage
TV	102	68%
Radio	65	43%
Speaker	42	28%
Neighbors	40	27%
Family	28	19%
Friends	28	19%
Community Leader	22	15%
Police	20	13%
Telephone	18	12%
Internet	2	1%
Others	14	9%

This result shows that many interviewees received tsunami warning by TV or/and Radio. In addition to the media information, they received tsunami information from public such as "Speaker" or "Police" and from family or community but their answers were limited to about 10 to 20%.

According to the comments on the interview sheets, most of interviewees trusted information provided by the media rather than government. However, many of interviewees received information

from speaker and/or other public sources, therefore, several methods have to be established to disseminate warnings.

When this result was analyzed by district level, no clear differences between districts are observed. However, interviewees in Mathatara and Hambantotha received information from various sources while interviewees in Kalutara answered that they received information only from media. The reason should be analyzed further but level of understandings and quality of interviewer might influence the result.

(3) Contents and Sources of Tsunami Warning on September 12, 2007

The contents of tsunami warning message (information received) could be divided into three levels (Q2.5):

1) Earthquake information and instruction to evacuation (85 answers)
2) Instruct to be aware of possible tsunami (3 answers)
3) Earthquake information in Indonesia (15 answers)

From this result, most of interviewee received earthquake information together with instruction to evacuate to the safe place.

(4) Evacuation Condition after the Tsunami Warning

Among total of 150 samples, 92 % (138 answers) actually evacuated to the safe place. Among who answered that they evacuated, 89% (82 % of total samples) evacuated soon after receiving the tsunami warning (Q3.1).

Among nine interviewees who answered that they did not evacuate soon was asked their reasons. The interviewees answered that "they thought tsunami is not coming soon (4 answers)".

According to the Q2.1, most of the interviewees replied that they received the information before 18:00, and this means that the information they received was not the evacuation instruction because the instruction was issued at 18:30 by DOM. In Q3.1, more than 80% of the interviewee evacuated soon after they received information. This shows that people in community mostly did not understand the meaning of the information/warning properly.

In Q3.4, place of evacuation was asked. About 40 % answered those public spaces or infrastructures such as school and temple that might be strong or it was the evacuation place in past experience. Also about 23% answered "Small hill".

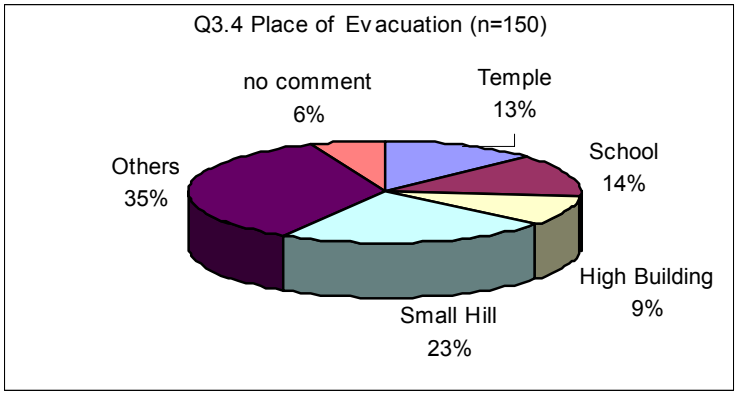


Figure K.2.3 Place of Evacuation

The location of schools and temples were not identified in this questionnaire. Major answer of "Other" was "friend or relatives house" which consist of 20% of total sample. From this question, it can be said that people were able to evacuate to safer place because of previous tsunami experience or/and evacuation drill that identified the evacuation place.

Means of evacuation transportation were mostly "On foot" (Q3.5). Figure K.2.4 shows the place of evacuation and means of transportation at the time of tsunami.

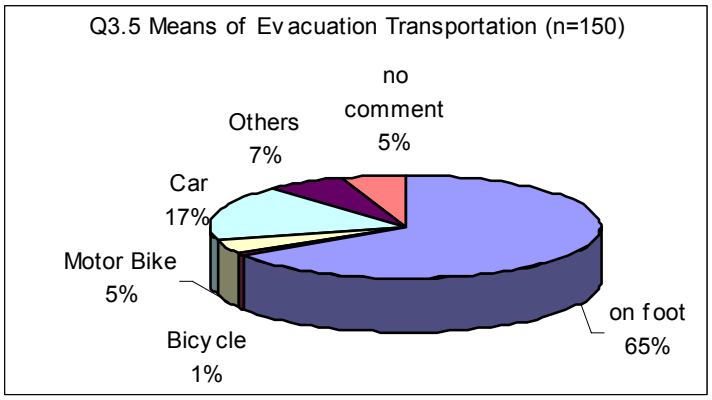


Figure K.2.4 Means of Evacuation Transportation

Question was asked about their knowledge of evacuation place prior to tsunami warning with multiple answers (Q3.8). Almost all (95%) of interviewees knew the evacuation place in advance by "Evacuation drill (81%)". Those who did not know the location of evacuation place answered that "they followed others" or "evacuated to the place based on previous experiences". From this question, evacuation drill was effective for responding to the actual situation of tsunami warning and for increasing the awareness of the people. Figure K.2.5 shows the reason of knowing about evacuation place.

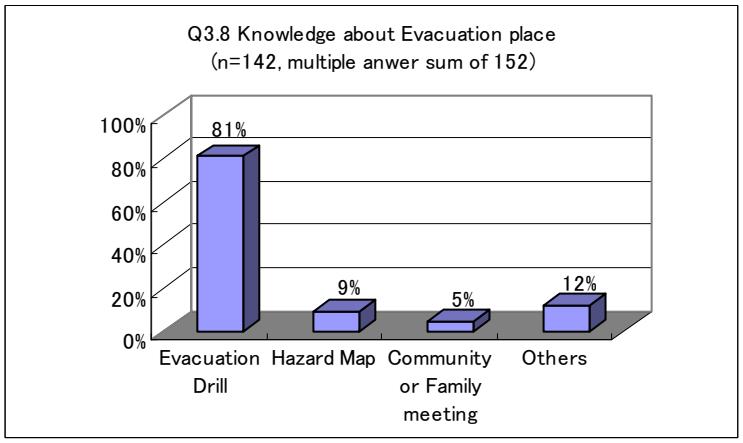


Figure K.2.5 Knowledge about Evacuation Place

(2) Cancellation of Tsunami Warning

Among total of 139 samples, 96 % (134 answers) returned their house because they received information of "evacuation cancellation" (Q4.2). From this result, it can be said that the most of interviewees received cancellation of tsunami warning. Only less than 3 % of interviewees left the evacuation place before the cancellation of tsunami warning (Q4.1 and Q4.2). The cancellation of

tsunami warning was issued at 20:30 and most of interviewees left the evacuation place around 21:00 to 22:00 after hearing the cancellation of the tsunami warning. Figure K.2.6 shows the time of leaving the evacuation place.

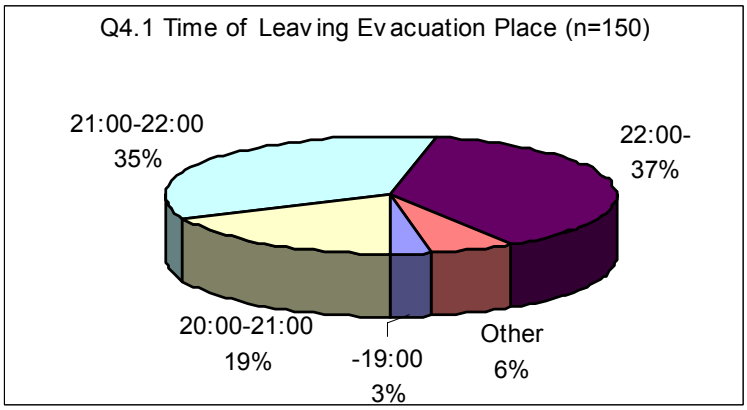


Figure K.2.6 Time of Leaving Evacuation Place

The source of cancellation of tsunami warning was asked with multiple answers in Q 4.4. The major answer was TV. This result shows that all the interviewees received cancellation of tsunami warning mainly from the media but also with several ways that can confirm that disaster information or warning is appropriately transferred and disseminated to people in the community in evacuation place. However, this result shows that the source of information is heavily depended on the media rather than instruction by the organization or verbal communication. Table K.2.4 shows the source of cancellation of tsunami waning.

Table K.2.4 Source of Cancellation of Tsunami Warning

Item	Answer	Percentage
TV	127	86%
Radio	78	53%
Speaker	27	18%
Friends	21	14%
Neighbors	20	14%
Family	19	13%
Community Leader	18	12%
Police	11	7%
Telephone	7	5%
Internet	2	1%
Others	14	9%

In Q4.5, the content of tsunami warning cancellation was asked. The result of message contents could be divided into two levels:

1) Inform that emergency situation is over and tsunami will not come to Sri Lanka (76 answers)
2) Inform that emergency situation is over and instruct to go home (44 answers)

From this result, most of interviewee received information on “cancellation of tsunami warning” and “end of emergency situation”. Also the result shows that one third (1/3) of interviewees received an instruction to go home together with cancellation of tsunami warning.

(3) Hazard Map and Evacuation Drill

About 60 % of interviewees knew hazard map and among those who knew hazard map saw the hazard map during the evacuation drill (94%) (Q5.2 and Q5.3). Figure K.2.7 shows the knowledge and usefulness of hazard map.

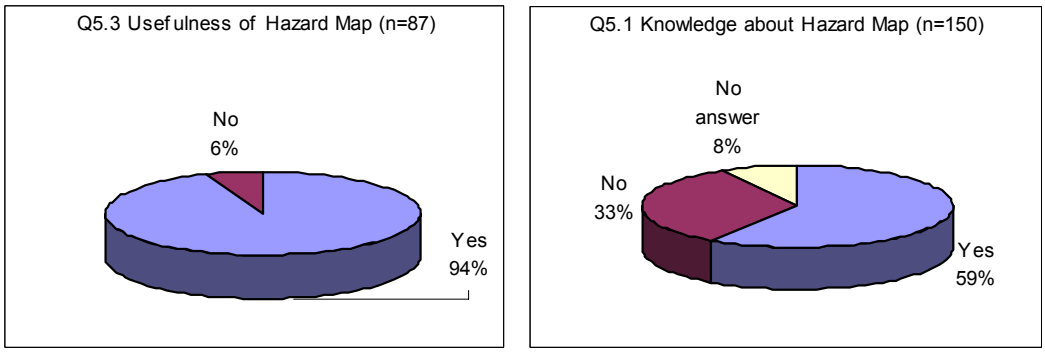


Figure K.2.7 Knowledge and Usefulness of Hazard Map

73% of interviewees had experience of participating the tsunami evacuation drill before (Q5.4). Among those who already knew the evacuation place reached about 91% (cross checked with Q3.7 and Q3.8). Based on this result, it can be said that almost all the participants who attended the evacuation drill could recognize the evacuation place appropriately and hazard map helped them to recognize the geological location of evacuation route and place. Also, All the interviewees who participated in the tsunami evacuation drill answered that "the evacuation drill was useful (100%)". On the other hand, the main reason of not participating to the evacuation drill was "did not know the drill (56%)" (Q5.6). It can be said that evacuation drill need to be widely informed in the community and the drill is useful for people during the actual evacuation of the disaster.

(4) Tsunami Information and Warning on September 13, 2007

About 82% of interviewees received the tsunami warning issued in the morning of September 13. Compare with the 100% on September 12, 18 points decreased (Q6.3). Also on 12th, 99% of the interviewees received information some kind within about one hour, however, on 13th, only 69% of interviewees received information within one hour. The earthquake was occurred in the early morning on 13th, it might cause delay in disseminating the information, however, in both cases, people had enough time to evacuate based on the estimation of the tsunami arrival. The source of information and tool that used for the information transfer were mostly same in 12th and 13th September.

About 84% of interviewees who heard the 2nd tsunami warning took some kind of action but only 21% actually evacuated even evacuation instruction was not issued by DOM or other government authorities, which is reduced about 71 points from 1st evacuation of about 92% actually evacuated (Q6.4). The reasons need to be further analyzed but the time (early morning), level of warning and 1st day experience might influence the result.

About 53% of interviewees answered that they had some changes of mind from 1st warning to 2nd warning (Q6.5) and said that about 70% of interviewees had negative impression about tsunami

warning answered that "it seems not necessary to evacuate (38%)" followed by "tsunami does not seems to occur (31%)".

(5) Others/ Comments

Reliable Information Source

The most reliable information source regarding the information transfer and evacuation was asked with multiple answers and about 72% answered "TV" followed by "Radio (59%)" and "Government (43%)" (Q7.2). This result shows that interviewees relied on media rather than government or police. Figure K.2.8 shows the reliable source of information for community people.

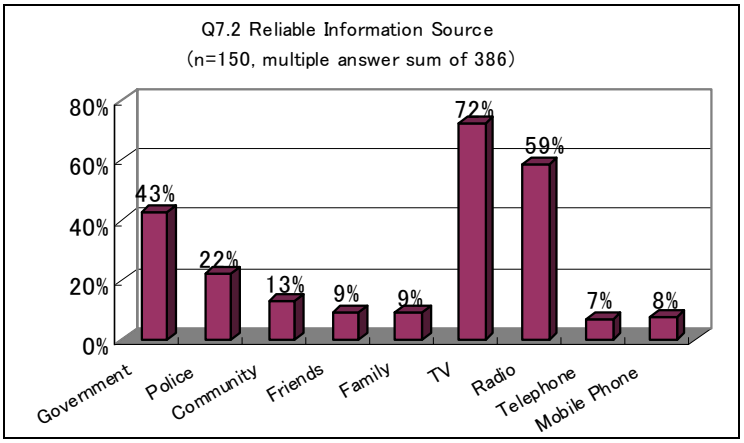


Figure K.2.8 Reliable Source of Information

Also, about 80% of interviewees said that there was some confusion. One of major reason of confusion was caused because "information received was different from the actual situation (52%)" (Q7.5). Therefore, people in the community are hoping to receive tsunami or other disaster related information/warning from reliable information source for responding and evacuating from their place.

Telephone Communication

The mobile phone (93%) and landline telephone (82%) was not able to use during the course of tsunami warning (Q7.3 and Q7.4).

Means of Information Dissemination

Many interviewees requested the installation of a siren or a speaker to inform the disaster warning which could be useful at the night. Also many thought that evacuation drill was useful and hoped to continue the practice in the future.

Some interviewees suggested using the bell in the temple, mobile phone at night, and also to make some arrangement to evacuate elders and heavy people.

(6) Summary of the questionnaire survey

Another tsunami was occurred after three years of the Indian Ocean Tsunami in December 2004. The complete system of information transfer and dissemination of tsunami warning to the community was not established yet at that time, however, this survey illustrated that 99% of interviewees received tsunami information/warning and evacuation instruction, and evacuated to the safer place. Almost all

interviewees evacuated to the safe place shows that people's awareness has increased because of the 2004 tsunami experience and some of activities in community such as evacuation drill and hazard mapping which were conducted during this three years.

However, the result also shows that about 50% of people changed their mind from 1st warning and 2nd warning and over 70% had negative impression about tsunami warning. Even though the time and warning level had some influence to their mind and behavior, it is necessary to inform the people that tsunami warning is based on an estimation of possible tsunami and not always tsunami occur, but it is important to take an appropriate action based on the tsunami warning.

K.3 Flood Disaster on April / May and May / June in 2008

K.3.1 Background

Southwestern part of Sri Lanka experienced flood three times in 2008 in the end of April to May (April/May flood), and the end of May to beginning of June (May/June Flood) and the middle of July, and the scale of floods were severe as 2003 flood. This questionnaire survey was designed and conducted to understand the local condition and psychology of the local people at the time of evacuation.

Damage by Flood in April/May and May/June Floods

April/May and May/June Floods caused severe damages such as death and many affected people in the seven districts namely, Colombo, Kalutara, Galle, Kegalle, Gampaha, Ratunapura and Matara. The details of damage by the flood in each district are shown below.

Table K.3.1 Location and Number of Affect People by May/June Floods

Number/District	Colombo	Galle	Gampaha	Kegalle	Mathara	Ratnapura
Affected GN*	11	96	79	3	-	31
Affected Family*	8,164	4,373	8,646	450	1,100	6,685
Affected People*	42,402	-	41,114	1,500	5,600	25,200
Death*	0	1	-	1	1	-

*Source:*Daily Mirror (Sri Lanka Newspaper), -No information*

K.3.2 Questionnaire Survey on Flood Disaster

(1) Survey Method

Questionnaire sheet was distributed to DDMCU in seven (7) districts (Colombo, Galle, Gampaha, Kalutara, Kegalle, Mathara and Ratunapura.) where were affected by the flood through DMC. Each district was asked to select total of 20 persons from several flood affected area to answer the questionnaire. Not all the DDMCU conducted 20 questionnaires but less. Total number of samples collected was 106 samples.

The officers in district conducted the questionnaire using face-to-face interview method.

(2) Survey Duration

The survey was conducted from July to September 2008.

(3) Location and Sample Number

The details of sampling location and number are shown below.

Table K.3.2 Location and Number of Samples Collected in Each District

No.	District	Sample collected
1	Colombo	24
2	Galle	24
3	Gampaha	13
4	Kalthara	6
5	Kegalle	19
6	Mathara	15
7	Ratunapura	5
	TOTAL	**106**

(4) Contents of Questionnaire

The questionnaire has seven sections with 50 questions in which consists of multiple choices and write in type questions. Major questionnaire items are shown below.

1. General Information of Interviewee - Sex, age, occupation, distance from river 2. The details about flood in May/June - Duration, height, maximum height, damage and frequency of flood, preparedness for flood 3. Regarding response before the flood situation - Psychological condition, activity and preparation activity of one day before the flood 4. Evacuation Activity - Decision making and psychological condition at the time of evacuation - height of flood and evacuation location	5. Flood Information - Time, contents and information source of flood information and evacuation address - Height of flood at the time of receiving information 6. Future Activity - Request for government - Willingness for participating early warning activity 7. Proposal for mitigating flood damage 8. Other - Comments

K.3.3 Result of Questionnaire Survey

(1) Basic information about interviewee

Among the total of 106 samples, gender distribution was “male (58%)” and “female (33%).

Interviewee’s age distribution was concentrated in “40s (30%)” and “30s (23%)”.

Current occupation of interviewees were “housewife (19%)”, “merchant (13%)”, “agriculture (11%)” and “unemployed (11%)”.

Their structure of house was also asked to understand their living condition (Q1.5). Majority of interviewees live in “one story house (76%)” and 20% live in “2nd story house”.

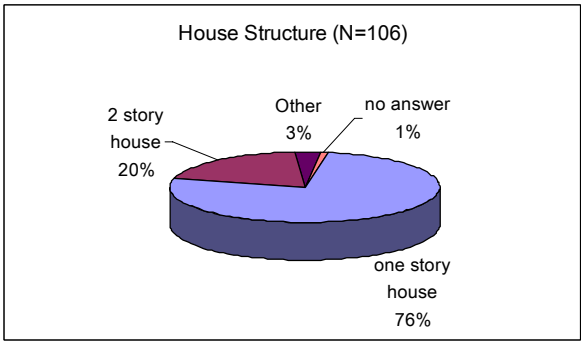


Figure K.3.1 House Structure

(2) Flood Condition of April/May and May/June Flood

The highest level of flood experienced either in April/May or May/June was asked. Most of interviewees experienced inundation and over 80% experienced maximum level of flood over "knee" to even "higher than their house" by these floods (Q2.1). Many interviewees experienced flood level of "knee (20%)", "waist (19%)" and "breast (17%)".

This result shows how severe these floods were and people actually experienced high level of flood which might put them in danger.

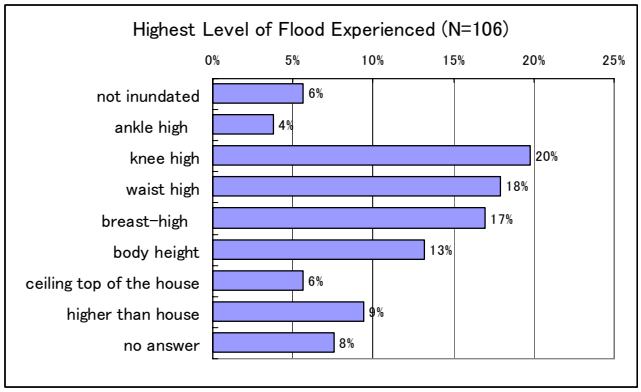


Figure K.3.2 Highest Level of Flood Experienced

The damages by the flood varied but many answered "damaged to furniture (16%)", "shortage of food and water (13%)" and "damage to food (10%)" (Q2.3). Since majority of people lives in one story house, the flood directly affects their property.

Table K.3.3 Damages by the Flood

Damage	No. of Answer	Percentage
No any damage	9	3%
Family member injured	3	1%
House was totally destroyed	4	1%
House was half destroyed	24	8%
House was partially destroyed	10	3%
Damage to house and shop equipment and facility	13	4%
Damage to commercial products/goods	16	5%

Damage	No. of Answer	Percentage
Damaged to furniture	49	16%
Damage to food	31	10%
No house damage but flooded the floor	19	6%
Work/business was not possible	19	6%
Could not live in the house	19	6%
Furniture was not usable	17	6%
Shortage of food and water	40	13%
Road was flooded and could to move	18	6%
Nothing particularly	2	1%
Other	19	6%
No answer	4	1%
TOTAL	**300**	

Did they take any preparation measures since people in Sri Lanka faces flood every year? (Q2.6).

About 50% of interviewees answered that they did not take any preparation measures before the flood. Some people participated in several activities like "community workshop (18%)", "formulation of Disaster Management Committee (14%)", or/and "community activities (10%)" which include monitoring the rain, preparing a hazard map and/or participating evacuation drill.

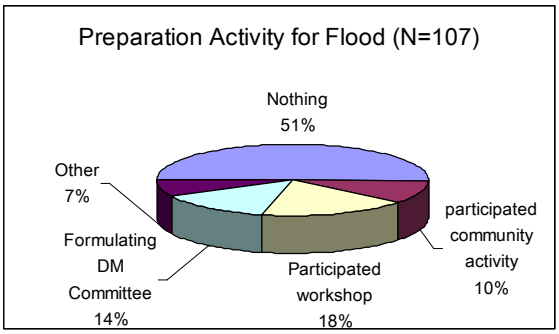


Figure K.3.3 Preparation Activities for Flood

(3) Response of People before the Flood

There was a situation that it was raining some days before flood occurred. Questions were asked to understand how people were assessing/assuming their situation and how they felt before the flood.

Question was asked "Did you think that flood is going to happen one day before the flood?" (Q3.2) Over 70% of interviewees thought that there would be a possibility of flood one day before the flood.

Also, over 50% of interviewees felt "very worried" when their feeling about one day fore the flood was asked (Q3.3). On the other hand, about 20 % of interviewees were not so much worried about the flood.

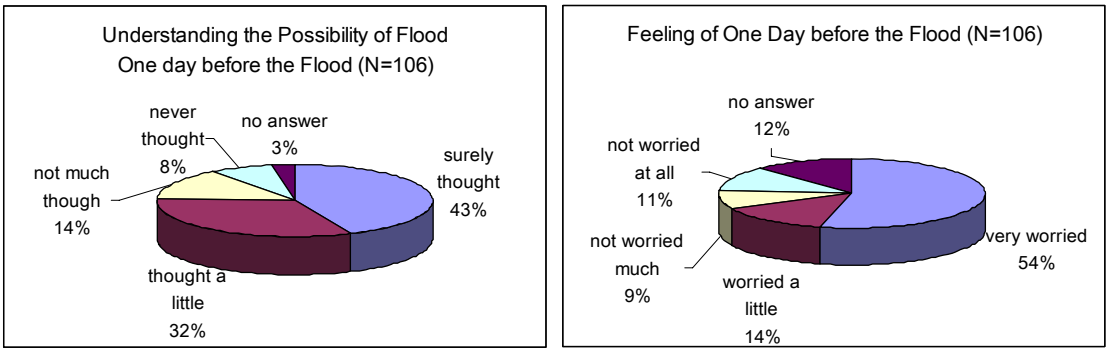


Figure K.3.4 Understanding of Situation and Feeling at One Day Before the Flood

The reason of not worry about flood was asked (Q3.4). Although this question was for person who answered "not worry" or "not worry at all", almost all the interviewees answered this question (Q3.3). This means many interviewees understood this question as a new question but relation to Q3.3 and instruction of questionnaire was not appropriate. Since this question and answer is consider to be important, this question is considered as a separate question and answer from Q3.3. Many interviewees answered that they "thought it wouldn't be so serious even thought it becomes flood (33%)", "thought it was a usual rain (20%)" and "thought water would not come until my house (18%)".

This result shows that people did not worry or did not think flood would occur based on their assumption. Also, people tend to think and judge the situation for their convenience.

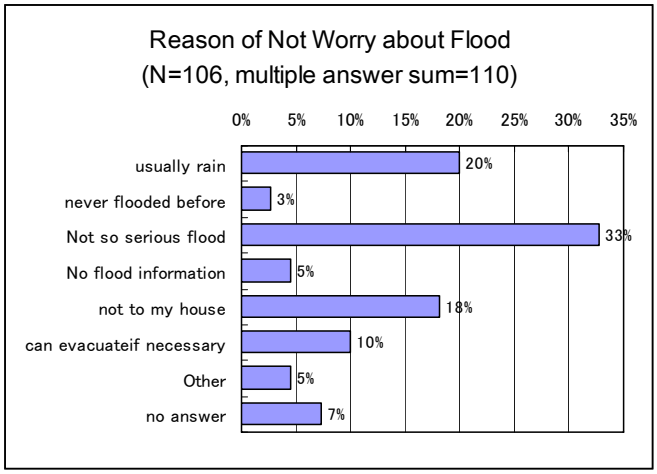


Figure K.3.5 Reasons for Not Worry about Flood

(4) Evacuation Activity

About 60% of interviewees evacuated to the safe place at the time of flood (Q4.1). About 20 % of interviewees evacuated when flood level was low like ankle or not inundated. However, over 40% of interviewees evacuated when water level was already at "knee (21%)", "waist (11%)" and "breast (10%)" or higher (Q4.3).

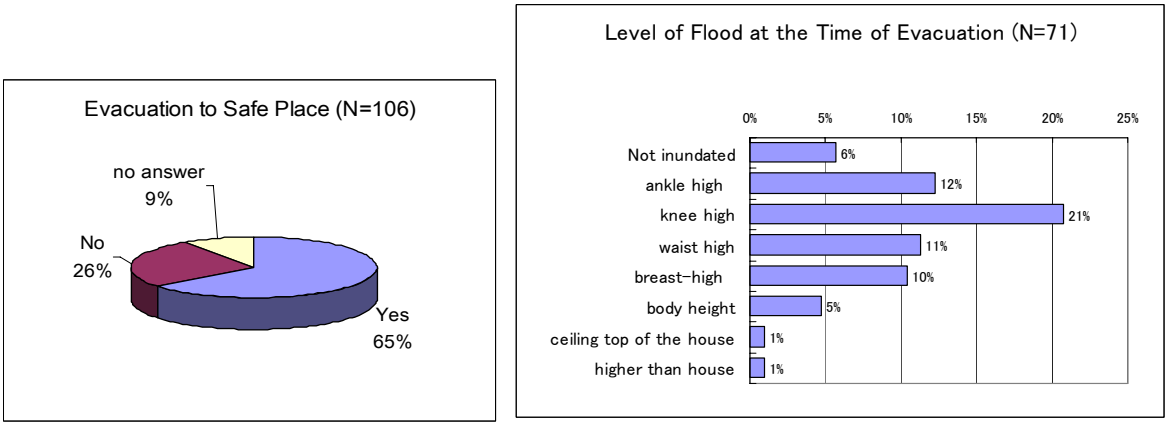


Figure K.3.6 Evacuation to Safe Place and Height of Water Level at the time of Evacuation

The reason to decide evacuating from their house was asked, "What made you to decide to evacuate?" (Q4.4). The result shows that about 20% of interviewees decided to evacuate because it was already flooded. On the other hand, about 30% evacuated before the flood because they thought that they are going to be in danger ("thought myself and family are in danger (24%)" and "thought house would be flooded (11%)"). Also, some people decided to evacuated because their family or neighbors recommended them to evacuate. In addition, some people heard flood warning or instruction by police and DS officers to evacuate.

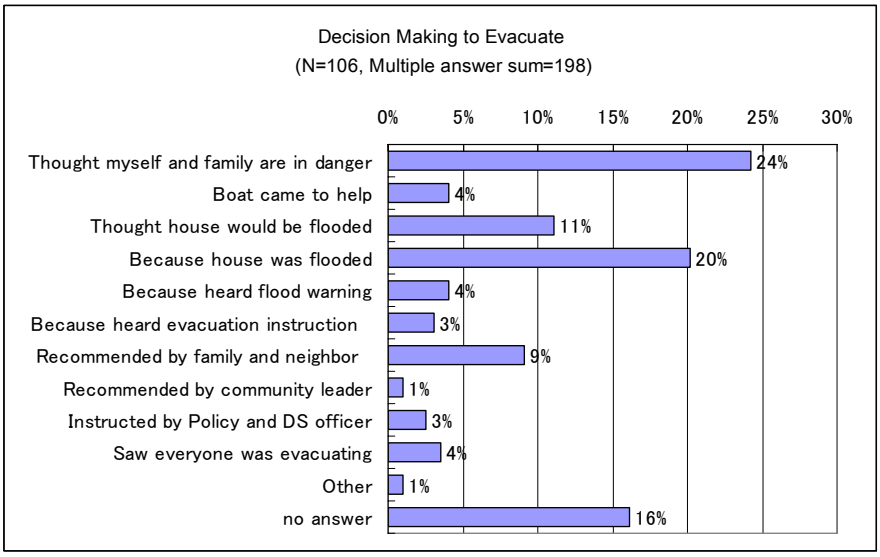


Figure K.3.7 Decision Making at the Time of Evacuation

Over 50% of interviewees evacuated to their "family and relative house (69%)". Others evacuated to "school" or "hill and higher place". The reason of deciding the evacuation place was mostly based on their "past experience (40%)", and 25% of people decided based on the community activities.

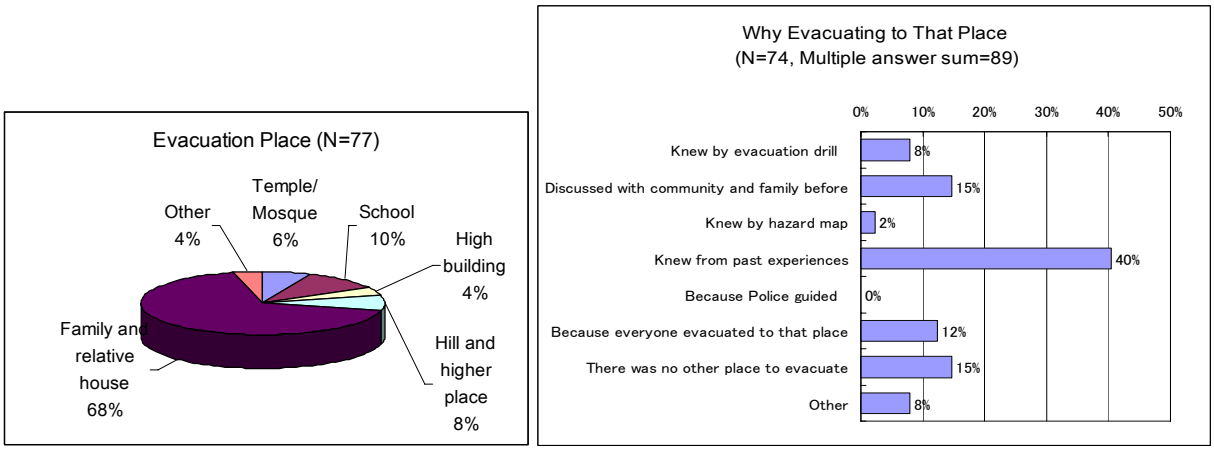


Figure K.3.8 Evacuation Place and The Reason for Deciding the Evacuation Place

The feelings at the time of evacuation was “worried about children and elderly (16%)”, “Worried about my poverty and belongings at home (15%)” and “felt a fear because it was hard to see the street at night (14%)” (Q4.9). This result shows that many people woried about their family and the vulnerable, at the same time, they worried about their property and belongings at home.

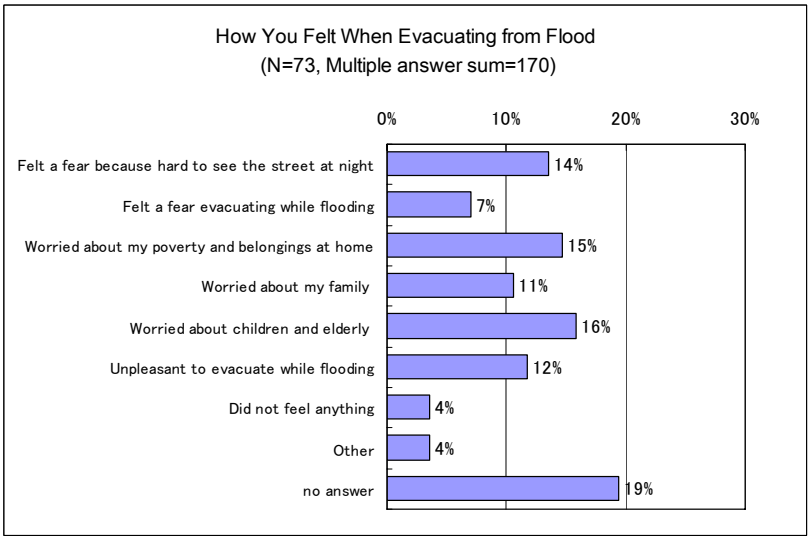


Figure K.3.9 Reception and Contents Flood Information

(5) Flood Information

Questions were asked how flood information was disseminated to people in the community.

About 40% of interviewees received flood information and 20% did not receive flood information (Q5.1).

The content of flood information was about “the river water level will increase (39%)”, “there is a danger of flooding (34%)” and “there is a heavy rain (24%)”.

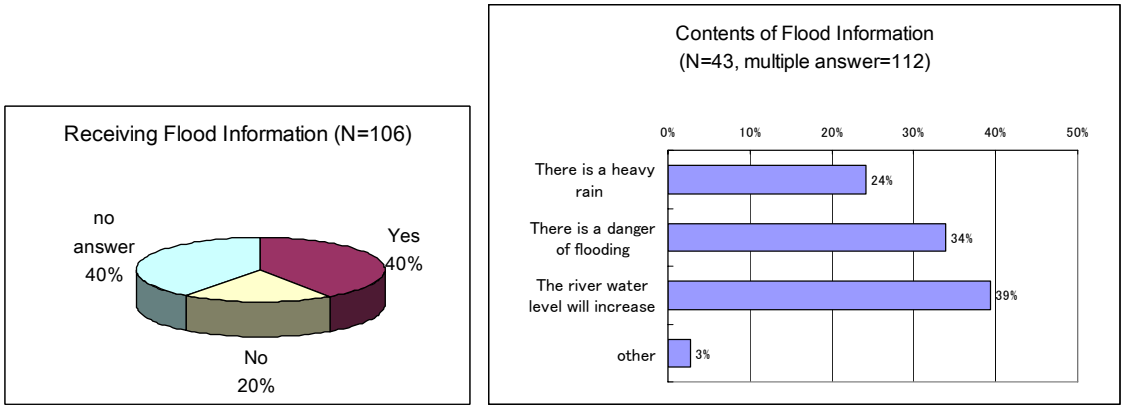


Figure K.3.10 Reception and Contents Flood Information

About 80% of interviewees received flood information verbally. They also received flood information by other means like "TV", "Radio", "phone" or "speakers" but the percentage is low as about 20%. In Colombo, Gampaha and Kaluthara, many people selected "TV" or "radio" as a means of receiving flood information but percentage is about 20% in each district.

About 40% received flood information through "neighbors", followed by "family (19%)" and "friend (18%)". Also some people answered "police (9%)" and "government officer (85%)" (Q5.1b).

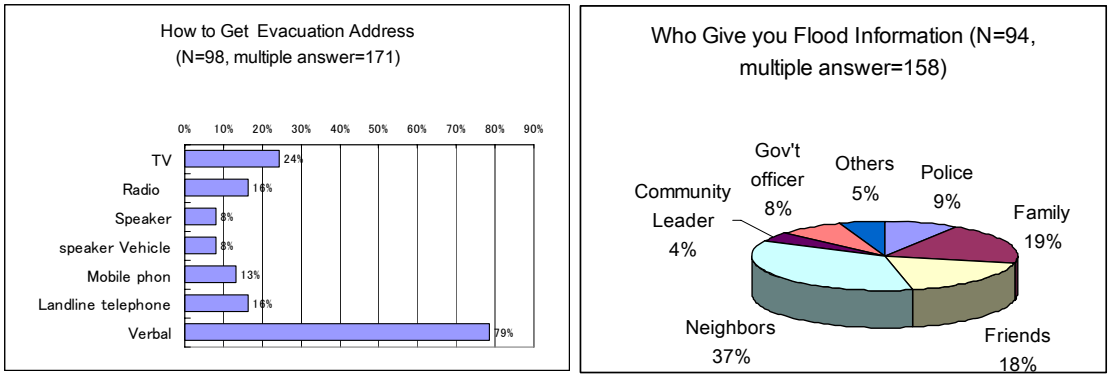


Figure K.3.11 How and from Who to Get Flood Information

The source of flood information varied and several organizations were listed. Among several organizations, "AGA (18%)" and "police (18%)" had high recognition followed by "meteorology department (14%)", "DMC (11%)" and "GN (11%)" (Q5.1c).

The height of water level at the time of receiving flood information was "not inundated (39%)" and "water level of river had increased (23%)" followed by "ankle (18%)" and "knee (15%)".

This result shows that flood information was disseminated when the height of water level is still low or below knee level.

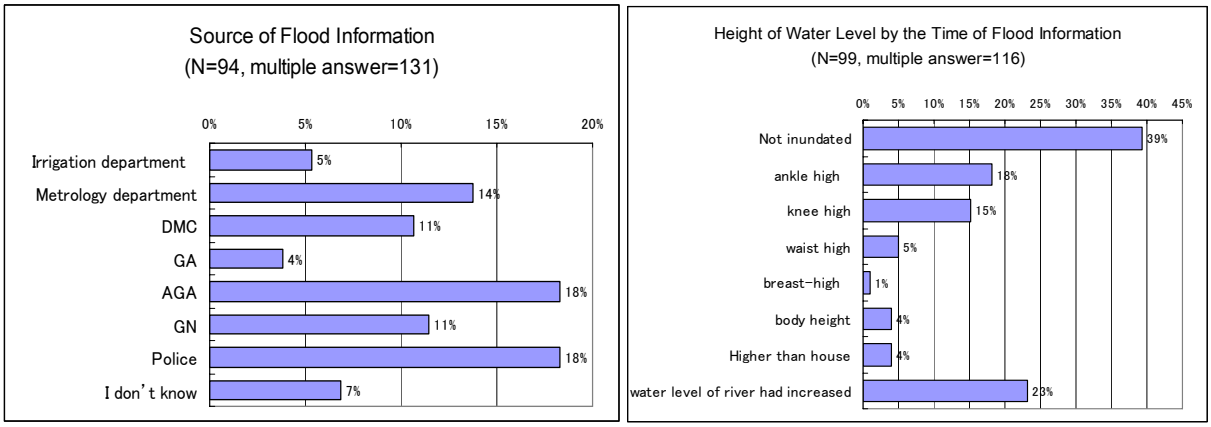


Figure K.3.12 Source of Flood Information and Height of Water Level at the time of Flood Information

Their feeling and thinking at the time of receiving flood information was asked (Q5.1e). Some people were optimistic like "There won't be a flood risk (22%)" and "nothing special but it is usual rain (11%)" even though they received flood information. On the other hand, some people felt that "there will be a flood risk (17%)" and thinking about next step like "better to evacuate (17%)" or "better to check the neighboring situation (21%)".

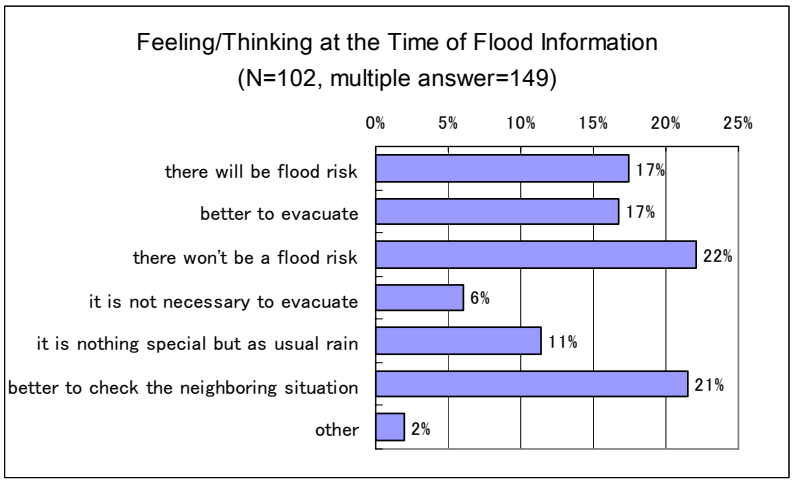


Figure K.3.13 Feeling/Thinking at the time of Receiving Flood Information

(6) Other

Evaluation for Government's Response

People's evaluation of government's response to this flood was asked (Q6.1). About 22% of interviewees answered "there was no or not enough boat (22%)" and "did not receive evacuation instruction (15%)" or "did not receive flood information (12%)".

This result shows that there is a shortage of boats for their evacuation. Also, people wants government to provide food information or evacuation instruction and some also wish to receive information/evacuation instruction earlier.

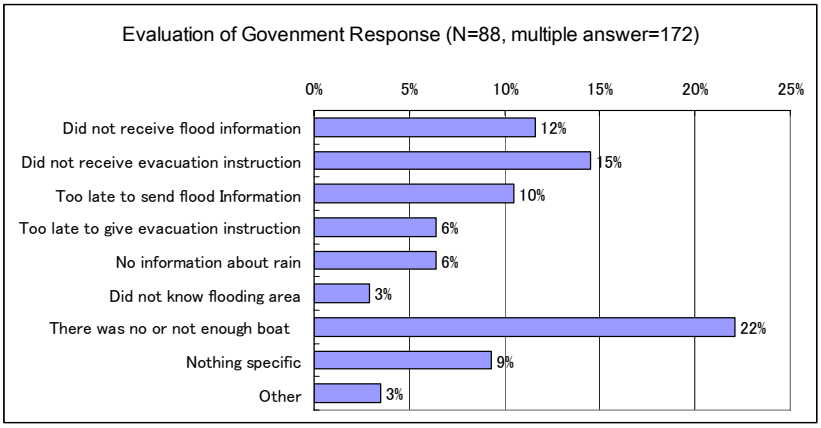


Figure K.3.14 Evaluation of Government's Response

Ideal Type of Information ,Timing and Informant for Flood Evacuation

A question of "With what kind of information, will you evacuate before flooding? (Q6.2)" was asked. People wants to receive information of "expected river water level (50%)" followed by "predicted amount of rainfall (31%)" and "became flood or not (26%).

About 45% of interviewees want flood information "one day before" and 30% want "6 hours before".

This result shows that people wants to receive flood information at early stage and they want to judge based on estimated or predicted river water level or rainfall in their area.

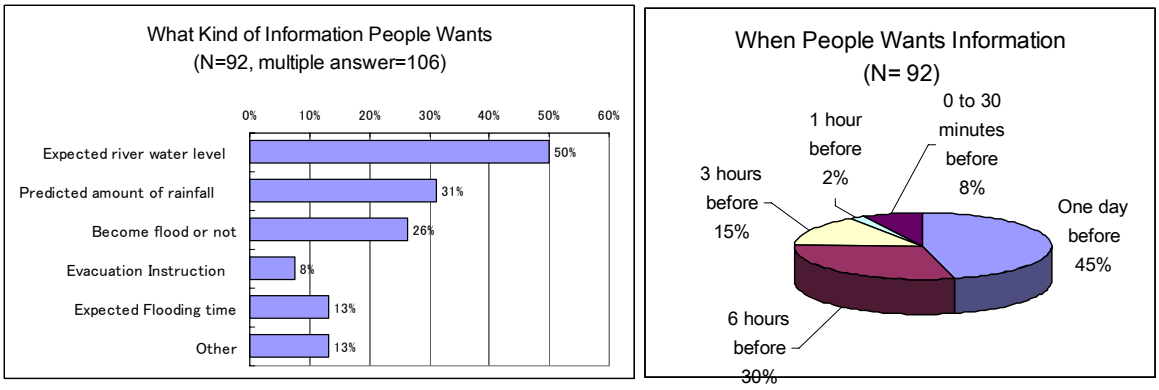


Figure K.3.15 Type of Information and Timing of Flood Information People Request

About 55% of interviewees think that “GN (55%)” is an appropriate person to give flood information followed by “neighbor (42%)”, “family and relatives (42%)”, “TV (35%)” and “police (32%)”.

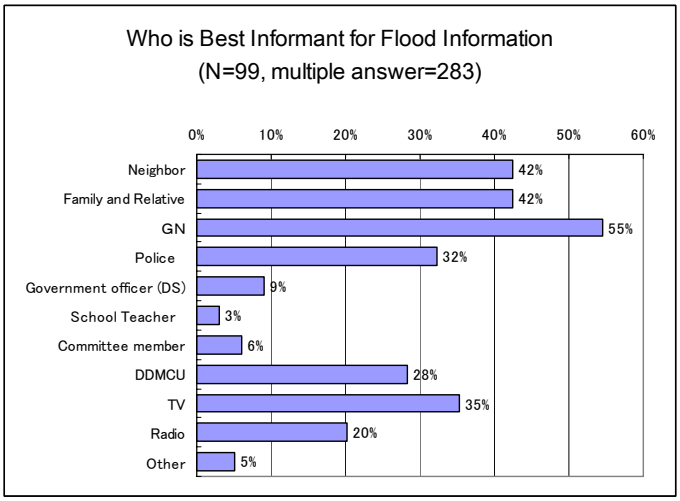


Figure K.3.16 From Who People Wants to Receive Flood Information

Proposal of Flood Mitigating Measures

People’s willingness for participating the community based flood mitigation activity was asked (Q6.4). Over 80% of interviewees want to receive early warning information even though flood might not occur.

Also, about 70% of interviewees were willing to participate in community based flood forecasting activity.

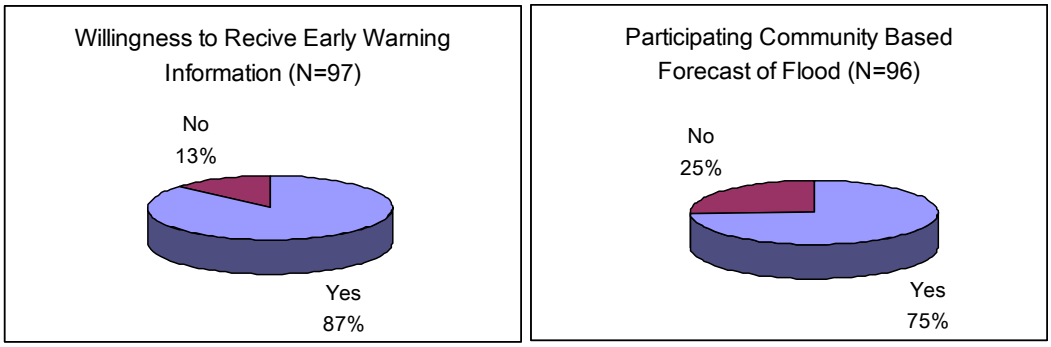


Figure K.3.17 Willingness to Receive Flood Information and Participate in Community based Flood Forecasting

Their proposal for mitigating the future disaster was asked. About 50% of interviewees selected “proper instruction of disaster preparedness” for proposed measures for flood mitigation, followed by “supporting service for evacuation (42%”), “early warning (41%)” and “construction/reinforcement of flood management structures (32%)”.

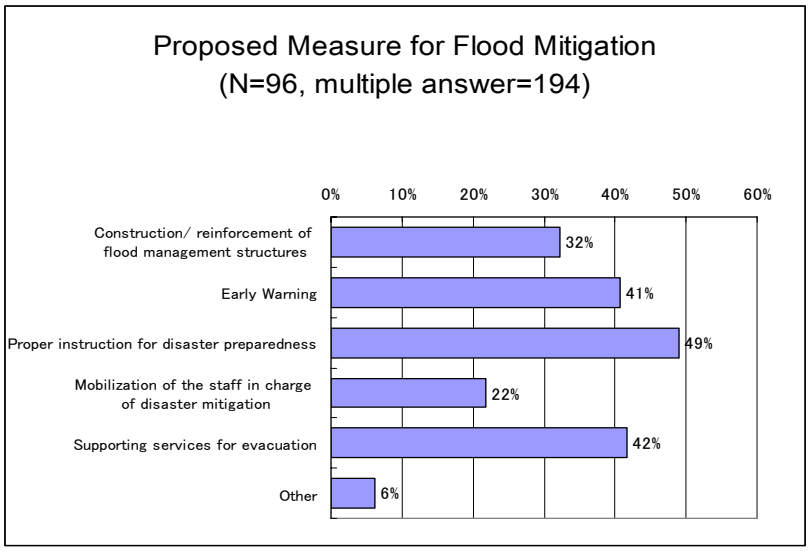


Figure K.3.18 Proposed Measure for Flood Mitigation

(7) Summary of the questionnaire survey

The two floods in April/May and May/June affected many divisions in Sri Lanka. Many people experienced high level of flooding over knee level to even higher than house level, and had damages to their furniture, food and water and their businesses.

Even though people experience flood almost every year, not many people did prepare for flood and take actions when they were in the situation of flooding or in danger. Many were optimistic about their situation and they assumed that flood would not be very serious or would not come to my house. However, this questionnaire illustrated that over half of interviewees have some kind of recognition/assumption that flood condition would occur one day before the flood and they worried about it.

During April/May and May/June floods, about a little more than half of interviewees received flood information through verbal communication through neighbors or family and friends when flood condition was not serious or not even inundated. In some area, GN or police instructed them to evacuate, therefore, there was an early warning and evacuation system in place in some area. However, the early warning and evacuation needs improvement to disseminate appropriate information to all the people in the community and actually address people to take actions..

For future flood situation, people are expecting the government to give early warning information many hours or one day before the flood for making their decision to evacuate before the flood. On the other hand, people in the community are willing to have some kind of community based measures like observing rainfall or river water level to obtain flood information before the flood.