CHAPTER 7 FLOOD VULNERABILITY ANALYSIS

7.1 Objective

Flood vulnerability analysis is aimed at evaluating the vulnerability of the four target basins. The vulnerability is evaluated through a comprehensive accounting of natural and social conditions of the river basins and existence of countermeasures against floods, etc. The results of evaluation will be the basis for the selection of priority projects and preparation of Action Plan of the current study.

7.2 Methodology

In this Study, flood vulnerability analysis is conducted using Flood Vulnerability Index (FVI) method . FVI method is developed by National Institute for Land and Infrastructure Management (NILIM), Japan, with the following objectives: 1) to build the index by combining several cause-effect components from a range of available data for assessment of flood risk, 2) to enable the comparison of the flood risk in several basins with different conditions and to grasp the secular change of the basins, 3) to enable people to determine the future flood vulnerability by varying cause-effect relations based on several scenarios, and 4) to prepare an effective and useful policy tool for providing guidance on water issues.

The FVI method evaluates the flood vulnerability using 11 indicators, which are roughly categorized into four components of climate, hydrogeology, socio-economy, and countermeasure as shown in Table II-56.

FVI is calculated by the following equation.

$$FVI = (No.1 + No.2) \times 3 + (No.\ 3 + No.\ 6 + No.\ 8 + No.\ 9) - (No.\ 4 + No.\ 5 + No.\ 7 + No.\ 10 + No.\ 11)$$

Where; "No." of the above equation corresponds to the "No. of Indicator" and "FVI Indicator" in Table 7.3.1

As an example, Table II-56 shows the FVI calculation results for 63 major world never basins, which are either equal to or wider than 0.1 million km^2 (multiple countries), or equal to or wider than 0.8 million km^2 (single country, e.g., Russia and Australia).

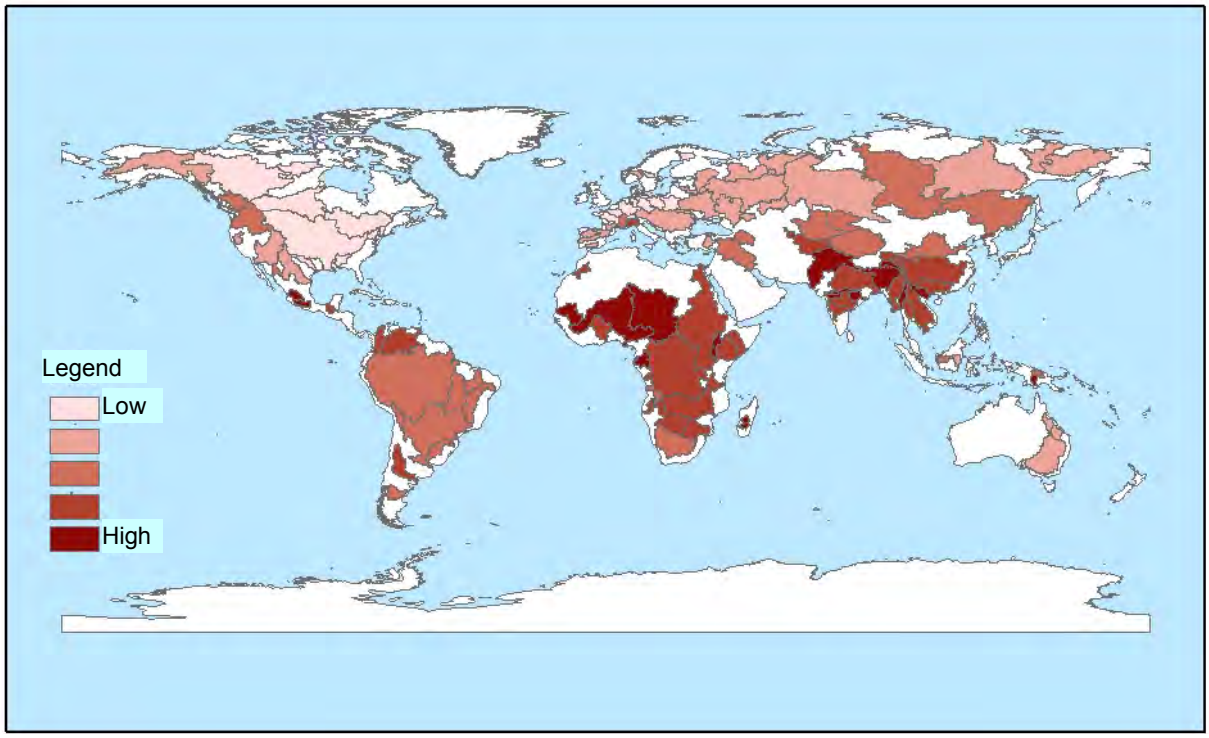
Table II-56 FVI Indicator

Component				No. of Indicator	FVI Indicator	Unit	Definition
Climate C	Hydrogeology H	Socio-Economy S	Countermeasure M				
X				1	Frequency of heavy rainfall (more than 100mm/day)	days/year	The number of days of heavy rainfall with more than 100mm/day in the basin in a year
	X			2	Averaged slope of basin	degree	Basin-wide averaged slope
	X			3	Urbanized area ratio in basin	%	Urbanized area ratio in basin
		X		4	TV penetration rate	units/1,000 pop.	The number of TV units per the population of 1000 people
		X		5	Literacy rate	%	The estimated value of population ratio of people (more than 15 years old) who can communicate (read and write) for ordinal daily life
		X		6	Population rate under poverty	%	The population ratio in overall basin, of those who live on less than 1 dollar a day
		X		7	Years sustaining healthy life	year	WHO-estimated years of healthy life in each country
		X		8	Population in flood area	pop./pop.	Population in flood area divided by population in each basin
		X		9	Infant mortality rate	pop./1,000 pop.	Infant mortality rate under 1 year of age
			X	10	Investment amount for structural countermeasure	1,000 m^3/km^2	Storage volume of dam reservoir per area (Alternatively used representing "Investment amount for structural countermeasure")
			X	11	State of non-structural countermeasure	-	State of non-structural countermeasures

Note: It can be deemed that, for each of FVI-affecting indicators, hatched indicators increase FVI value and others decrease FVI value.

Source: Study on Flood Mitigation Measure and Flood Risk Management in Asia Monsoon Area

: Indicators making increase of FVI (to make and shift more vulnerable side)



Source: Study on Flood Mitigation Measure and Flood Risk Management in Asia Monsoon Area

Figure II-28 Example of FVI Calculation Results

7.3 FVI Analysis for Target Basins

7.3.1 Redefinition of Indicators

Flood vulnerability analysis is conducted for the four target four river basins using FVI method. Definitions of some of the FVI indicator are not applicable for the target basins of this Study in case that original definition is applied as it is. Therefore, definitions are redefined fitting to this Study Area. Table II-57 shows the redefinition of the indicators for this analysis.

7.3.2 Values of Indicators

Values of each indicator are calculated in the following procedure:

(1) To collect basic data (Data source is shown in Table II-57)

(2) To input/convert the collected data to GIS data

(3) To calculate the values using GIS

Examples of calculation results of indicators are show in Figure II-29 and Figure II-30, and all the values of each indicator are summarized in Table II-57.

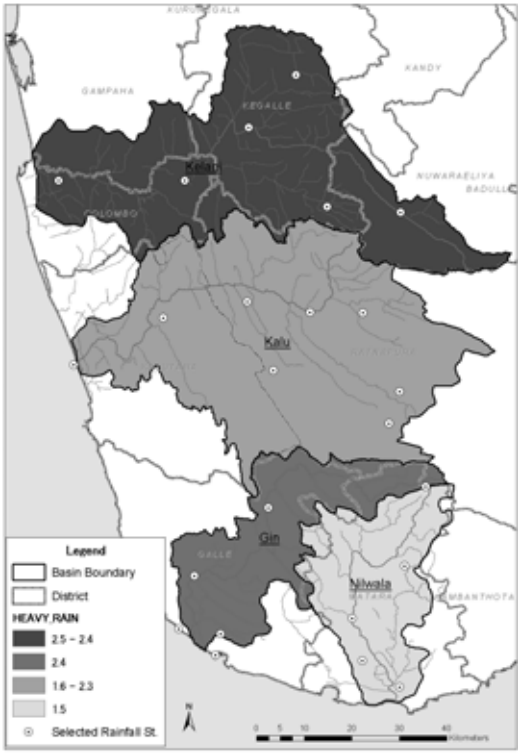


Figure II-29 Frequency of Heavy Rainfall

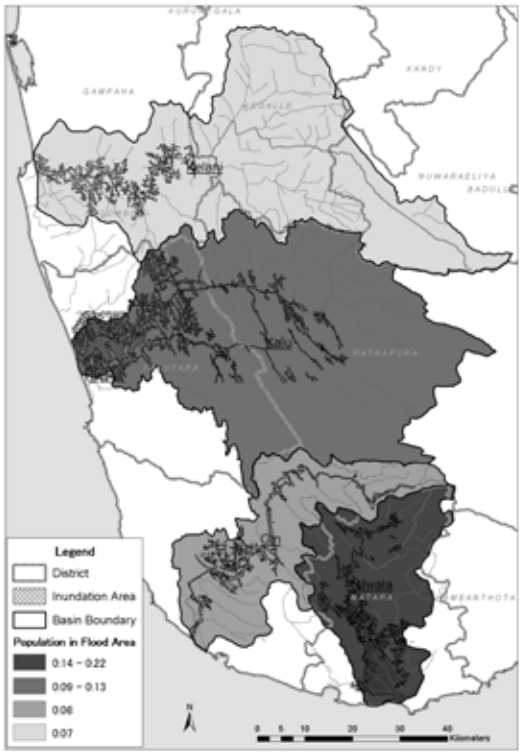


Figure II-30 Population in Flood Area

Table II-57 FVI Indicator in the Study

Component				No. of Indicator	FVI Indicator	Unit	Definition	Data			Value of Indicator			
Climate C	Hydrogeology H	Socio-Economy S	Countermeasure M					Data Source	Year	Data Level	Kelani	Kalu	Gin	Nilwala
X				1	**Frequency of heavy rainfall (more than 100mm/day)**	days/year	Average value of frequency of heavy rainfall of representative stations in each sub-basins	DOM	1985-2005	Sub-basin Level	2.4	2.3	2.4	1.5
	X			2	**Averaged slope of basin**	degree	Basin-wide averaged slope	USGS Website	-	20m contour	2.90	2.76	1.81	1.33
	X			3	**Urbanized area ratio in basin**	%	Urbanized area ratio in basin	Landuse data of Survey Dept	-	Sub-basin Level	1.4	0.3	0.0	5.8
		X		4	**TV penetration rate**	units/1,000 pop.	Number of TV units per the population of 1000 people	"POVERTY STATISTICS/ INDICATORS FOR SRI LANKA", Department of Census and Statistics	2000	National Level	114	114	114	114
		X		5	**Literacy rate**	%	Literacy rate of people who are more than 15 years old	"POVERTY STATISTICS/ INDICATORS FOR SRI LANKA", Department of Census and Statistics	2001	District Level	92.7	89.4	92.5	89.9
		X		6	**Population rate under poverty**	%	Percentage of household population below poverty line	"Headcount Index and Population Below Poverty Line by DS Division – Sri Lanka: 2002", Department of Census and Statistics	2002	DS divisions Level	13.8	25.4	24.2	24.2
		X		7	**Years sustaining healthy life**	year	Life expectancy at birth	"POVERTY STATISTICS/ INDICATORS FOR SRI LANKA", Department of Census and Statistics	2001	National Level	74.0	74.0	74.0	74.0
		X		8	**Population in flood area**	pop./pop.	Population living in recent past maximum inundation area divided by population in each basin	Inundation area: DOI, Population: Survey Dept	-	GND Level	0.07	0.13	0.08	0.22
		X		9	**Infant mortality rate**	pop./1,000 pop.	Infant mortality rate under 1 year of age	Registrar General's Department	2003	District Level	10.9	9.7	10.6	8.4
			X	10	**Investment amount for structural countermeasure**	km/km	Total length of bund divided by main river length	1:50,000 Map of Survey Department	-	Basin Level	0.09	0.03	0.23	0.25
			X	11	**State of non-structural countermeasure**	unit/100km^2	Number of hydrological stations divided by basin area	DOM	-	Basin Level	1.3	1.1	0.8	1.0

7.3.3 FVI of Target Basins

FVI of target basins is analyzed using the calculation results of each indicator. Figure II-31 shows the result of FVI analysis. The extent of flood vulnerability was verified based on the estimated FVI in the Kalu, Kelani, Gun and then Nilwala river basins.

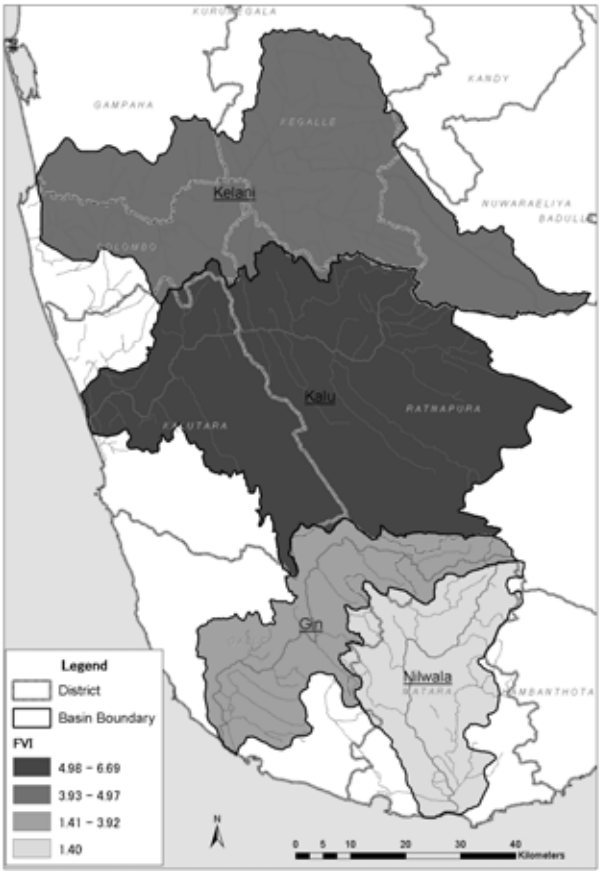


Figure II-31 Tentative FVI Calculation Results for Target Basins

CHAPTER 8 SELECTION OF PRIORITY PROJECT

8.1 Criteria for Selection of Priority Project

As for selection of the Priority Project, the following two step evaluation was applied:

Step 1: Evaluation of Alternative Plans from economical, socio-environmental and technical aspects in the respective river basin

Step 2: Evaluation based on the flood vulnerability analysis to deicide the priority order among the target river basins

In Step 1, the most viable Alternative Plan, which is formed as the proposed Master Plan, was already selected individually in the four river basins as explained in Chapters 3 to 6. As for the succeeding process of Step 2, the results of flood vulnerability analysis were applied as presented in Chapter 7.

8.2 Priority Order among Target River Basins

The order of the priority of short-term measures among the four river basins was decided taking account of the results of flood vulnerability analysis. The vulnerability was ranked by the FVI (Flood Vulnerability Index) that the Kalu is as No.1, Kelani as No.2, Gin as No.3 and Nilwala as No.4. However, since the economic performance of the Nilwala (short-term measure) is superior to the Gin, priority order among the four river basins has been eventually decided in the Study as follows:

Table II-58 Overall Evaluation for Selection of Priority Project

Criteria	Kelani	**Kalu**	Gin	Nilwala
Economic analysis	1st	**1st**	4th	3rd
Flood vulnerability	2nd	**1st**	3rd	4th
Overall	2nd	**Priority Project**	4th	3rd

Source: JICA Study Team

In particular, it should be noted that no flood management structures exist in the Kalu River at present except minor low flood bunds at downstream areas. Ratnapura Land Use Plan prepared by UDA, which is the development plan requiring effective flood management in the future, will be launched soon after authorized by the ministry concerned. This issue emphasizes the urgency and importance of implementation of effective structural measures at the earliest opportunity to reduce the vulnerability of the Kalu River basin.

However, although the priority order among the four river basins was decided as mentioned above, it is recommend that DOI shall undertake the countermeasures in other three river basins as much as possible in parallel considering the current flood situation, which has proved the vulnerable state of the river basins naturally.

8.3 Urgent Rehabilitation Works of Existing Flood Management Structures

Aside from the Priority Project selected in the Kalu River basin, some structural measures are recommended for implementation at earlier stage due to its current deteriorated status. In order to reduce the flood risks and to realize benefit, it is expected to repair/rehabilitate the existing structures within a shorter period. In fact, the requirement of implementation of such structural measures is rather high among Sri Lankan side. In view of this, following structural measures were identified in the short term plans of the master plan as urgent rehabilitation works:

(1) Kelani River

The improvement and rehabilitation works of the MFPs, bank protection works of the existing flood bund and new flood bund at lower reaches were recommended as short term component in the master plan (ref: Chapter 3). The recommendation in the Master Plan could be justified through the lessons learnt during the floods occurred in May to June 2008. Although the short-term plan in the Kelani was not selected as the Priority Project, it is recommended that the plan should be implemented at earlier stage considering its state of emergency and impact to the Metropolitan Colombo. It is essentially noted that proposed non-structural measures should be conducted in parallel with the implementation of the structural measures in order to reduce flood vulnerability of the unprotected area.

(2) Gin River

The downstream area is protected by the existing flood bund and drainage system with 10 pumping stations. However, the DOI is currently suffering from heavy financial burden of operation cost of the pumping stations. Therefore, it is recommended to include renewal/rehabilitation of the existing pumping stations as well as expansion of the flood bund toward upstream in the Urgent Rehabilitation Works of Exiting Flood Management Structures through further detailed study of the rehabilitation works required. The composition of the proposed project is the same as proposed in the short-term measures in the master plan for the Gin River basin.

(3) Nilwala River

Similar situation of the current issues to be solved in the Gin River basin can be observed in the Nilawa River basin as well. The components of the short term measures are recommended to be implemented in the urgent works as proposed in the Gin River. In particular, renewal/rehabilitation of existing pumping station at both river basins including the Gin will be conducted after verification of the detailed manner and equipment for related works aiming at renewal/ rehabilitation of the existing system.

Taking into consideration on the above, the following components are recommended as the urgent rehabilitation works (structural measures) with high priority:

- Kelani River basin : Construction of sluices (improvement: 8 nos., reconstruction: 8 nos., new construction: 1no.), canal lining and bank protection at downstream.
- Gin River basin : Modernization/rehabilitation of existing 10 pumping stations
- Nilwala River basin : Modernization/rehabilitation of existing 3 pumping stations

CHAPTER 9 ACTION PLAN FOR PRIORITY PROJECT

9.1 Introduction

In this Chapter, the Action Plan for implementation of the Kalu River Basin Flood Control Project (10-year scale), which was selected as the priority project after formulation of the master plan, is presented. Focusing the mitigation of the flood risk in the basin, ring levee and flood bund system was selected for structural measures in the master plan with non-structural measures. The technical component was further examined through field reconnaissance, interviews to the agencies concerned and hydraulic analyses. In particular, a large scale of flood hit Ratnapura district between April 27 to May 01, 2008 due to southwest monsoon, which is the same cyclone bringing about more than 130,000 death toll in Myanmar. Further, Kalutara District was seriously damaged due to heavy downpour in the Kuda Ganga basin (biggest tributary of Kalu River) between May 30 and June 2, 2008 rather serious than former one recorded about one month before.

9.2 Review of Technical Component

9.2.1 Review of Structural Measures in Master Plan

Among the components of structural measures proposed in the Master Plan, the height and alignment of the flood bund were reviewed and modified as follows:

(1) Flood bund in Ratnapura

Based on the topographic map in scale of 1:10,000 collected from UDA Ratnapura, river cross section at Steel Truss Bridge in Ratnapura Town and other information from the Ratnapura Municipality Council, the "Ring Levee" scheme was reviewed. As the results, some modifications have been conducted in terms of technical and economic aspects. The naming of the proposed structure of "Ring levee" has been changed to be "Flood bund" considering its fundamental function.

To keep protection of the high dense population zone in the urban area of Ratnapura, the alignment of flood bund was shortened to reduce initial investment cost. Further, to leave the land as present (without flood bund) was also taken into account as natural retarding basin to cope with excessive floods in the future.

The modification of the flood bund in Ratnapura is summarized as follows:

Table II-59 Principal Feature of Flood Bund in Ratnapura

Zone	Bank	Protected Area (ha)	For Protection			For Resettlement		Proposed Structures			
			Affected Houses (nos.)	Affected Population	Remarkable Buildings to be Protected	Affected Houses	Affected Persons	Length (km)	Height (m)	Type of Levee	Nos. of Sluiceway
A	Left	42	200	1,000	Common Houses, local roads	20	100	1.26	3.0	Earth Bund	2
B	Left	40	200	1,000	Common Houses, local roads	20	100	1.05	2.1	Earth Bund	1
C	Left	42	300	1,500	Common Houses, local roads	15	75	1.47	3.4	Earth Bund	2
D	Right	46	1,300	6,500	Municipality hall, police station, clock tower, post office, college, school, hospital, temple, church, mosque, Muslim school, public market place, shops & restaurants, common houses, main & local roads, play ground etc.	35	175	1.57	3.4	Earth Bund	4
D	Right							1.05	3.1	Concrete Wall	2
Total		170	2,000	10,000		90	450	6.40	3.1		11

Source: JICA Study Team

The applied hydraulic conditions to decide the design channel geometry is as follows:

Table II-60 Hydraulic Conditions for Design Channel Geometry

Description	Dimensions
Design discharge	850 m^3/s (10-Year)
Design channel	
- Bottom width	30.0 m
- Channel height	10.0 m
- Side slope	1:2.0
- Distance between flood bunds	80 m
- Roughness coefficient	0.035
Flood bund (earth)	
- Height	3.4 m
- Crown width	4.0 m
- Slope	1:2.0
Flood wall (concrete)	
- Height	4.4 m
- Width of buttress	3.0 m
- Thickness of buttress	0.7 m

The comparison of dimensions (flood bund) modified from the Interim Report is summarized in Table II-61:

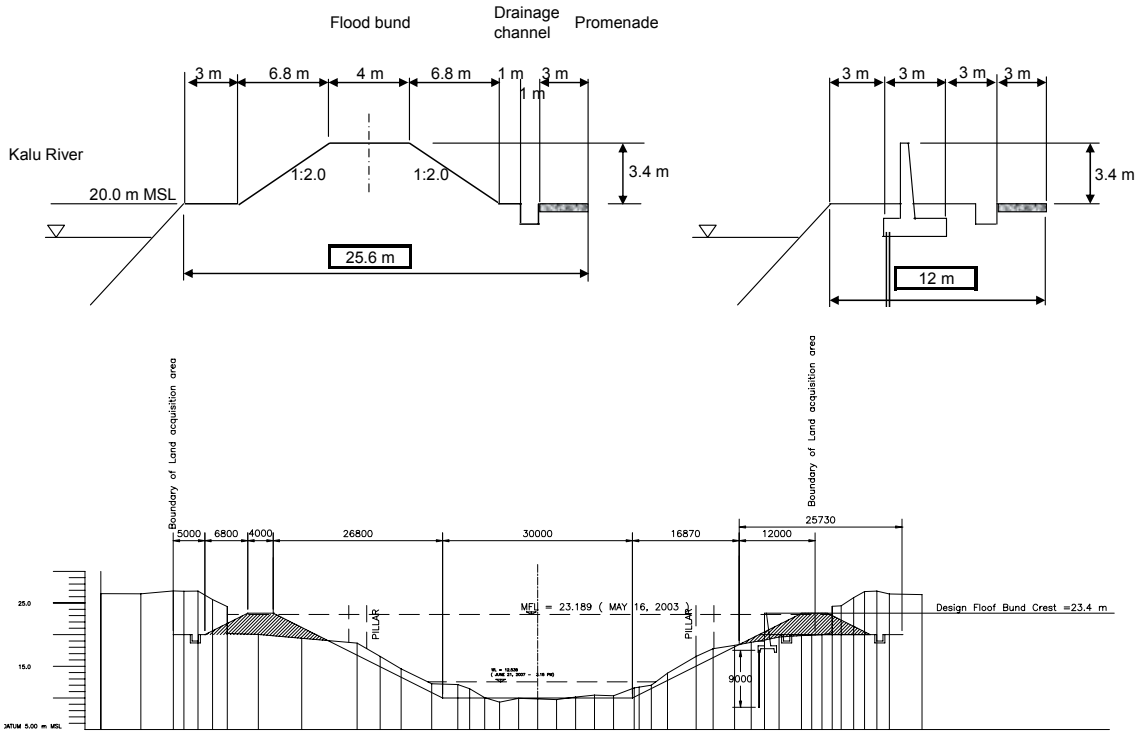
Table II-61 Modification from Interim Report

Item	Interim Report (Dec. 2007)	Draft Final Report (Jun. 2008)
Planning scale	30-Year	10-Year
Total length	12.6 km	6.4 km
- Flood bund	6.2 km (H=4.0 m)	1.05 km (H=3.1m)
- Flood wall	6.4 km (H=4.0 m)	5.35 km (H=2.1~3.4 m)
Nos. of sluice	9	11

The feature of existing channel situation of the Kalu in Ratnapura and cross section with proposed flood bund and wall with typical section are presented in Figure II-32:

Steel Truss Bridge in Ratnapura (WL G/S is operated)

Kalu River in Ratnapura Urban Area (DS view)



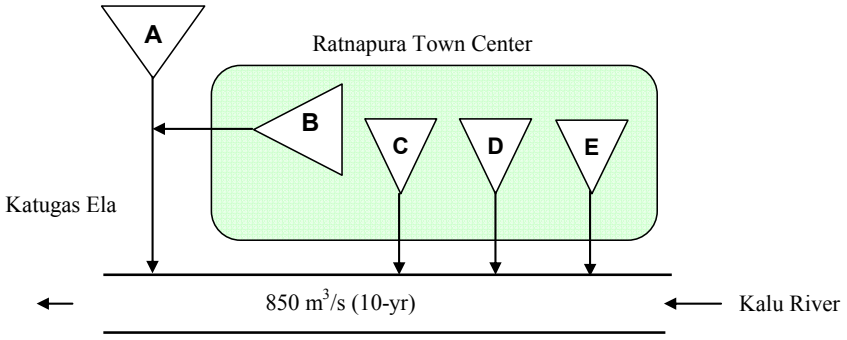
Note: River cross section at Steel Truss Bridge in Ratnapura (measured in June 2007, Ref: Appendix I)

Source: JICA Study Team

Figure II-32 Typical Section of Flood Bund (Earth) and Flood Wall

(2) Drainage Conditions in Ratnapura Urban Area

In order to assess necessity of the pumping facility for drain of internal rainwater in the Ratnapura urban area based on the topographic map of scale 1:10,000. Since the traveling time for discharge is very short, it is assumed to be able to drain gravity flow without pumping facilities. However, further detailed drainage network shall be confirmed in order to decide the appropriate locations of sluices in the next study stage. Present drainage system in Ratnapura urban area (right bank) is shown in Figure II-33:

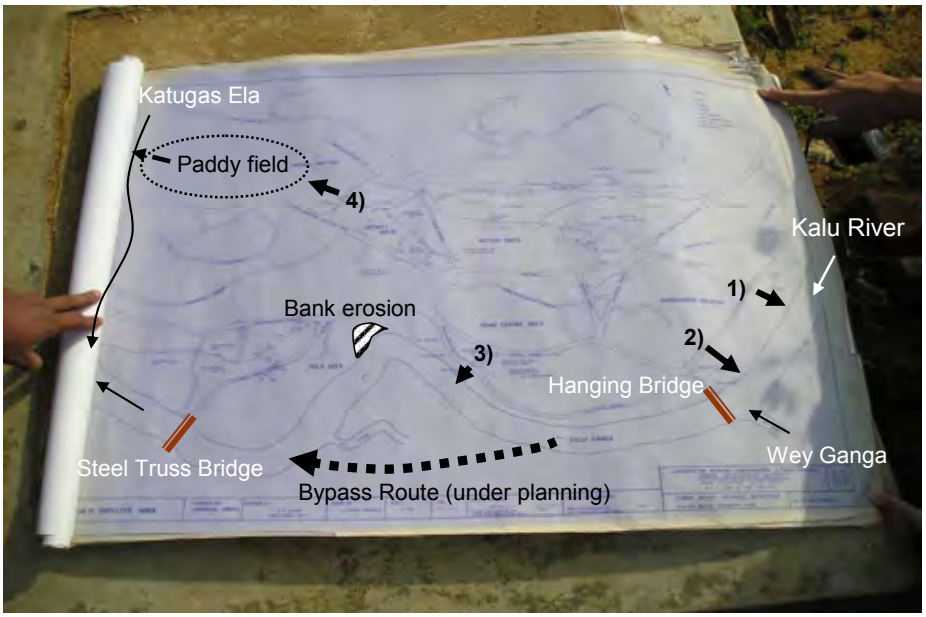


Zone	Drainage area (ha)	Drainage area (km^2)	Length (km)	f	r* (mm/hr)	Q (m^3/s)
A	934.3	9.34	6.4	0.7	20	36.3
B	60.3	0.60	1.0	0.8	30	4.0
C	8.3	0.08	0.5	0.9	50	1.0
D	4.3	0.04	0.3	0.9	50	0.5
E	8.0	0.08	0.5	0.9	50	1.0
Total	1,015.2	10.15				

Note: *, Assumed based on daily rainfall record (need to be further verified)

$$Q=1/3.6 \cdot f \cdot r \cdot A \quad \text{(Rational Formula)}$$

Where, Q: Design flood discharge (m^3/s)
f: Runoff ratio
r: Average rainfall intensity within travelling time (mm/hr)
A: Dranage area (km^2)



Note: Location map of showing drainage outlet in the urban area of Ratnapura Municipality

Source: JICA Study Team (based on information of Ratnapura Municipality)

Figure II-33 Location Map of Drainage System in Ratnapura

(3) Flood bund in Kalutara

The height, length and alignment of the minor flood bund in Kalutara to cope with 10-year probable flood are sustained as proposed in the Interim Report. Configuration of the sluice and pump houses (included in the long-term scheme) are also maintained with no change. The principal feature of the proposed structures is tabulated in Table II-62.

9.2.2 Non-Structural Measures

Basically the non-structural measures as proposed in the Master Plan will be undertaken by the Priority Project. Especially the following item shall be planned in the feasibility study stage and conducted in parallel with the construction of structural measures:

(1) Flood zoning and Hazard Mapping

(2) Expansion of early warning and monitoring system

(3) Promotion of water-resistant architecture

(4) Resettlement

9.3 Scope of the Project

9.3.1 Objective

The Project aims to protect the flood prone area along the Kalu River basin, in particular Ratnapura Municipality area and low lying area in Kalutara District, up to the protection level of 10-year probable flood.

9.3.2 Scope of the Project

The Priority Project is named as the "Kalu River Basin Flood Management Project". The scope of the project is composed of the seven major items listed below:

(1) Feasibility Study for the project

(2) Social and environmental assessment (to be conducted by the GOSL)

(3) Land acquisition (to be conducted by the GOSL)

(4) Funding for the project

(5) Procurement of consulting services

(6) Main civil works

(7) Early warning and monitoring system

9.4 Project Cost Estimate

(1) Outline of Priority Project

Configuration of the priority project is shown in aforementioned sections. Summary of the priority project is presented in Table II-62. The construction plan and cost estimation for the priority project are carried out in connection with the modification of the structural design and updating of the price level.

Table II-62 Outline of Priority Project

Name of River Basin	Selected Alternative	Component of Structural Measures
Structural Measures		
Kalu River	Flood bund system	i) Flood bund in lower reach (L=21,355m) - left(L=9,625m, H=3.3m) - right(L=11,730m,H=3.2m) - new sluiceway (24 nos) ii) Flood bund in upper reach (L=6,400m) - earth levee (L=5,350m, H=2.1-3.5m), - concrete wall (L=1,050,H=3.1m) - new sluiceway (11 nos)
Non-structural Measures		
Kalu River	(1) Early warning monitoring system (2) Restriction of further development in urban area (3) Promotion of water-resistant architecture (4) Promotion of flood fighting activities (5) Institutional strengthening of implementing agency	・6 rain gauging stations ・3 hydrometric stations ・Management and monitoring of land use ・Prohibiting housing development in flood prone area ・Flood zoning with hazard mapping, ・Heightening of building foundation ・Construction of column-supported housing, change to multi-storied housing ・Water proofing of wall/housing materials, etc. ・Information dissemination in the communities, ・Evacuation to safer area, ・Removal of properties in house/building, etc. ・Consensus building for project implementation ・Integration with urban development and land use development plans

Source: JICA Study Team

(2) Conditions of Cost Estimate

1) Criteria and Reference Documents

The project cost is estimated based on the preliminary design, current prices of construction resources and the construction plan. In addition to the criteria and reports collected in the course of the master plan study, the latest information of the price level for construction materials and works were collected for the purpose to update cost estimation as listed in Supporting Report F.2.

2) Composition of Project Cost

The financial project cost comprises the following cost items:

A) Construction cost

B) Land acquisition and compensation cost

C) Engineering service cost

D) Administration expenses

E) Price escalation

F) Physical contingency

G) Tax and duty

3) Price Level and Foreign Exchange Rate

All costs are estimated at the price level in June 2008.

The exchange rate is estimated as average of the exchange rate between January and May 2008 and is set as follows:

US$1.0 = Rs. 107.90

4) Foreign and Local Currency Portion

All costs are estimated by separating the foreign currency portion (FC) and local currency portion (LC) based on the ratio of the imported and local materials and equipment and also by referring to similar projects such as "The Study on Storm Water Drainage Plan for the Colombo Metropolitan region (March 2003)".

The ratio of foreign currency and local currency for major works adopted in this estimation is shown in Supporting Report F.2.

(3) Unit Cost/Construction Cost

Unit costs of construction resources and materials, and unit construction costs for flood control structures and drainage facilities were updated from those estimated in the master plan study taking into account that commodity prices in Sri Lanka have raised sharply under the worldwide inflation on the fuel prices. According to the information from local authorities, the price escalation for construction resources in Sri Lanka from January to June 2008 was assumed to be about 30%. Referring to this information and the latest criteria of Sri Lanka published in January 2008, unit costs and unit construction cost for flood control structures and drainage facilities as of June 2008 are derived from following manners:

Table II-63 Conditions of Price Escalation

from January 2007 to January 2008	Price escalations of unit costs for each item are estimated referring to the criteria of Sri Lanka published in Jan. 2007 and Jan. 2008. (see Table II.9.5)
from January to June 2008	: assumed to be 30% for all items

Source JICA Study Team

(4) Price Escalation

The following price escalation rates are applied for the cost estimation.

1) 4.6% per annum for foreign currency (FC)

2) 10.0% per annum for local currency (LC)

The above price escalation rate for local currency was determined based on the consumer price index of Sri Lanka between 1996 and 2005 (Supporting Report F.2). The price escalation rate for foreign currency is set at 4.6% based on the world's inflation index between 1997 and 2006.

Table II-64 Escalation Rate of Commodity Prices

Year	Foreign Currency: World's Inflation, GDP deflator (annual rate %)	Local Currency: Escalation rate of consumer's price index in Colombo (CCPI) (annual rate %)
1996	-	15.9
1997	4.83	9.6
1998	4.71	9.4
1999	3.98	4.7
2000	4.77	6.2
2001	3.55	14.2
2002	3.59	9.6
2003	4.09	6.3
2004	5.32	7.6
2005	5.44	11.6
2006	5.72	-
Average	**4.60**	**9.51**

Source: World Bank, World Development Indicators, and Statistic Office in Sri Lanka

(5) Project Cost

The project costs of the alternative cases of each basin are summarized below.

Table II-65 Project Costs of Priority Project

(unit: US$, thousand)

Item			Amount		
			FC	LC	Total
I.	Construction cost				
	A	New sluice	3,003	1,153	4,157
	B	Ring levee (Ratnapura)	9,025	3,467	12,492
	C	Flood bund (short term)	8,954	3,020	11,974
	D	Early warning monitoring system	185	46	231
		Sub Total	**21,167**	**7,686**	**28,854**
II.	Land acquisition cost		0	17,920	17,920
III.	Engineering service cost		3,175	1,153	4,328
IV.	Administrative expenses		0	1,022	1,022
V.	Price escalation		3,290	4,751	8,041
VI.	Physical contingencies		2,434	2,778	5,212
VII.	Tax and duty		-	4,977	4,977
Grand Total			**30,067**	**40,287**	**70,354**

Source: JICA Study Team

(6) Operation and Maintenance Cost

1) Operation and Maintenance (O&M) Cost of the Pumping Stations

Annual O&M cost of pumping stations including personnel expenses, power costs and costs for materials and equipment for O&M works is assumed to be 2.5% of the electrical and mechanical facility cost of the pumping station referring to the data of similar projects.

2) Maintenance Cost of the Other Civil Structures

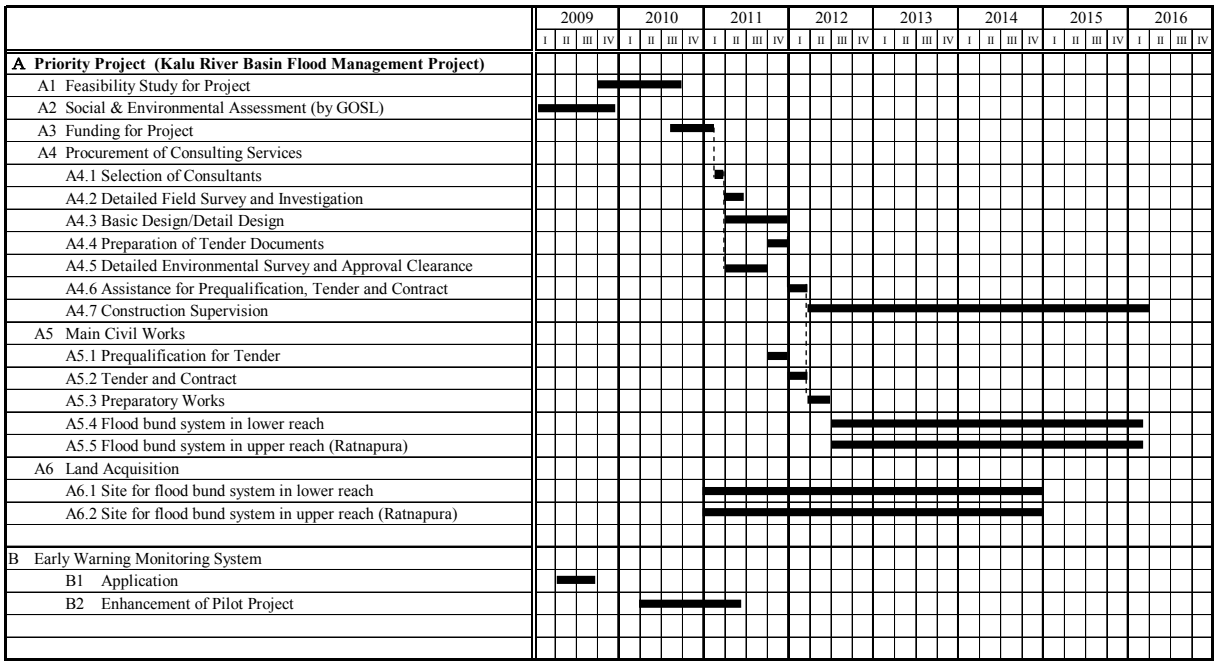
The annual operation and maintenance costs for the other civil structures are also assumed to be 1% of the construction cost.

3) Operation and Maintenance Cost

Operation and maintenance cost is 289,000 US$.

9.5 Implementation Schedule

The construction period of flood bunds in lower (Kalutara area) and upper reaches (Ratnapura area) is assumed 5 years respectively including detailed engineering design. Parallel construction of the two main civil works by dividing into two contract packages is assumed. The implementation schedule is shown in Figure II-34.



Source: JICA Study Team

Figure II-34 Implementation Schedule of Priority Project

9.6 Project Evaluation

Economic evaluation of the Priority Project was carried out in the same manner and conditions as conducted in the master plan formulation. The indicator of the economic analysis is shown in table below.

Table II-66 Results of Economic Analysis of Priority Project

Index	Priority Project
B-C (Rs. mil.)	7,617
B/C	2.89
EIRR	23.5%

Source: JICA Study Team

9.7 Organization for Project Implementation

The executing agency of the project will be DOI taking account the mandate stipulated in the Flood Ordinances, practical experiences of similar works for flood management and project management capability.

Three alternative plans were contemplated for the organization for implementation of the proposed project. The basic concept of the plans is summarized as follows:

- Plan A: To utilize present organization with expansion of required function for management of the proposed project
- Plan B: To create the Project Implementation Unit (PIU) for exclusively management in both technical and logistic aspects of the proposed project
- Plan C: To create the Flood Management Bureau (or River Bureau) as permanent institution, which is responsible for implementation management of new project

Based on the key concept, organization structures for above three plans are prepared as drawn in Figure II-35.

As the result of the preliminary assessment shown in Table II-67, Plan B was selected as most appropriate structure considering the Department's practices and present organization. However, further discussions with the Department will be required aiming at setting of an efficient organization in the succeeding stage.

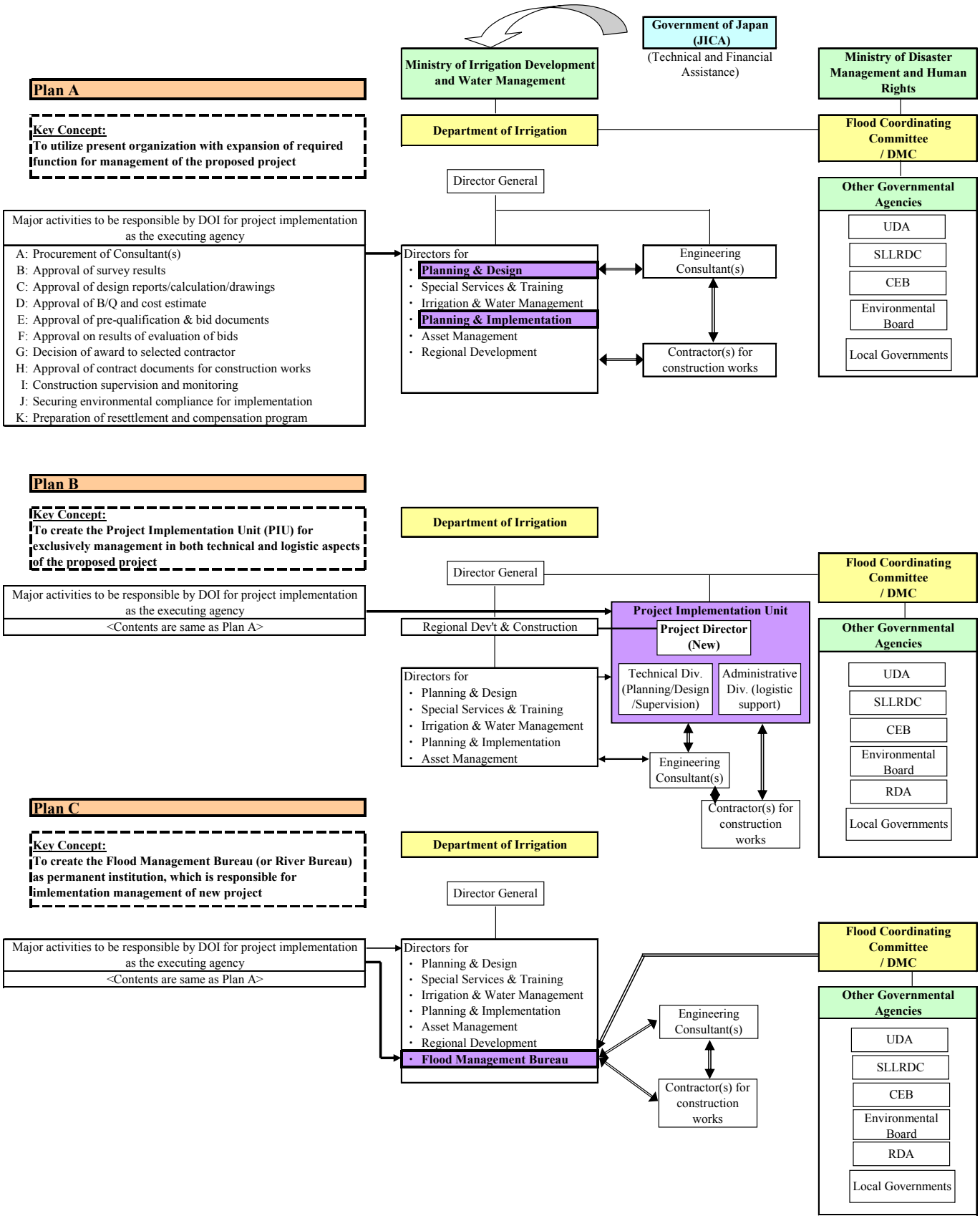
Table II-67 Preliminary Assessment of Alternative Organization Plan

	Issues	Plan A	Plan B	Plan C
1.	Technical capability for project implementation	△	△	△
2.	Accumulation of technical knowledge and experiences	△	△	△
3.	Project management efficiency in logistic aspect	△	○	○
4.	Sustainability for effective flood management	△	○	○
5.	Coordination with other Governmental agencies	×	○	△
6.	Saving budget for operation	○	△	△
7.	Transparency on disbursement of budget	△	○	△
8.	Available human resources in the Department	△	○	×
9.	Empowerment of human resources through the project	△	○	○
	Overall evaluation	3	1	2

Rate: ○, High △, Moderate ×, Low

DMC will organize the Flood Management Committee as responsible body to be chair and will monitor progress of the project with DOI (implementing agency). Further, DMC will hold the committee as required and will adjust and solve the issues, which are related to the plural agencies concerned. As regards to the concrete demarcation of responsibility and procedures, further discussions involving the both agencies are absolutely necessary. In order to provide a platform for consultation to the stakeholders and consensus building among them, setting-up of the river basin forum is recommended. The concept of the forum is described in detail in Section 10.3.

As for the non-structural measures, in principle, DOI shall take initiative and promote them. In particular, coordination with DMC and local administrative organizations will become key issues from the aspect of community disaster management.

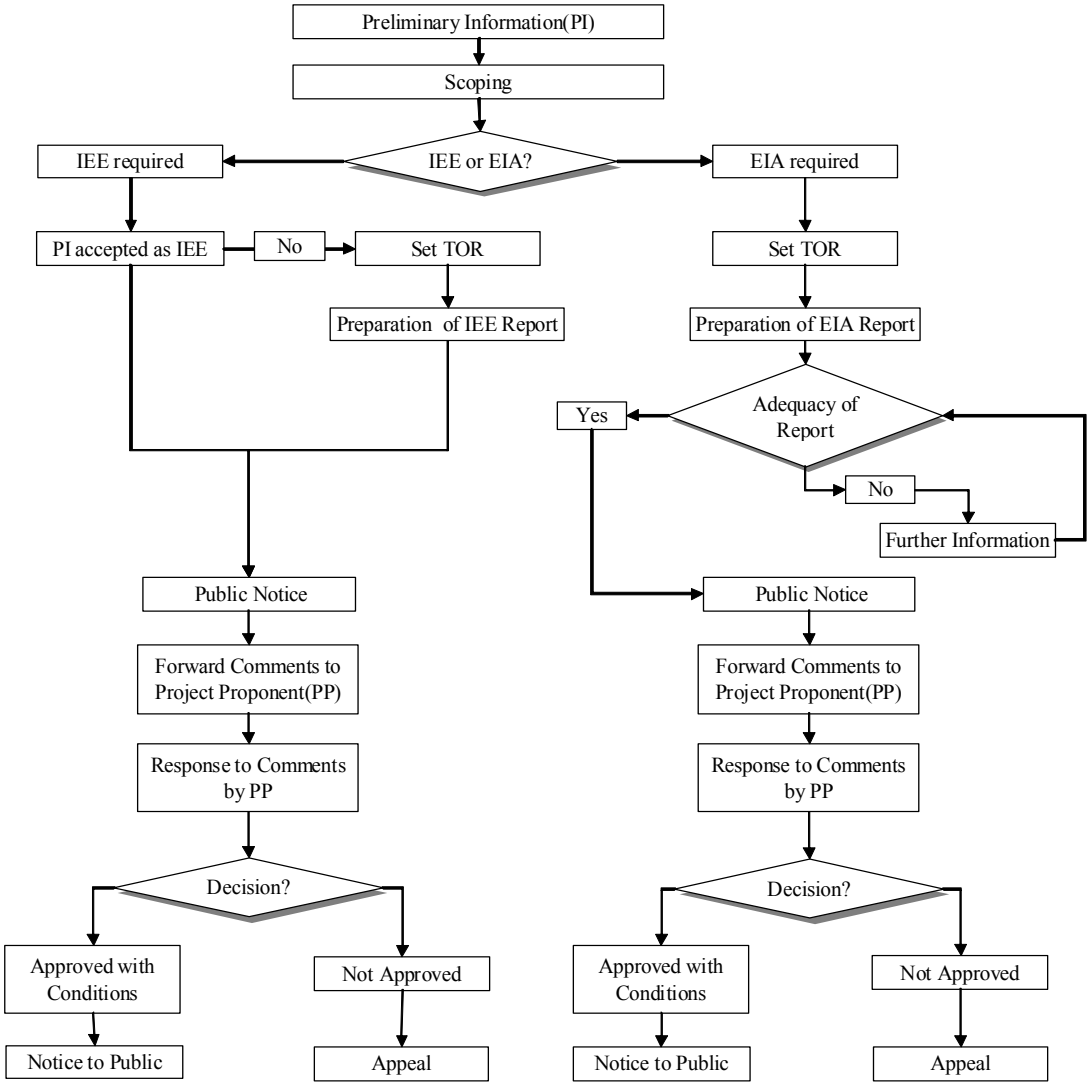


Source: JICA Study Team

Figure II-35 Alternative Organization Plans for Implementation of the Project

9.8 Required Environmental and Social Considerations

Under the Amended National Environmental Act No.56 of 1988, the activities of the Priority Projects are required to obtain environmental clearance by following the designated process for Environmental Impact Assessment (EIA). This must be conducted prior to the approval of the individual development projects, and thus planned during the first year of project implementation. The procedures for EIA in Sri Lanka are carried out through two different sequences as indicated in Figure II-36. The procedures of the activities under the Priority Projects to be taken will be decided based on concrete implementation plans.



Source: Guideline for Implementing the Environmental Impact Assessment Process-No.1: A general guide for Project Approving Agencies (CEA:1988)

Figure II-36 Environmental Assessment Process in Sri Lanka

Based on the results of IEE conducted for the structural measures proposed in the Priority Project in the Kalu River basin, the following issues should be further examined and incorporated into the outputs of the EIA procedure.

Table II-68 Focus Items of EIA for Installation of New Sluice Gates

Item	Description	Proposed Mitigation Measures
Hazards (Risk) Infectious diseases such as HIV/AIDS	Installation of flood protection structures may block the current flow pattern during flood periods and result in increasing of flooding in certain areas.	- Conduct detailed hydrological studies at design stage. - Plan and execute appropriate operation and maintenance works of facilities
Flora, Fauna and Biodiversity Water Pollution	Installation of flood protection structures may block the current flow pattern during flood periods and result in disturbing ecosystems dependant on duration of flooding.	- Avoid construction at locations within protected areas or areas likely to largely influenced in the protected areas - Consider alternative habitats where construction in most important areas are inevitable - Monitoring of important ecosystems

Table II-69 Focus Items of EIA for Construction of Flood Bund in Ratnapura

Item	Description	Proposed Mitigation Measures
Involuntary Resettlement	Acquisition of land for construction of concrete walls and bunds may result in a number of involuntary resettlement of local residents	- Avoid resettlement by selecting location of structures with minimum influence - Preparation of Resettlement Action Plan with necessary considerations for the process of resettlement and support for the resettled households
Local economy such as employment and livelihood, etc. Land use and utilization of local resources	Physical consolidation of areas facing the Kalu River may obstruct easy access to the river and result in hampering economic activities such as fishing and gem mining.	- Avoid impact on economic activities by selecting location of structures with minimum influence - Install small piers for local fishing boats and paths to access water surfaces on the flood bunds
Existing social infrastructures and services	Construction of concrete walls and bunds may alter conventional routes to cross rivers	- Install new access routes on flood bund
Misdistribution of benefit and damage Local conflict of interests	Construction of concrete walls and bunds may alter the conventional flow of flood waters and result in worsened flood situations in other areas.	- Detailed planning and design based on detailed hydrological studies - Installation of culverts and other drainage facilities where required.
Water Usage or Water Rights and Rights of Common	Construction of concrete walls and bunds may obstruct easy access to river courses	- Install small piers for local fishing boats and paths to access water surfaces on the flood bunds - Monitoring of fisheries resources
Sanitation	Blocking of water by new structures may result in local stagnation of water, which may lead to increased vector borne diseases.	- Installation of culverts and other drainage facilities where required.
Hazards (Risk) Infectious diseases such as HIV/AIDS	Installation of bunds may block the current flow pattern during flood periods and result in increasing of flooding in certain areas.	- Conduct detailed hydrological studies at design stage. - Plan and execute appropriate operation and maintenance works of facilities
Gender	Construction of concrete walls and bunds may limit the access of women to waters for water collection and washing	- Install small platform for water collection / washing and paths to access water
Topography and Geographical features	Construction of concrete walls and bunds may have negative impacts to important topographical / geological sites	- Further research on existence of sites of topographical / geological importance - Avoid structure on important topographical / geological sites at the extent possible - Consideration on scale of structure
Hydrological Situation	Construction of concrete walls and bunds may alter the conventional flow of flood waters and result in worsened flood situations in other areas.	- Conduct detailed hydrological studies at design stage. - Installation of culverts and other drainage facilities where required.
Flora, Fauna and Biodiversity	Installation of bunds may block the current flow pattern during flood periods and result in disturbing ecosystems dependant on periodical flooding	- Avoid construction at locations within protected areas or areas likely to largely influenced in the protected areas - Consider alternative habitats where construction in most important areas are inevitable - Monitoring of important ecosystems

Item	Description	Proposed Mitigation Measures
Landscape	Construction of concrete walls and bunds may have negative influence on landscape depending on its scale and location.	- Consideration on type and design of structure - Consideration of vegetation cover on structure sites
Air Pollution	Operation of construction machines may have temporary impact during construction	- Consideration of low pollution type construction machines - Appropriate management of construction sites
Water Pollution		- Apply methods to minimize turbulence (block water with sheet piles during construction, works in dry season, etc.)
Noise and Vibration		- Consideration of low pollution type construction machines - Appropriate management of construction sites

Table II-70 Focus Items of EIA for Extension and Rehabilitation of Flood Bund in Kalutara

Item	Description	Proposed Mitigation Measures
Involuntary Resettlement	Acquisition of land for construction of new bunds may result in a number of involuntary resettlement of local residents	- Avoid resettlement by selecting location of structures with minimum influence - Preparation of Resettlement Action Plan with necessary considerations for the process of resettlement and support for the resettled households
Local economy such as employment and livelihood, etc.	Physical consolidation of areas facing the Kalu River may obstruct easy access to the river and result in hampering economic activities such as fishing, gem mining and operation of small ferries.	- Avoid impact on economic activities by selecting location of structures with minimum influence - Install small piers for local fishing boats and paths to access water surfaces on the flood bunds
Land use and utilization of local resources		
Existing social infrastructures and services	Construction of new bunds may influence access of conventional transportation services (small cargo / passenger boats, etc).	- Install small piers for local fishing boats and paths to access water surfaces on the flood bunds
The poor, indigenous and ethnic people	Acquisition of land for construction of new bunds may influence the poor through involuntary resettlement	- Avoid resettlement by selecting location of structures with minimum influence - Preparation of Resettlement Action Plan with necessary considerations for the process of resettlement and support for the resettled households
Cultural heritage	Construction of new bunds may influence cultural heritage if any	- Detailed examination of distribution of cultural heritage and sites of local importance - Avoid construction at locations of important cultural sites - Consider detours for cultural sites at stage of detailed design.
Local conflict of interests	Construction of new bunds may alter the conventional flow of flood waters and result in worsened flood situations in other areas.	- Detailed planning and design based on detailed hydrological studies - Installation of culverts and other drainage facilities where required.
Water Usage or Water Rights and Rights of Common	Construction of concrete walls and bunds may obstruct easy access to common river resources	- Install small piers for local fishing boats and paths to access water surfaces on the flood bunds - Monitoring of fisheries resources
Sanitation	Blocking of water by new structures may result in local stagnation of water, which may lead to increased vector borne diseases	- Installation of culverts and other drainage facilities where required.
Hazards (Risk) Infectious diseases such as HIV/AIDS	Extension of flood bunds may block the current flow pattern during flood periods and result in increasing of flooding in certain areas.	- Conduct detailed hydrological studies at design stage. - Plan and execute appropriate operation and maintenance works of facilities
Gender	Construction of new bunds may limit the access of women to waters for water collection and washing	- Install small platform for water collection / washing and paths to access water
Soil Erosion	Construction of new bunds may block the current flow pattern and result in changes of hydrological situation in the downstream areas	- Conduct detailed hydrological studies at design stage. - Plan and execute appropriate operation and maintenance works of facilities - Implementation of bank protection works in combination with flood bunds

Item	Description	Proposed Mitigation Measures
Hydrological Situation	Construction of new bunds may alter the conventional flow of flood waters and result in worsened flood situations in other areas.	- Conduct detailed hydrological studies at design stage. - Installation of culverts and other drainage facilities where required.
Coastal Zone	Construction of new bunds may have impact on the important ecosystems in the costal zones through the change in river flow.	- Further study on location of important costal ecosystems and possibility of influence - Avoid construction at locations within protected areas or areas likely to largely influence protected areas
Flora, Fauna and Biodiversity	Extension and rehabilitation of flood bunds may block the current flow pattern during flood periods and result in disturbing ecosystems dependant on duration of flooding	- Avoid construction at locations within protected areas or areas likely to largely influenced in the protected areas - Consider alternative habitats, where construction in most important areas are inevitable - Monitoring of important ecosystems
Air Pollution	Operation of construction machines may have temporary impact during construction	- Consideration of low pollution type construction machines - Appropriate management of construction sites
Water Pollution		- Apply methods to minimize turbulence (block water with sheet piles during construction, works in dry season, etc.)
Noise and Vibration		- Consideration of low pollution type construction machines - Appropriate management of construction sites

Source: Prepared by JICA Study Team

CHAPTER 10 RECOMMENDATIONS

10.1 Common

(1) Water resources development and management aspect in the Study

As mentioned in Chapter 1, the objective of this study is primarily to prepare flood management master plan in the selected four river basins as well as to prepare the Action Plan for Priority Project. Aside from the aspect of flood disaster mitigation, appropriate policy of water resources development and management are envisaged. In particular, integrated water resourced management, which aims at maximizing benefit of diverged usages of water resources with social and environmental consideration required in standards/guidelines concerned, is predominant international.

However, based on the scope of work of the Study for disaster management, the Study rather focuses on reduction of vulnerability to floods in order to formulate the Flood Management Master Plan. In the course of the Study, the Study Team discussed with DOI and responded to their requirement at maximum extent with mutual understandings on the importance of water resources development on the target river basins as emphasized by DOI.

In particular for the multipurpose dam schemes, which are recently under contemplating by DOI in the Study Area, are to be preliminarily assessed their possibility of implementation by the current Study. Therefore, it is recommended that further update of the proposed plan will be required in the integrated water resources development and management aspect.

(2) Strengthening of Capability Building for Project Management

In order to enable self-development of human resources with active interaction in the organization of DOI through project implantation, technical assistance will be still required especially for a large scale of development project. In addition, the manner of coordination with other related agencies and detailed methodologies for public consultation with stakeholders should be transferred for successful project management. In view of this, assistance of the Government of Japan will be effectively functioning in empowerment of management in administrative issues to achieve the objectives.

(3) Enhancement of Technical Capability for Flood Management

Transfer of technical knowledge on planning of flood management has been carried out for the counterpart personnel and technical staff in DOI in various phases throughout the current Study. In particular, process of master plan formulation including comparison of conceivable alternative measures, hydrological analysis, economic analysis of those alternatives and IEE concerned, etc. were discussed and explained in a series of counterpart meetings. However, the details on hydrological analysis and design of flood management structures are further demanded to be transfered at more practical levels through actual implementation of the proposed project.

(4) Improvement of Accuracy in Hydrological and Hydraulic Analyses

The current Study commenced with provisions that data/information available at present would be utilized at maximum extent without any large scale of field survey and investigations due to the budget limitation for the Study. Therefore, the Study was undertaken based on this premise throughout the Study. In particular, the number and coverage of available river cross sections and

longitudinal profiles of the four river basins are quite limited to estimate river channel capacity, inundation area and longitudinal water profile against probable flood discharges with certain accuracy. This will affect the reliability of hydraulic models for respective river basins and eventually appropriateness of the Master Plan.

In this sense, it is strongly recommended to carry out a full scale of river cross section survey including site topographic survey as required in the future study stage at approximate interval of 200 to 300 m with substantial coverage of the inundation area. Further, in order to link the information of river channel geometry with topographic coordinates on GIS, digital maps on 1:10,000 basis will be required. These will be prerequisite information in feasibility studies. However, they have not been prepared/published yet by the Survey Department except the Kelani (partially published in 1984 but not covered all areas). Therefore, close coordination between DOI and Survey Department is indispensable for further elaboration and updating of the proposed Master Plan.

(5) Improvement of Data Management System of DOI

The Hydrologic Division supervised by the Director of Special Services and Training, DOI, is responsible to manage, store and observe the records (rainfall, water level and discharge, etc.). It is strongly recommended to accelerate to save the data in computer hard disk (or CD) from hand-written on papers, since the recorded papers have almost totally decayed in the hot and humid atmosphere over a long time. Such valuable data will not be able to be restored if the records become unreadable.

Further, it is strongly recommended to convert from water levels to discharges by means of rating curves without any delay after water level records reach the Division. In order to do this properly, updating of rating curves with changes of cross sections (after floods) is fundamentally required. This improvement is highly recommended to enhance the present data management system in DOI. Reliable discharge records are key information for appropriate flood management planning in any river basin.

(6) Updating the Hydrological Models established in the Study

The hydrological models were installed on the computers in Water Resources and Project Planning Branch, DOI with rainfall and discharge data collected through the Study. As hydrological and topographical information are accumulated, development of the models is recommended, because they will be strong tools for assessment of floods and inundation as well as planning of certain structural measures in the future. In this connection, a lot of staff has quit from the Department and so only very few staff can operate the computer software such as MIKE 11 for hydrological and hydraulic analysis. In order to realize the updating the model, training and education of the junior engineers will be prerequisite for sustainable management.

(7) Key Issues on Environmental and Social Consideration

As for implementation of the proposed priority project in the Kalu and Master Plans in other three river basins as proposed in the current study, the procedures specified in the Amended National Environmental Act No.56 of 1988 in Section 9.8 shall be taken. Toward implementation of the project in the Kalu River Basin, further investigation including analysis of affected issues and extent

and study on mitigation measures will be required. In addition, the National Environmental Act specifies dissemination of information to the public and consultation of stakeholder by the executing agency in order to secure accountability and transparency of implementation of the project. Since the Sri Lankan government has their own laws, the project needs to conduct environmental consideration and acquire permission for the project implementation in compliance with the laws.

(8) Institutional Strengthening of Irrigation Department (setting-up of Flood Management Sections)

The governmental organization for flood management in Sri Lanka is still vulnerable. In particular, it was clarified that non-existence of an organization having jurisdiction over flood management in DOI is major cause on lack of consistency of plans and delay of implementation through this study. Therefore, it is recommended to establish the department, which exclusively handles flood management (it is provisionally named as "Flood Management Department") in DOI. The function of new department is described in Part V Chapter 6, Main Report in detail.

(9) Setting-up of River Basin Forum

In general, river improvement works take quite a long time and affect numerous business entities and land owners in the basin. The issues between upper and downstream areas, left and right bank sides will be derived from implementation of the project. In the target river basins, the downstream basin of the Kelani is devided into two districts of Colombo and Gampaha. Further, in the Kalu River basin lies on two districts of Kalutara and Ratnapura. In order to smoothly implement the project, a coordinator will be required, who can facilitate building of consensus among stakeholders. In the river basins belong to the first category in Japan, the river basin forum is set up and he takes the responsibility of coordinator.

In order to implement the Master Plan and Priority Project as proposed in this study, the opinions of the stakeholders shall be integrated in those plan and project if judged appropriate through consultation to the related agencies and local people concerned in the light of environmental consideration. As for a platform to transfer the information of the plan/project to the stakeholders and to facilitate building of consensus, setting-up of the river basin forum in individual four river basin is recommended. The objective of the forum is to be a "Coordinator" between inhabitants in the river basin and also between inhabitants and implementing agency. The members will be composed of representatives of high-level experts, local governments, related inhabitants and implementing agency, etc. Regarding the river basin forum in the Kalu River basin for implementing Priority Project, its role and members are described in Section 10.3.

(10) Strengthening of Engagement in Climate Change

The climate change, which is likely derived by increase of greenhouse gas, becomes to be serious all over the world. The Master Plan and Priority Project proposed in the current study does not involve the effect of climate change in the future. Therefore, the study on appropriateness of the dimensions of proposed plan and adaptation measures through further review of characteristics over the river basins is the issue from this time forward.

10.2 Kelani River Basin

(1) Early implementation of Urgent Works

Considering the current conditions of eroded bank slope and existing Minor Protection Structures proposed as the Urgent Works, earlier implementation can accrue benefit by means of reduction of perennial flood damage along the Kelani River. Since the Colombo Regional Office, DOI, is executing the restoring works of the existing structures to some extent, further verification of required component of repair and reconstruction works should be conducted.

(2) Availability of Flood Retention Volume in Proposed Retarding Basin

Since the contour lines of topographic maps available for the Study are at 5.0 m intervals in the Kelani River basin, the potential volume for flood water storage was estimated approximately. In addition, certain areas cannot be expected to be used for the retarding basin due to the current reclamation and construction works of new buildings. Therefore, it is highly recommended that flood zoning and hazard mapping shall be prioritized including review of institutional strengthening of laws and regulations for conservation of vulnerable low and wet zones along the Kelani. For these purposes, topographic mapping with scale of 1:5,000 (required contour interval of 0.5 m) is required in the proposed area for retarding basins between Ambatale and Pugoda. However, the subject area will be nearly 5,000 ha, so spot leveling to supplement the present topographic maps will be more practical. Through the flood zoning activities, the available volume for flood retention in the candidate retarding basins should be updated with more detailed land use and topographic information.

(3) Importance of Non-structural Measures

Priority of non-structural measures in the Kelani River basin is rather high compared with other three, because structural measures will need large finance and time for implementation. In addition, the Kelani is far beyond other three river basins in terms of population density. Therefore the non-structural measures as proposed in the master plan should be undertaken in earlier stage to reduce vulnerability to floods. In particular, it will take a long period for planning, designing and construction of flood retarding basins, and meanwhile urbanization and transforming to residential areas from unused land will be progressed at the candidate sites identified in this study. In order to restrict this movement and sustain the effect as natural retarding basins of floods, institutional strengthening such as monitoring of land development and stipulation of responsibility of implementing agency, etc. shall be accelerated.

(4) Urgent Rehabilitation Works of Existing Structures

As proposed in Chapter 8, the urgent works of MFPs and bank protection including minor flood bund is recommended to realize flood damage reduction benefit in the short term. In this connection, feasibility study should be conducted to further verify the economic viability of the project.

(5) Study on New Pumping Station

A study on new pumping station at Petiyagoda is underway by DOI. The details of design dimensions, extent of effect, construction cost and construction schedule, etc. require a review through field reconnaissance.

10.3 Kalu River Basin

(1) Early Implementation of the Priority Project

In order to implement the Priority Project at early stage, feasibility study should be carried out in due course. As mentioned in Section 9.5, the Priority Project is expected to be implemented along with the proposed schedule.

(2) Forming Organization of Implementing Agency and Setting-up of River Basin Forum

In the scope of work for the Feasibility Study, a concrete study on the Project Implementation Unit is recommended to be involved and a preparatory study for setting-up of the river basin forum is proposed to facilitate building of consensus and smoothly implementing projects as a "Coordinator" by mainly DOI through cooperation with DMC. As a draft plan, the following members and role are recommended:

Kalu River Basin Forum	
・Objective for foundation	: To contribute in building consensus between stakeholders through realization of smooth implementation of flood protection measures
・Expected function	: "Coordinator" between inhabitants in the river basin and/or between inhabitants and implementing agency (DOI)
・Composition of members	: DOI (regional Offices in Kalutara and Ratnapura), DDMCU Kalutara and Ratnapura, local administrative organizations in Kalutara and Ratnapura area (Province, District, Division, Municipality, GN etc.), high-level experts, representatives of inhabitants and monks, etc.

(3) Possibility of Malwala Multipurpose Dam scheme

As discussed in Chapter 4, multipurpose development of Malwala Dam is promising from water resources management aspect in the future. However, the following factors should be further investigated and studied:

1) Geological conditions and preliminary design of dam and other appurtenant structures
2) Hydrological and hydraulic conditions along mainstream of the Kalu and Wey Ganga
3) Future demand projection of water supply on municipal, industrial, agricultural and hydropower generation
4) Social and natural environmental impact by creating a large scale reservoir

In particular, it should be noted that resettlement action program (RAP) including compensation programs is required to prepare through stakeholder meetings and consultations in accordance with the domestic and donor's Guidelines/Standards. In this context, social and baseline survey in the proposed reservoir area is fundamentally required by DOI prior to the planning of the resettlement.

(4) Ratnapura Urban Development Project, UDA

As introduced in Chapter 4, urban development plan will be launched soon by UDA in Ratnapura. In this respect, it is recommended that appropriate coordination with UDA and Municipal Office will be necessary. In particular, flood zoning and hazard mapping (one of non-structural measures) should involve cooperation with each other. Flood management concept should be substantially implanted

in the development plan.

(5) Dredging for prevention of river mouth closure in Kalutara

Monitoring of the river mouth should be continued by the Regional Office in Kalutara whether any change of river channel topography has occurred or not. Periodic sounding and survey of the river profile and cross section is recommended to judge the dredging works near the river mouth.

(6) Monitoring of South Expressway Project (under RDA)

Huge earth embankment with approximately 10 m height at certain sections along the route of South Expressway connecting Colombo with Matara is ongoing by dividing it into several stretches to undertake construction works in parallel. In this connection, it is primarily observed that the huge embankment will change the existing drainage conditions because it affects surface drainage in the vicinity.

Since the new Expressway crosses at yjr downstream area of the Gina and Nilwala River basins as well, the same situation as abovementioned in the Kalu can be anticipated in the future. Therefore, alignment of the flood bund and inland drainage improvement should be determined with due consideration of the location/alignment of the embankment of the ongoing road project.

10.4 Gin River Basin

(1) Early Implementation of Urgent Works

Considering current status of the existing pumping stations, the Urgent Works are recommended to be implemented at an early stage. In particular, the sharp rise of oil and diesel prices seriously impacted the financial balance sheet of DOI. On the other hand, there are many similar old pumping stations in Japan that need to be repaired in an appropriate manner.

Due to such situation in Japan, manuals for renewal and rehabilitation of the gate and pumping facilities were prepared and published by the Ministry of Land, Reclamation and Transport. Since the manner of assessment of the facilities seems to be very effective and applicable to Sri Lanka, detailed assessment of replacement of such facilities should be conducted.

(2) Handling of the people who are living in unprotected area

Mound dike scheme was recommended in the unprotected area. Site selection will be required through the discussions and consultation with the people who are frequently affected by floods. The proposed sites should be further examined from hydraulic and social point of views.

(3) Modernization/Rehabilitation of existing pumping stations

The existing 10 pumping stations in the Gin River basins, which have been constructed by the financial assistance of the Government of China, were utilized for approximately 30 years. Due to aged equipment with frequent stoppage of operation, drainage functioning has drastically deteriorated compared with the original plan. In particular, DOI is recently suffering from expenditure of operation cost of existing pumping stations. In order to cope with the current problem, renewal/rehabilitation of the existing equipment and appurtenant structures (pumps, gates, trash racks,

cranes, electrical panels and indicators, etc.) are necessary.

(4) Monitoring of South Expressway Project (under RDA)

The same as the Kelani River basin monitoring of the captioned project is required to prevent further deterioration in the current drainage conditions in the residential area. .Because deterioration of drainage conditions in the area can be seen, careful monitoring by DOI is important to avoid flooding near the vicinity of the embankment.

10.5 Nilwala River Basin

(1) Early implementation of Urgent Works

The same method proposed in the Gin River can be applied in the Nilwala River as well. In order to reduce the heavy load of DOI in budget raising, early implementation of assessment of renewal is highly recommended.

(2) Sounding of gaps in the downstream reaches

A gap in the riverbed near the river mouth of the Nilwala can be seen. It is located about 2 km from the river mouth. French consultants verified the effectiveness of the dredging at river bottom at the gap (from river mouth to the Manahama bridge in Matara City) by their review and reconnaissance. However, in order to realize the project, stability of bridge pier and flood bund during floods shall be carefully examined. Therefore, verification of hydraulic feature under ordinary and flood conditions by means of additional river sectional survey will be essential.

(3) Trans-basin Project at upstream area

The scheme of water trans basin from the Gin – Nilwala – Warawe is under study by DOI. The purpose of the project is to meet the water demand in agriculture, industry and municipal use in the future at Hambantota area. Since the area is promising to develop rapidly, harmonized development is required from technical and also social/environmental impact viewpoints.

The following table shows the responsible and implementing agency, priority and necessity of assistance for the abovementioned recommendations.

Table II-71 Recommendations

No.	Recommendation	Responsible Organization	Implementing Organization	Schedule	Necessity of Foreign Assistance
Common					
(1)	Water resources development and management	DOI	DOI, DMC	B	Technical assistance to IWRM
(2)	Strengthening of capacity building for project management	DOI	DOI, DMC	C	Technical assistance to capacity building
(3)	Enhancement of technical capability for flood management	DOI	DOI	B	Technical assistance on skills for flood management
(4)	Improvement of accuracy in hydrological and	DOI	DOI	B	Technical assistance on skills for numerical analyses

No.	Recommendation	Responsible Organization	Implementing Organization	Schedule	Necessity of Foreign Assistance
	hydraulic analyses				
(5)	Improvement of data management system of DOI	DOI	DOI	C	Technical Assistance on data base system
(6)	Updating of hydrological models	DOI	DOI	B	Technical assistance on skills for numerical analyses
(7)	Environmental and social consideration	DOI	DOI, CEB	B	Technical assistance for project implementation
(8)	Institutional strengthening of DOI (setting-up of Flood Management Department)	DOI	DOI	C	Technical assistance on institutional strengthening
(9)	Setting-up of River Basin Forum	DOI	DOI, DMC, local administrative organizations, Inhabitants	B	Technical assistance for consensus building
(10)	Strengthening of engagement for climate change	DOI, DOM	DOI, DMC、UDA, CEB、Water Management Board	C	Technical assistance to IWRM and disaster management in relation with climate change
Recommendation for Kelani River Basin					
(1)	Early implementation of Urgent Works	DOI	DOI	B	Technical assistance on Feasibility Study
(2)	Availability of flood retention volume in proposed retarding basins	DOI	DOI	B	Technical assistance to build basic information of retarding basin
(3)	Promotion of Non-structural measures	DOI	DOI, UDA、RDA, SLLRDC, local administrative organizations	B	Technical assistance for organization and institutional strengthening
(4)	Urgent Rehabilitation Works of existing structures	DOI	DOI, local administrative organizations	B	Technical assistance on Feasibility Study
(5)	A study on new pumping facility	DOI	DOI, SLLRDC、local administrative organizations	B	Technical assistance in verification of cost-benefit relations, etc.
Recommendation for Kalu River Basin					
(1)	Early implementation of Priority Project	DOI	DOI	B	Technical assistance in Feasibility Study
(2)	Forming organization of implementing agency and setting-up of river basin forum	DOI	DOI, DMC, local administrative organizations, Inhabitants	B	Technical assistance for securing accountability and consensus building
(3)	Malwala multipurpose dam scheme	DOI	DOI, local administrative organizations in Ratnapura area、DMC	B	Technical assistance in various investigation and Feasibility Study
(4)	Ratnapura urban development project	UDA	UDA、DOI	B	Integration of urban development and flood protection plans
(5)	River mouth closure in Kalutara	DOI	DOI、local administrative organizations in Kalutara area	C	Technical assistance on treatment of river mouth
(6)	Monitoring of South Expressway Project	DOI	DOI	B	Technical assistance on drainage system
Recommendation for Gin River Basin					
(1)	Early implementation of Urgent Works	DOI	DOI	B	Technical assistance in Feasibility Study

No.	Recommendation	Responsible Organization	Implementing Organization	Schedule	Necessity of Foreign Assistance
(2)	Handling of people living in unprotected area	DOI	DOI, Inhabitants	B	Technical assistance for handling of stakeholder meetings
(3)	Modernization/ rehabilitation of existing pumping stations	DOI	DOI, local administrative organizations	B	Technical assistance on evaluation of gates and pumps
(4)	Monitoring of South Expressway Project	DOI	DOI, RDA	B	Technical assistance on drainage system
Recommendation for Nilwala River Basin					
(1)	Early implementation of Urgent Works	DOI	DOI	B	Technical assistance in Feasibility Study
(2)	Sounding of gaps in downstream reaches	DOI	DOI	B	Technical assistance for hydraulic and stability analysis
(3)	Trans-basin project at upstream reaches	DOI	DOI	B	Technical assistance on various investigation on feasibility of the dream project

A: within one year, B: within 2 years, C: within 5 years

Source: JICA Study Team

Part III:

Early Warning and Evacuation System Planning

PART III EARLY WARNING AND EVACUATION SYSTEM PLANNING

CHAPTER 1 GENERAL

1.1 Background and Necessity of EWE System

There are two types of measures for mitigating damages from natural disasters: structural and non-structural measures. For flood damage mitigation, regulating the flood discharges by constructing dams and preventing the overflowing of excess floods by constructing river banks are examples of structural measures, while methods to minimize the damage by implementing advance evacuation, regulating land use in the flood prone area, etc. are some examples of the non-structural measures. Structural measures are usually cost-intensive and take a longer period to implement. Non-structural measures, on the other hand, are relatively less expensive and effects, that is, in terms of the reduction of human casualties, can be realized sooner. However, significant activities such as development of laws, enhancement of the people's awareness and the eventually the practice in people's daily lives are required so that the effects of these non-structural measures will be sustainable.

Since it will take time to implement structural measures in Sri Lanka, earliest implementation of Early Warning and Evacuation (EWE) system, one of the most effective non-structural measures, is desirable. therefore, EWE system planning was included as one components of the Study.

1.2 Objective of the Study

Although the GOSL recognizes the necessity of an EWE system and has conducted several meetings and workshops with related organizations, it has yet to prepare the necessary regulatory and implementation environment such as formulation of concrete guidelines and manuals, drafting of relevant laws, etc. Main reasons of this situation are as follows:

- There are so many relevant, and sometimes redundant organizations with unclear mandates.
- Inadequate capacity for forecasting
- Lack of experience to operate the system such as issuance of warning and evacuation instruction, emergency response during disaster situation, etc.

Objective of Component2 is to plan the Multi-Hazard (Flood, Sediment Disaster, Tsunami) EWE System by solving the above issues through the Pilot Project in Kelani and Kalu river basin. The plan includes recommendation for role allocation of related organizations, information flow and its tools. In addition to this, the procedure for Hazard Mapping, setting of warning criteria, and methods for O&M of the system and equipments are recommended.

CHAPTER 2 MULTI-HAZARD EWE SYSTEM PLANNING

2.1 Procedure of Planning

Procedure for Multi-Hazard EWE System planning is shown below.

Conceptual Planning

Information flow, methods of dissemination and role allocation of related organization from monitoring to warning issuance and to people's evacuation were shown in the concept design and table after discussion with GOSL. This conceptual plan was the basis of following activities.

Implementation of Pilot Project

Based on the conceptual plan of EWE system, Flood EWE system for Kelani and Kalu was established as a pilot project. The pilot project consists of the following activities.

- Establishment of Hydrological Information System to automate hydrological monitoring
- Establishment of Intra-Governmental Network to share information among related organizations
- Recommendation of information dissemination method to people
- System development from monitoring to warning issuance, information dissemination and sharing, evacuation instruction issuance, and peoples evacuation
- Implementation of disaster management exercise as a trial of the developed system

Review of Actual Events

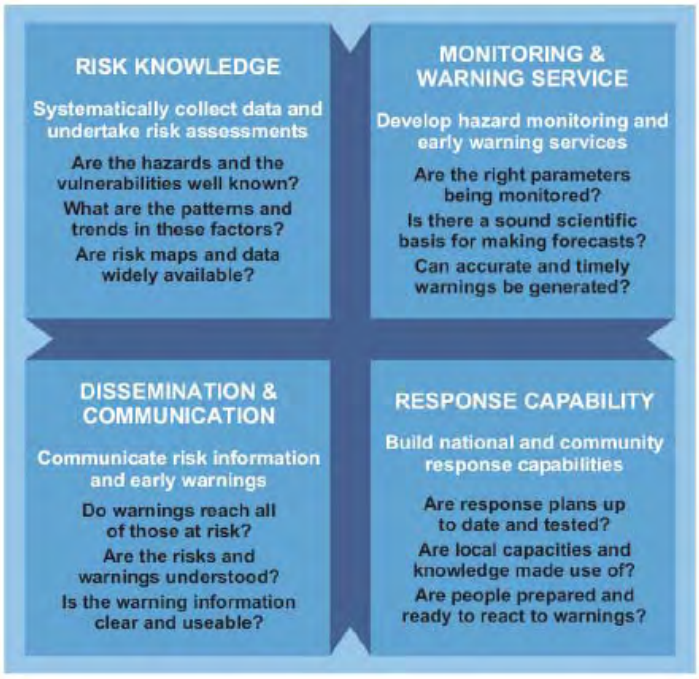
Actual "Tsunami warning" was issued due to earthquake at Indonesia and flood disaster occurred due to heavy rainfall during this Study. These actual events were reviewed from the point of EWE system and issues and lessons were raised for system development.

Multi- Hazard EWE System Planning

Present conditions and issues of existing system were studied using the results of the above activities. Also, Multi-Hazard EWE System was planned with recommendation for implementation of the plan.

2.2 "A Checklist" of EWC III

"Developing Early Warning Systems: A Checklist" was developed as a result of The Third International Conference on Early Warning (EWC III) held in Bonn, Germany from 27-29 March 2006. The Checklist, which is structured around the cross-cutting elements and other four key elements of effective early warning systems, aims to be a simple list of the main elements and actions that national governments or community organizations can refer to when developing or evaluating early warning systems, or simply checking that crucial procedures are in place. To be concrete, in addition to "Role Allocation" as cross-cutting elements, there are 4 key elements: 1) Risk Knowledge, 2) Monitoirng & Warning Service, 3) Dissemination & Communication, 4) Response Capability. General character of these four elements are shown in the following figure.



Source: Check List

Figure III-1 Four Elements of People-centered Early Warning Systems

Correspondence between Activities in the Study and these elements are shown below.

Table III-1 Checklist and Activities in the Study

Checklist Item	Activity in the Study
Role Allocation	➢ Conceptual planning of role allocation ➢ Discussion of role allocation for Exercise ➢ Planning and recommendation of role allocation
Risk Knowledge	➢ Simulation of rough inundation area in Kelani, Kalu, Gin and Nilwara (Component 1) ➢ Community level hazard mapping at selected 15 communities (Component 3) ➢ Planning and recommendation of methods for hazard mapping
Monitoring & Warning Service	➢ Establishment of realtime monitoring system of rainfall and water level of Kelani and Kalu river by Pilot Project ➢ Planning and recommendation of monitoring and warning service ➢ Community level monitoring activity of rainfall and water level (Component 3)
Dissemination & Communication	➢ Conceptual planning of information flow and tools ➢ Establishment of Intra-Governmental Network: Dedicated communication tool for related organizations ➢ Discussion of information flow and tools for Exercise ➢ Planning and recommendation of information flow and tools ➢ Implementation of Exercise for Information Transfer ➢ Discussion on community level role allocation, information flow and tools (Component 3)
Response Capability	➢ Implementation of exercise for Information Transfer ➢ Preparation of exercise manual ➢ Planning and recommendation of response capability ➢ Implementation of community level evacuation drill (Component 3)

As it is shown in the above table, the Study conducted broad activities to cover all the elements of Checklist. Especially for "Monitoring & Warning Service" and "Dissemination & Communication", the intensive activities were conducted through installation of equipment and implementation of exercises.

This report was made up from the point of these elements of Checklist.

2.3 Conceptual Planning

(1) Background

In Sri Lanka, laws and documents to clearly state that role allocation and information flow, etc. of multi-hazard EWE system do not exist. In fact, most of related organizations are conducting roles of EWE system as additional to their traditional roles. In consequence, there is no responsible division or responsible officer for EWE system in most organizations. Therefore, coordination of related organizations is very difficult even though it is very important for EWE system.

On the other hand, there is "Scheme of Organization and Standing Order" (Standing Order) only for flood disaster at downstream of Kelani river, that was prepared mainly by DOI on 1993. Contents of "Standing Order" are excellent as flood EWE system, because "Standing Order" shows inundation areas by different flood levels, methods for hydrological monitoring, timing for warning issuance, route and methods for information dissemination to related organizations, methods for dissemination to people, preparation of evacuation place and emergency foods, and flood defense works etc. Since "Standing Order" was prepared through the discussions with related organizations, the system is appropriate to Sri Lankan institutional framework. General description of "Standing Order" is shown below.

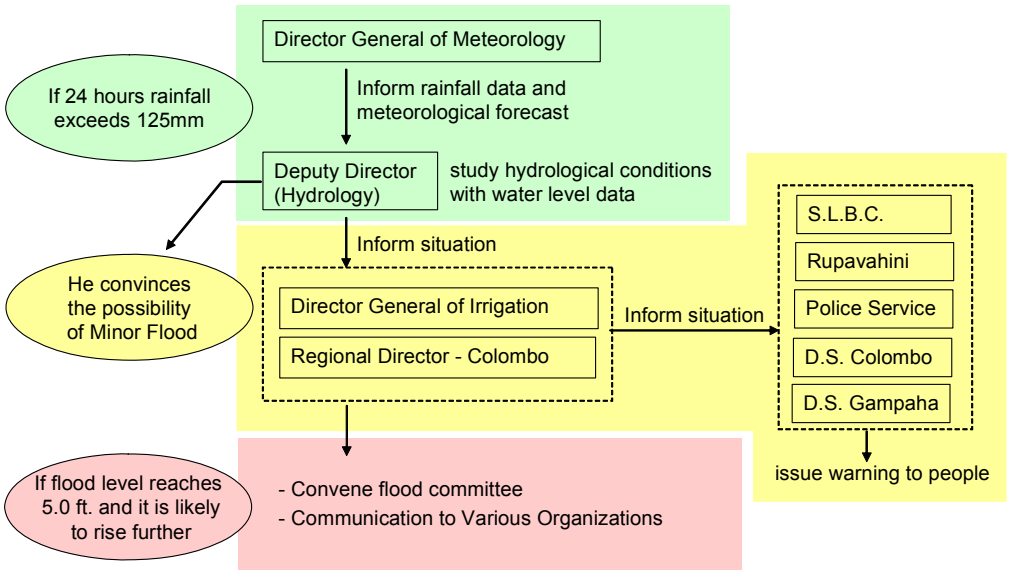
(2) "Scheme of Organization and Standing Order"

Technical Advisory Group on flood under the chairmanship of DOI appointed by the Cabinet Subcommittee on natural disasters improved the previous "Standing Order" on April 1993.

The "Standing Order" classifies the floods of the river into four at Flood Levels of Nagalagam St. gauging station based on the magnitude of damage as follows.

Minor Flood:	5 - 7 ft
Major Flood:	7 - 9 ft
Dangerous Flood:	9 - 12 ft
Critical Flood:	12 ft +

Based on past experience, a minor flood will be forecast when rainfall amount of 24 hours exceeds 125 mm. In case of possible minor flooding, warning issued by DOI will be disseminated to the people in high-risk area through the local government, police and media. The work flow of flood warning procedure defined by the "Standing Order" is shown below.



Source: Scheme of Organization and Standing Order arranged by JICA study Team

Figure III-2 Flood Warning Procedure

According to the role allocation defined by the "Standing Order", DOI is responsibile to provide the flood forecasting as well as to transfer the discussion result of the flood committee to the local government, police, military, etc. Role allocation of related organizations is also described in the "Standing Order". The major responsibilities of related organizations are shown below. Actions to be taken are described according to the flood level.

Table III-2 Principal Responsibility of Related Organizations

Organization	Role and Responsibility
District Office (GA) Provincial Office	➢ Information Dissemination to DS and people ➢ Preparing for evacuation sites and food supplies ➢ Coordination with police, military etc. for emergency response
Department of Irrigation	➢ Flood defense works ➢ Gauge reading, Patrol and Gunny bag preparation ➢ Gate operation and closure by gunny bags ➢ Flood forecasting and Information dissemination to related organization ➢ Coordination of Flood Committee
Police	➢ Information Dissemination to people ➢ Patrol to save lives, to save property and to prevent looting ➢ Cooperation for emergency response ➢ Cooperation for flood defense works
Navy	➢ Preparation for relief operation
Department of Meteorology	➢ Informing Rainfall data to DOI ➢ Participation in Flood Committee
The Sri Lanka Land Reclamation & Drainage Corporation	➢ Proper operation of outlets ➢ Participation in Flood Committee
Colombo Municipality	➢ Preparing the shelter and food for victims
The Ceylon Electricity Board	➢ Informing water level and rainfall amount to DOI ➢ Participation in Flood Committee
C.G.R.	➢ Patrol of Railway and Railway Bridge

Source: Scheme of Organization and Standing Order arranged by JICA study Team

Although the "Standing Order" is an excellent system, based on the survey in the study, there are not many organizations that are utilizing the "Standing Order" as a manual for EWE system after about 15 years from its preparation. The securing of system continuity is recommended in this report.

(3) Conceptual Plan

In this report, the conceptual plan of multi-hazard EWE system aims to respect "Standing Order" as much as possible since it is the only EWE system in Sri Lanka, and to incorporate DMC into the system since it did not exist at the time of preparation of "Standing Order".

In the conceptual plan, organizations related to EWE system are classified based on these three categories: Decision making, Technical Support and Information Dissemination. The Table below shows the classification of concerned organizations in the conceptual plan.

Table III-3 Classification of Organizations (Conceptual Plan)

Category	Organization
Decision Making	GA, DOM for Tsunami (DMC and DDMCU support GA)
Technical Support	DOI, DOM, NBRO, Mahaweli Authority, NWSDB, CEB, CCD, NARA, GSMB
Information Dissemination	DMC(DDMCU), GA office, DS office, GN, Local Authorities, Police and Military

The role allocation that was agreed on at the time of conceptual planning is shown below. During the discussion process, duplication of responsibilities among related organizations were identified due to recent institutional changes in disaster management administration. (Final recommendation of the role allocation after the study is shown in Table III-17.)

Table III-4 Role Allocation of Related Organization (Conceptual Plan)

Organization	Monitoring Information	Warning	Evacuation
DMC	Information from Related Organizations / Compiling Local Conditions and Issuing Press Release	Information Dissemination	Advice to GA / Information Dissemination
DDMCU	Local Conditions	Information Dissemination	Advice to GA / Information Dissemination
DOI	Water Level, Rainfall	Issue Flood Warning	Technical Support to DMC and GA
DOM	Meteorological Data (Rainfall, Temperature, Wind, Pressure, etc.) Tsunami(Earthquake)	Issue Rainfall, Tsunami, Storm Surge, Cyclone, Lightning Warning	Technical Support to DMC and GA
NBRO	Rainfall, Movement of Slope, Local Condition	Issue Landslide Warning	Technical Support to DMC and GA
GSMB	Earthquake, Tsunami	-	-
NARA	Tsunami, Tide	-	-
CEB	Dam related flood	-	-
NWSDB	Dam related flood	-	-
Mahaweli Authority	Water Level, Rainfall Dam related flood	Issue Flood Warning	Technical Support to DMC and GA
CCD	Coast Information	-	-
Police	Local Conditions	Information Dissemination	Information Dissemination

Organization	Monitoring Information	Warning	Evacuation
Military	-	-	Information Dissemination
Media	-	Information Dissemination	Information Dissemination
GA	Local Conditions	Information Dissemination	Issue Evacuation Instruction / Information Dissemination
DS	Local Conditions	Information Dissemination	Information Dissemination
GN	Local Conditions	Information Dissemination	Information Dissemination

The concept design regarding information flow is shown in the Figure below. Planning principles for the concept design are as follows:

- Disaster-related information, such as meteorological information, river water level, tide, earthquake, warnings and evacuation instruction, shall be shared by everybody from governmental officers to local people.
- Governmental organizations shall be connected by dedicated line to share information even during the disaster period.
- Basically, communication with local people is through the local government (District – Division – GN etc). Multiple modes, such as police network, TV, Radio, Internet, etc., shall be prepared to widely disseminate the information to local people.

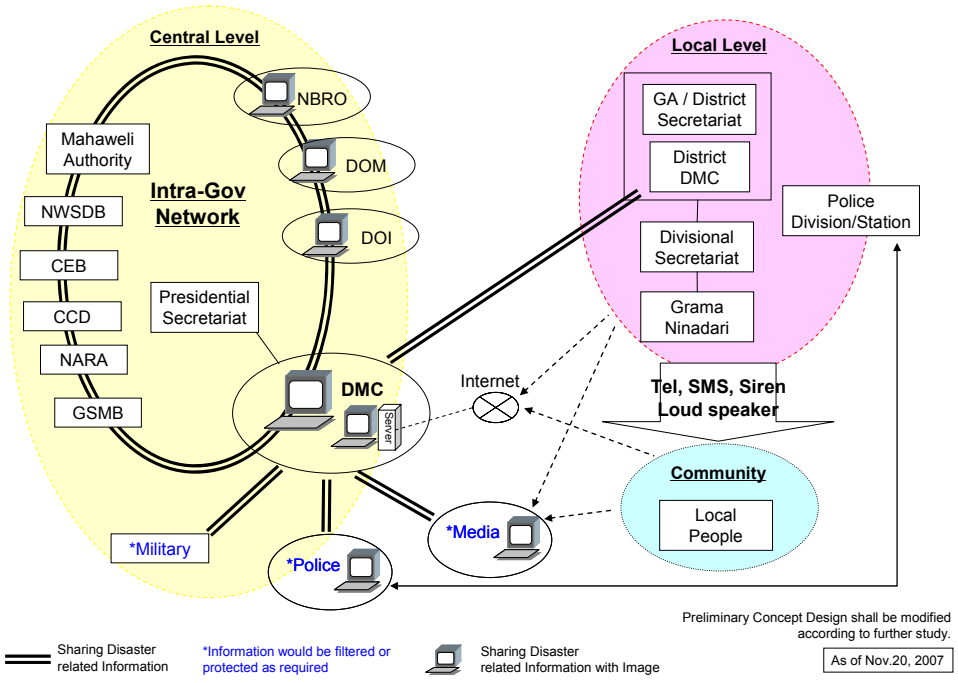


Figure III-3 Concept Design

CHAPTER 3 FINDINGS OF THE STUDY

3.1 Findings from the Pilot Project

3.1.1 General

Based on the conceptual EWE system plan, Flood EWE system for Kelani and Kalu was established as a pilot project. The pilot project consists of following activities:

- Establishment of Hydrological Information System to automate hydrological monitoring
- Establishment of Intra-Governmental Network to share information among related organizations
- Recommendation of information dissemination method to people
- System development from monitoring to warning issuance, information dissemination and sharing, evacuation instruction issuance, and peoples evacuation
- Implementation of disaster management exercise to trial the developed system

Relation of Hydrological Information System and Intra-Governmental Network is shown below.

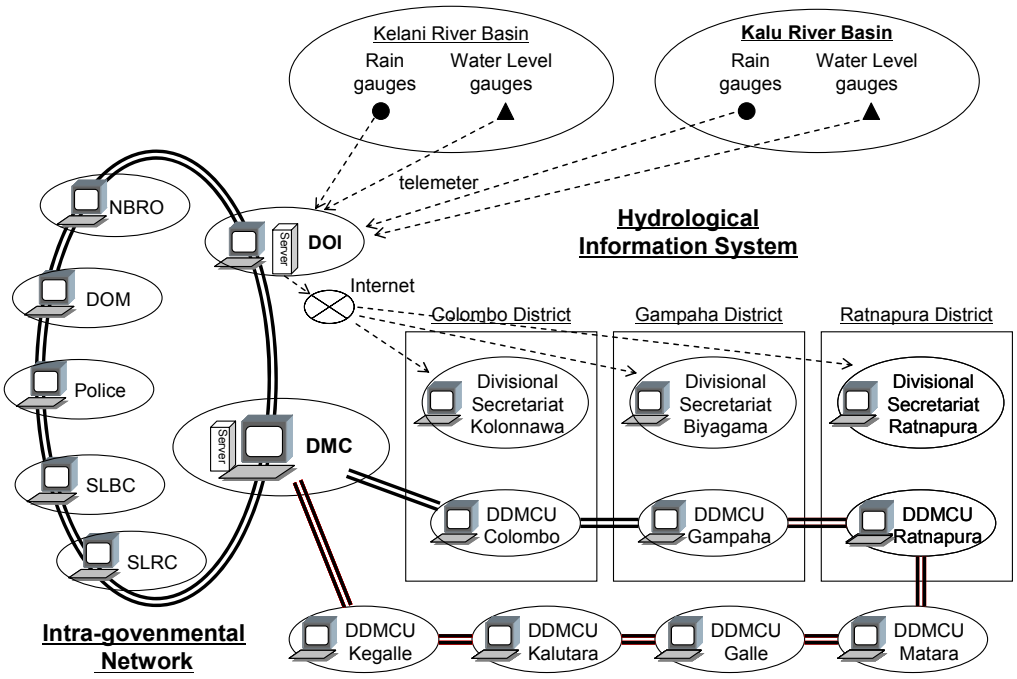


Figure III-4 Relation of Hydrological Information System and Intra-Governmental Network

By restricting the type of disasters and areas, the number of relevant organizations is decreased, information flow is simplified, and delineation of roles is clarified. Accuracy and efficiency of forecasting is improved by automating the monitoring system of rainfall amount and water level. Installation of Intra-Governmental Network supports information transfer and sharing among the relevant organizations. Implementation of this system plan by conducting the exercise will make up for the lack of experience as well as clarify issues and improve the plan.

3.1.2 Establishment of Hydrological Information System

(1) Summary of Hydrological Information System

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

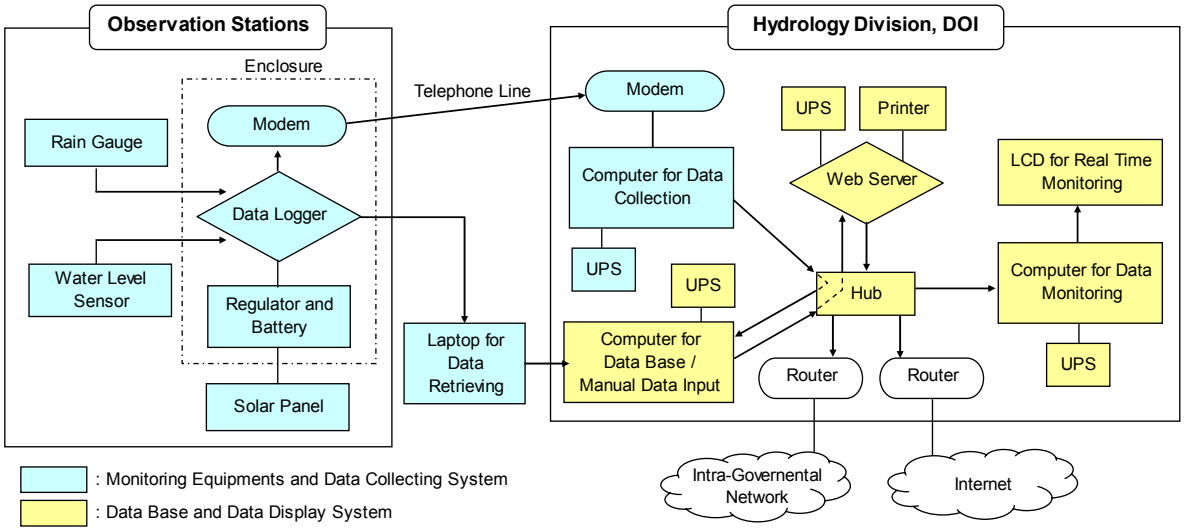


Figure III-5 System Diagram of Hydrological Information System

1) Monitoring Equipments and Data Collecting System

At present, rainfall amount and water level are observed every hour or every three hours around the clock at the main observation stations in Kelani and Kalu river basin. Observed data is relayed to Hydrology Division, DOI by telephone or radio. Realtime data is documented on a white board inside the room of the Deputy Director.

Figure III-6 Present Monitoring 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 was transferred to the hydrology division by telemeter system. Criteria for selection of observation equipment is low cost and easy maintenance. The normal telephone line that is widely used in Sri Lanka was also selected for the telemeter system for the same reasons.

Table III-5 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)

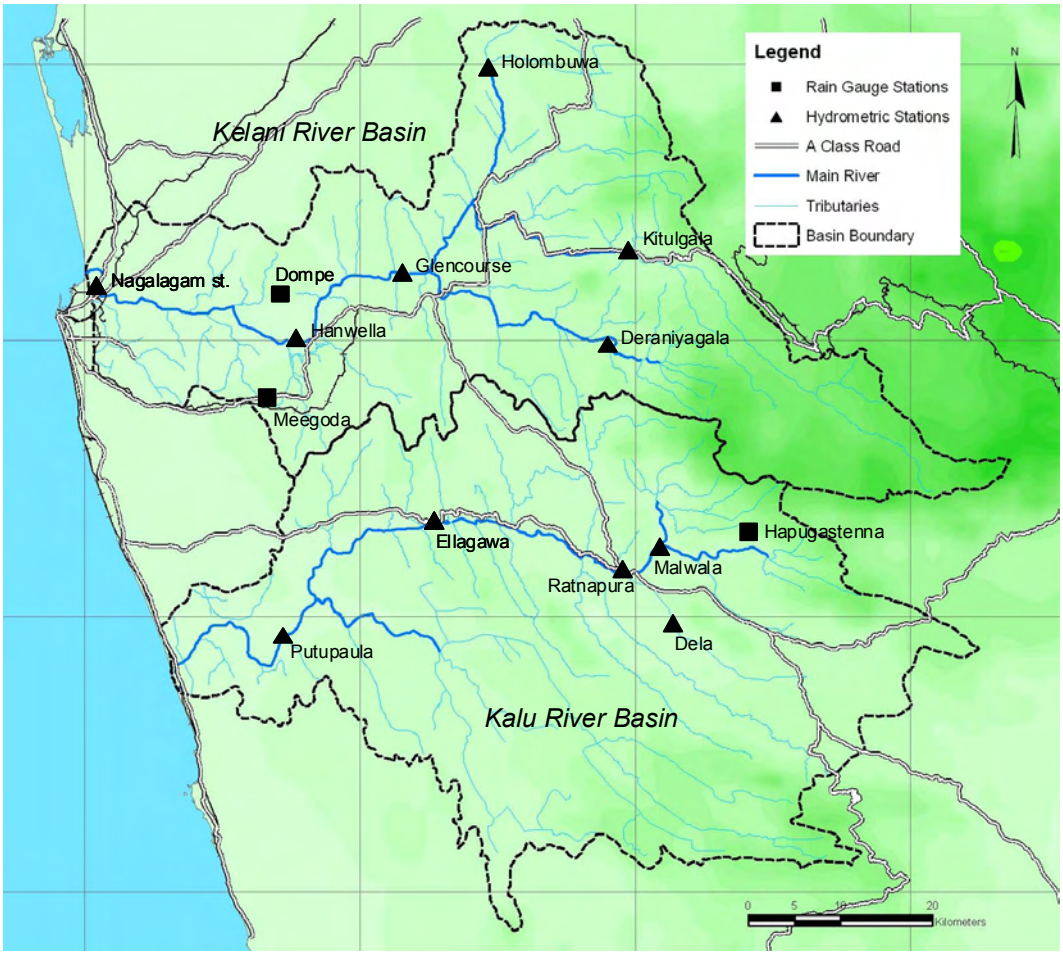


Figure III-7 Location of Observation Stations

Figure III-8 Installed Equipment at Observation Stations

2) Database and Data Display System

At present, observed data is compiled in a monthly written report collected by and kept with DOI. In the pilot project, collected data by telemeter system is saved in a 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. The data can be monitored through the website and the Intra-Governmental Network.

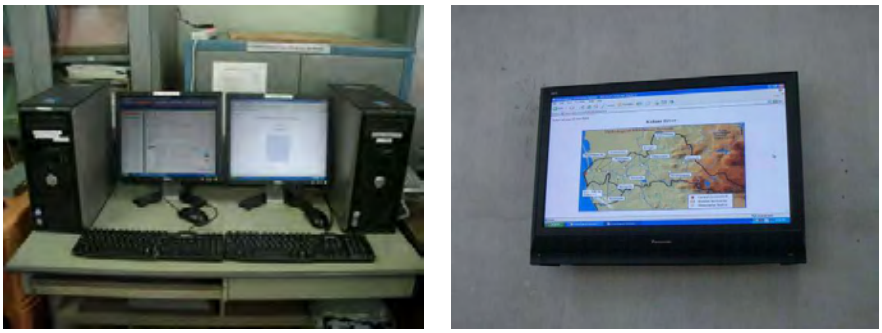


Figure III-9 Installed Equipments at Hydrology Division, DOI

Figure III-10 Monitoring Screen of Hydrological Information System

(2) Findings from Establishment of Hydrological Information System

1) Findings after Provision and Installation of Equipment

"Motivation for Participation to the Study" : Automation of hydrological monitoring and data collection provided an incentive for officers in DOI to positively participate in this Study. Officers in DOI recognize the benefit from automation, because they have performed periodical manual data collection for long time.

"Selection of Communication Line" : It is the first system in Sri Lanka to collect hydrological data by telemetry. Therefore it was very difficult to select a communication line. Since the cost for system establishment seems in proportion to the stability of the system, it is necessary to discuss well with counterpart organizations including budget allocation.

2) Findings from O&M of Equipment

"Information Disclosure" : DMC feeling positive about information disclosure and DOI the system manager have started to discuss information disclosure. Continuous discussion is necessary.

3.1.3 Establishment of Intra-Governmental Network

(1) Summary of Intra-Governmental Network

1) General

At present, information transfer among relevant organizations is conducted mainly by landline telephone, mobile phone and fax. These tools can not be said as "stable tools" because the number of telephone lines is limited, it takes some time to send and receive information by fax during an emergency, and the lines also tend to get congested during times of emergency.

In the conduct of the pilot project, an 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).

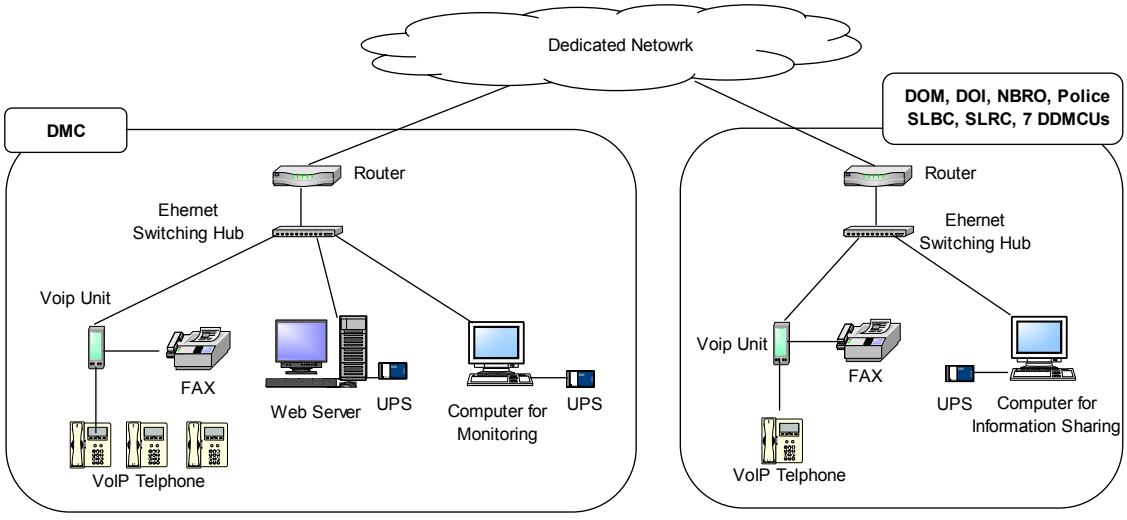


Figure III-11 System Diagram of Intra-Governmental Network

Each organization was provided a personal computer, telephone and fax 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. Commercial line was judged to have an advantage over independent dedicated line for the selection of communication line, in terms of the present capacity of DMC because the independent line has to be maintained by DMC by itself and commercial line is maintained by communication company. Although there was a possibility to

select wired network such as ADSL and optical fiber to secure the broad band communication, Wimax system was selected because of its easy installation and low O&M cost.

Figure III-12 Installed Equipment
(Antenna for Wimax (Left), Provided Equipment for each organization (Right))

2) Utilization of Intra-Governmental Network

The best advantage of Intra-Governmental Network is that it is possible to communicate during emergency period without congestion because of dedicated line. Another advantage is that stable budget planning is possible because of the fixed price contract with communication company. Also, 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.

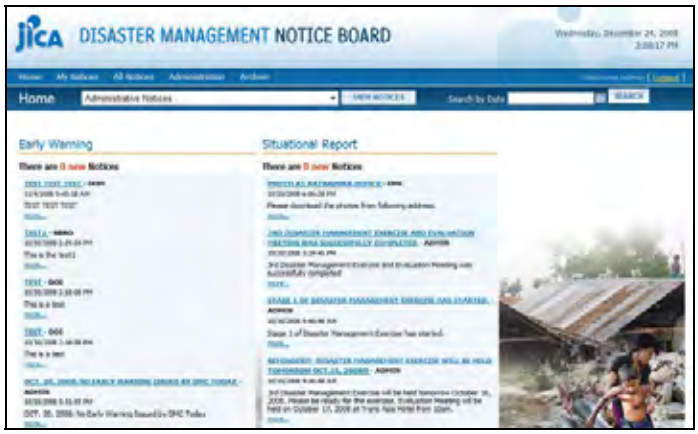


Figure III-13 First Page of Notice Board

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

(2) Findings from Establishment of Intra-Governmental Network

"Proper Operation and Maintenance" : Regarding the use of the telephone and fax, Intra-Governmental Network is an important communication method for DDMCU since it does not have sufficient number of telephone lines. On the other hand, there are some issues such as officers who do not know how to use it in case of emergency, and the printer toner has to be changed when necessary etc., because Intra-Governmental Network is not used during normal times in some organizations.

3.1.4 Recommendation of Methods to Disseminate Information to People

(1) Information Dissemination by Internet

Anyone can monitor the data after uploading the Hydrological Information System to a website. PC and ADSL lines were provided to DS office to monitor the system through the internet because DS office has the important role to disseminate information to GN and people.

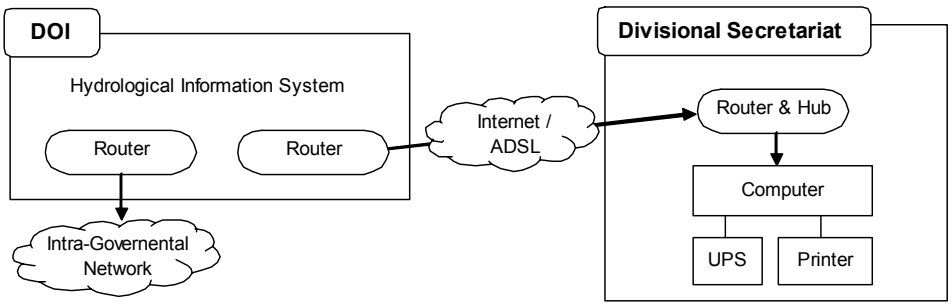


Figure III-14 System Diagram of Information Transfer through Internet

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

(2) Information Dissemination by Car Mounted Loud Speaker

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

Figure III-15 Installed Equipment at Divisional Secretariat Office
(Provided monitoring equipments (Left), Car mount type loud speaker (Right))

(3) Findings from above Activities

"Motivation for Participation to the Study" : Provision of PC and ADSL lines motivated officers in DS office to actively participate in the Study. It is necessary for DS officers to continue the activity because they have never conducted water level monitoring and information dissemination by car mounted loud speaker.

3.1.5 Implementation of Disaster Management Exercise

(1) Summary of Disaster Management Exercise

Implementation of Disaster Management Exercise consists of two major activities: namely 1) Establishment of EWE System, 2) Implementation of Disaster Management Exercise. Details of each activity are explained below.

1) Establishment of EWE System

It is necessary to establish EWE system and to prepare a manual that describes role allocation and detailed activities of each organization. This study adopted a participatory planning process for system establishment from the point of capacity development, and repeated preparatory meetings with related organizations chaired by DMC. More details about participatory planning process are described in Part V.

Preparatory meetings started about 1 month before the implementation of Exercise. Preparatory meetings consist of joint meetings and individual meetings. Consensus was obtained by related organizations at the joint meetings and concrete activities of each organization were discussed at the individual meetings. Based on the discussion at the preparatory meetings, exercise outline, objectives, guidelines, and actions to be taken by each organization were described and illustrated in the manual.

Figure III-16 Exercise Manual (abstract)

2) Implementation of Disaster Management Exercise

Objectives of exercise were to understand role allocation of each organization, and to evaluate the planned system. Disaster Management Exercise were conducted three times during this Study. The table below compares the contents of the three exercises. Target area and target disasters were gradually expanded, and Information Transfer Exercise was developed to Disaster Management Exercise where community level evacuation drill was successively conducted.

Table III-6 Comparison of Exercises

	1st Exercise	2nd Exercise	3rd Exercise
Date	October 16th, 2007	February 26th, 2008	October 16th, 2008
Exercise	Information Transfer Exercise	Information Transfer Exercise + Evacuation Drill	Information Transfer Exercise + Evacuation Drill
Disaster	Flood in Kelani	Flood in Kelani and Kalu, Landslide in Ratnapura	Flood in Kalu and Gin, Landslide in Ratnapura and Kalutara
District	Colombo, Gampaha	Colombo, Gampaha, Ratnapura	Ratnapura, Kalutara, Galle
Division	Kolonnawa, Biyagama	Kolonnawa, Biyagama, Ratnapura	Ratnapura, Nivithigala, Dodangoda, Horana, Bulathsinhara, Baddegama
G.N.	Kittanpahuwa, Malwana	Kittanpahuwa, Malwana, Mahawala, Anganmana	Mudduwa, Mahawala, Waniyawatta, Ukwatta, Nagalakanda, Niggaha, Baddegama South
Community	―	Kittanpahuwa, Malwana, Herauda, Anganmana	Mudduwa, Herauda, Kiribathgala, Ukwatta, Nagalakanda, Niggaha, Baddegama South

The following table shows the scenario of 3rd Disaster Management Exercise. Exercise had three stages. Stage-1 is the exercise to disseminate information from technical organization to GN through DMC and related organizations. In Stage-2, DDMCU and GA convene DM committee and issue evacuation instruction based on the received information, and disseminate information to community people, and community people conduct evacuation drill. In Stage-3, disaster conditiona at local level is reported from GN to DS, to DDMCU and to DMC based on the instruction by DMC, and DMC consolidates all the disaster condition and conducts press conference.

Table III-7 Objectives and Activities of Exercise on October 16th, 2008

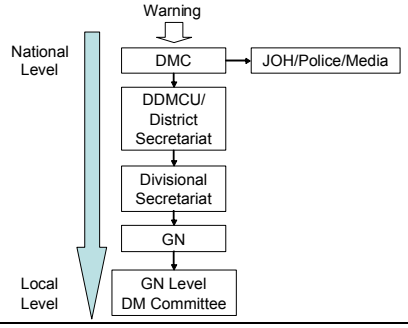
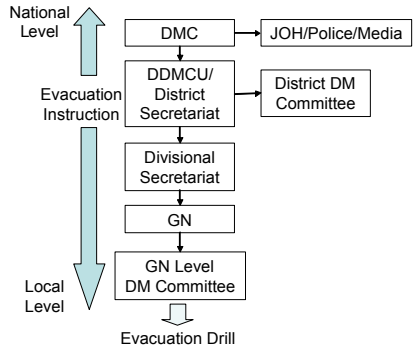
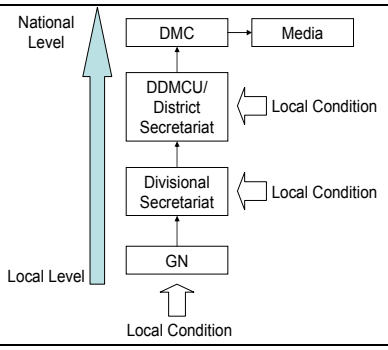
Stage	Objective	Activity		Information Flow
		Government / Organization	Community People	
1	- To confirm the information flow from national level to local level.	- Early Warning Message Dissemination ➢ Bad weather advisory by DOM ➢ Flood warning by DOI ➢ Landslide warning by NBRO		
2	- To confirm 1) the procedure to issue the evacuation instruction 2) the information flow from district level to national, local level, and community people. 3) the evacuation activity by community people	- Preparation of Evacuation Instruction Message and its Dissemination ➢ Evacuation Instructions to affected area specified by District Disaster Management Committee by DDMCU (GA)	- Information Disseminati on - Evacuation Activity	
3	- To confirm the information flow from local level to national level. - To exercise 1) to consolidate the various information. 2) to have a press conference.	- Reporting and Consolidation of Local Conditions ➢ Situation Report by each level - Conducting Press Conference		



Figure III-17 Photo of Exercise

(2) Findings from Disaster Management Exercise

1) Findings through 1st Exercise

Although there are some issues, information was disseminated from central government to GN and information was reported from GN to central government as planned in the exercise manual. Since

there were not big problems in the system established through a number of meetings, 1st exercise was successful. The following are the findings of 1st Exercise.

"Understanding of the Manual" : There were several mistakes in people's action because of not understanding of the manual. This is because participants were not accustomed to read and understand the manual.

"Responsibility to Issue Evacuation Instruction / Order" : Discussion had been repeated from the beginning of the Study on who should issue evacuation instruction / order. Although there was still an opinion that technical organization should issue it, consensus was obtained from related organizations that GA issues it.

"Difference between Exercise and Actual Events" : There were some actions written in the manual that were different from actual actions because of limited time and simplification for the exercise. It is necessary to make manual consider a range of real situations.

2) Findings from 2nd Exercise

In the 2nd Exercise, "Preparation of action manual for each organization", "Implementation of DIG", and "Read-through of the manual" were conducted in the preparatory meeting based on the review of 1st Exercise. These were conducted to have officers actively participate in the exercise and understand the manual well.

2nd Exercise was conducted more smoothly than 1st Exercise. The following are the findings of 2nd Exercise.

"Unexpected Situation" : The objective of this exercise was just to conduct the actions written in the manual. However, there was a situation such that warning letter, which should have arrived, did not arrive at receiving side organizations, because some organizations, especially on the sending side, did not take action properly.

"Contents of Warning Letter" : Discussion was made on the contents of warning letter between the technical organizations that want to inform the situation in detail as much as possible, and DMC that wants to disseminate the minimum required information.

Also, there were cases that many organizations retyped the received letter.

"Maintenance of Communication Equipment" : There were some cases that Fax malfunctioned, and transmitting and receiving were not conducted simultaneously.

"Capacity of GN and Community" : Most GN and communities that were the low-end of the system conducted evacuation drill properly although this drill was their first time. It was found that GN and community level had enough capacity to conduct actions properly if those actions were instructed properly. Therefore, in the case of EWE system, if the correct information is disseminated in the short time, GN and community will be able to act properly

3) Findings from 3rd Exercise

In the 3rd Exercise, participants from local area, who attended the exercise for the first time, were assembled at one place to conduct rehearsal before the exercise to make participants understand the manual well. The following are the findings of 3rd Exercise.

"Importance to Repeat Exercise" : This 3rd Exercise was 3rd time for DMC, 2nd time for Ratnapura DDMCU, and 1st time for Kalutara and Galle DDMCU. There was obvious difference in the results of the exercise depending on the amount of experience. Several actions could not be conducted at Kalutara and Galle, information was disseminated in the shortest time by Ratnapura DDMCU among 3 DDMCUs, and exercise was conducted smoothly by DMC even though the number of new staff, who participated for the first time, was increased. It was found that the capacity would be developed by repeating the exercise.

"Issues on Communication" : There were several cases that information was not disseminated properly. One of the reasons was problem of equipment such as congestion of telephone line and malfunction of fax. The other reason was the problem of communication between sender and receiver when "Acknowledgement" was not conducted properly.

"Contents of Letter" : Warning message should be understood by DS and its lower organizations. Warning should state if the level of the warning is alert level or evacuation level, and what should be done, etc.

3.2 Findings from Actual Events

Actual "Tsunami warning" was issued due to earthquake in Indonesia and flood disaster actually 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.

3.2.1 Tsunami Warning Issued on September 2007

(1) Summary of Event

Due to an earthquake which occurred in South Sumatra, Indonesia, a tsunami warning was issued in Sri Lanka on 12-13 September 2007. The local people as well as the government officials were very worried of the possibility of a big and damaging tsunami, which, fortunately, did not occur.

The Table below shows the events of tsunami warning in chronological order, which were issued from the occurrence of the earthquake to cancellation of the tsunami warning.

Table III-8 Information Related to Tsunami Warning on 12th and 13th September 2007

Time	Event
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
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

Time	Event
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

(2) Findings from Tsunami Warning Issued on September 2007

Findings from the actions by governmental organizations and actions by people on this event are shown below. Actions by governmental organizations were monitored by one of study team members and also grasped by interview survey after the events. Actions by people were grasped by interview survey and newspapers.

1) Actions by Governmental Organizations

"Decision Making for Warning Issuance" : DOM immediately responded to issuing tsunami warning/evacuation instruction responsibly while the role allocation for issuing evacuation instruction and warning criteria for Tsunami were not clear. Although most people agreed that the decision making for issuing evacuation instruction for flood and landslide were conducted by GA, there was not enough discussion if the technical organization, DOM shall be decision maker for tsunami.

"Decision Making for Warning Cancellation" : Official warning cancellation by DOM was at 20:30, although the estimated tsunami arrival time to Trincomalee was at 20:32 and Colombo at 20:45. Actually, people started to leave evacuation place when DG of DOM stated that the devastating tsunami would not come around 20:15 on TV. On the other hand, police that were guiding people to evacuate, were confused by people at the evacuation place for about 30 minutes because Police received warning cancellation officially at 20:41 but people already started to go home around 20:15, and Police could not take action without official information.

"Contents of Warning" : Tsunami warning issued at 17:20 on 12th only stated the possibility of tsunami and the recommendation to get away from the coastline, and did not show the estimated arrival time of tsunami forecasted by PTWC. Because of this, there is a possibility that some of the people, who experienced Indian Ocean Tsunami, misunderstood tsunami would come immediately even though there was enough time. The title of evacuation instruction issued at 18:30 same day was "Tsunami Warning" even though it was instructing evacuation. Therefore, it was difficult to know the difference from the warning issued at 17:20 and importance of evacuation instruction was not felt. Tsunami warning issued on 13th did not show the necessary actions such as "should get away from coastline" or "recommend people to evacuate". This may be because of that PTWC did not include Sri Lanka for tsunami warning area this time. Therefore, Police were confused by the warning for what should be done. And all the warning messages were written in English and Sinhala, but warning message in Tamil is necessary for eastern province which was affected heavily at the time of Indian Ocean Tsunami.

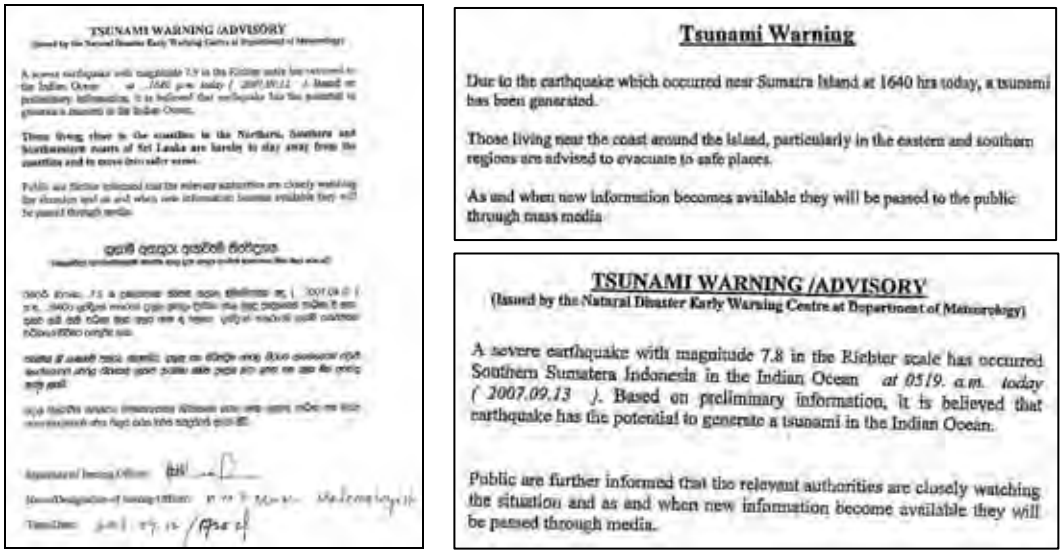


Figure III-18 Contents of Warning Message

(Tsunami Warning on 12th (Left), Evacuation Instruction on 12th (Right up), Tsunami Warning on 13th (Right down))

"Information Dissemination" : Although the information dissemination and sharing among central government organizations were conducted smoothly, information dissemination from DDMCU to people was not. Telephone and fax could not be used properly, and people had already started evacuation by getting information through media when DDMCU contacted people. Timing of events seemed good because many people were watching TV at early-evening time. Information dissemination by using Tsunami Warning Towers, that were established at three locations, also could not be conducted properly because of wrong password for system operation. Therefore it is necessary and urgent to establish effective tools to disseminate information to people.

"Response to Media" : Officers in DMC and DOM were responding to inquiry from outside on an individual basis during emergency period. This would be one of the reasons for confusion. Press releases at regular intervals or when they receive new information will be important instead of answering to each inquiry, to secure the telephone of DMC and DOM for emergency use. Now, DMC is establishing a "Call Centre". Information to the people shall be unified by providing only the contents of "Press Release" etc.

2) Actions by People

Interview survey was conducted for 150 people at Southwestern four districts (Kalutara, Galle, Matara and Hambantota). Ages of interviewees were mainly from 30's to 50's and their occupations were fishery, housewife, merchant, office worker, etc. 90% of interviewees lived within 500 m from coastline and also 90% have experienced Indian Ocean Tsunami; therefore it were found that many people still live near coastal area even if they had been the victims of tsunami.

Contents of questionnaire are shown below. Questions asked included: What kind of information, when and how the information is disseminated to people and how people acted based on the information, and people's awareness for tsunami warning and background of those awareness.

Table III-9 Contents of Questionnaire

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

The following are the findings of the questionnaire survey.

"Information Dissemination" : Tsunami warning was disseminated to 99% of interviewees within one hour from warning issuance by DOM. But the people stated that their source of tsunami warning was media and its reliability was higher than governmental network.

"Evacuation Activity" : 92% of interviewees who received tsunami warning on 12th took evacuation action. But people did not understand well about contents of tsunami warning; therefore, unfavorable evacuation activity and confusion during evacuation period were identified. Although the tsunami warning was disseminated on 13th, only 25% of interviewees who received warning actually evacuated. This was because the tsunami warning issued on 12th became "False Warning".

"Disaster Management Education" : Most of the interviewees answered that knowledge on evacuation place, etc. was obtained by "evacuation drill". Therefore, it can be said that the community level disaster management education that was conducted for long time after Indian Ocean Tsunami disaster was helpful for evacuation activity and selection of evacuation place.

3.2.2 Flood Disaster from April to July 2008

There were three flood disasters around southwestern Sri Lanka on April/May, May/June, and mid July 2008. These events were good opportunities to evaluate the result of this study and clarify the issues for future activities.

(1) Summary of Disaster

1) April/May Flood

Flood disaster occurred mainly along Kelani river and upstream of Kalu river. Daily rainfall amount around Kalani river basin and upstream of Kalu river basin are shown below. More than 200 mm/3days for whole basin and more than 400 mm/3days for upstream of Kalu river basin were recorded.

Table III-10 Daily Rainfall (April 27 to 29)

River	Kelani			Kalu		
Station	Hanwella	Glencouse	Kitulgala	Ratnapura*	Hapugastena	Asoka Estate
April 27	118.2	121.5	102.2	71.8	147.0	190.0
April 28	48.6	121.3	160.1	159.9	182.0	105.0
April 29	7.4	0.0	3.3	0.5	97.0	20.0
3 days	174.2	242.8	265.6	232.2	426.0	315.0

(Daily Rainfall (mm): 9:00am to 9:00am next day. *8:30am to 8:30am next day at Ratnapura)

Kelani River: In Kelani river, water level at Nagalagam St. gauging station exceeded the Minor Flood level (5feet) for about 2 days.

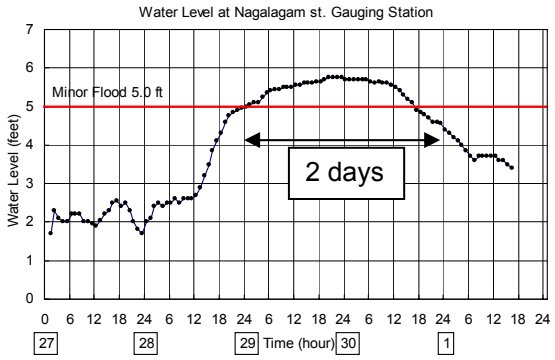


Figure III-19 Water Level at Nagalagam St

Kalu River: In Kalu river, water level at Ratnapura gauging station exceeded Minor Flood Level (20 feet = about 6 m) for about two days. Noteworthy point of Kalu river flood is that hourly rainfall amount at Asoka Estate at the upstream of Ratnapura was 62 mm from 7:00am to 8:00am on 28th and 54 mm from 8:00am to 9:00am, and water level at Ratnapura rose from normal level 3 m to minor flood level 6 m during two hours from 8:00am to 10:00am. From the point of EWE system, flood warning, information dissemination and evacuation activity has to be completed during these three hours.

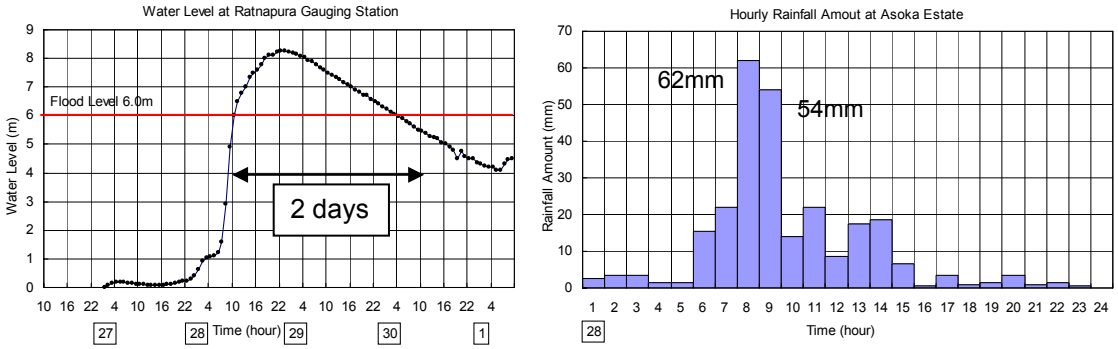


Figure III-20 Water Level at Ratnapura Gauging Station and Rainfall Amount at Asoka Estate

2) May/June Flood

Flood disaster occurred mainly along Kelani river and mid-downstream of Kalu river. Especially in mid-downstream of Kalu river basin, flood level exceeded flood in 2003. Daily rainfall amount around Kalani river basin and upstream of Kalu river basin are shown below. 400–600 mm/week were recorded.

Table III-11 Daily Rainfall (May 27 to June 2)

River	Kelani			Kalu		
Station	Hanwella	Glencouse	Kitulgala	Ratnapura*	Hapugastena	Asoka Estate
May 27	28.2	52.5	17.7	9.3	14.0	49.0
May 28	48.2	20.3	41.9	64.3	84.0	96.0
May 29	5.0	16.2	24.3	20.7	76.0	35.0
May 30	95.1	246.6	185.6	148.1	106.0	148.0
May 31	50.5	41.5	39.3	110.1	132.0	118.0
June 1	143.6	32.8	21.5	57.6	130.0	48.0
June 2	68.2	53.2	33.1	48.6	72.0	65.0
7 days	438.8	463.1	363.4	458.7	614.0	559.0

(Daily Rainfall (mm): 9:00am to 9:00am next day. *8:30am to 8:30am next day at Ratnapura)

Kelani River: In Kelani river, water level at Nagalagam st. gauging station has exceeded the Minor Flood level (5 feet) for about 3 days.

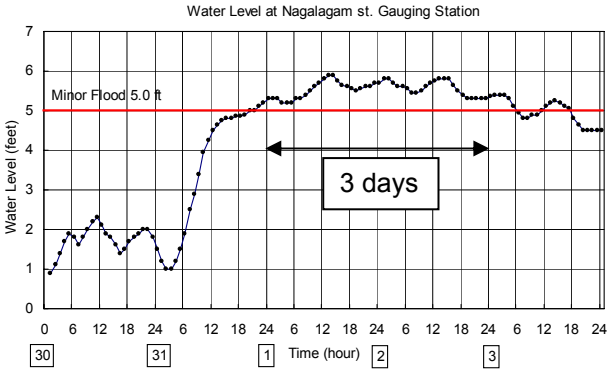


Figure III-21 Water Level at Nagalagam St. Gauging Station

Kalu River: Noteworthy point of Kalu river flood is that flood in Ratnapura at upstream of Kalu main river was smaller than the April/May flood, but flood in mid-downstream was much bigger than the April/May flood. This is because the discharge from Tributary Kuda river was big. In addition to the mid-downstream of Kalu river basin, Kuda river basin such as Bulathisinhara and Palinda Nuwara etc. was greatly affected.

3) July Flood

Although the water level at Kelani and upstream of Kalu exceeded the Minor Flood Level, damage was smaller than the above two floods.

(2) Findings from Flood Disaster

Data collection and interview survey were conducted to know the condition of issuing flood warning and evacuation instruction, and the condition of information dissemination regarding April/May Flood and May/June Flood. Also, workshop aiming information sharing on flood disasters among related organizations was conducted.

1) Condition of Issuing Warning/Evacuation Instruction and Information Dissemination

"April/May Flood"

Relation between the timing of issuing following four warning/evacuation instruction and water level at Kelani and Kalu river are shown below.

1. 28th 10:00 Bad Weather Advisory by DOM
2. 28th 10:00 Flood Warning for Kelani, Kalu, Gin rivers by DOI
3. 28th 15:00 Flood Warning for Kelani river by DOI
4. 29th 08:00 Evacuation Instruction by Colombo GA

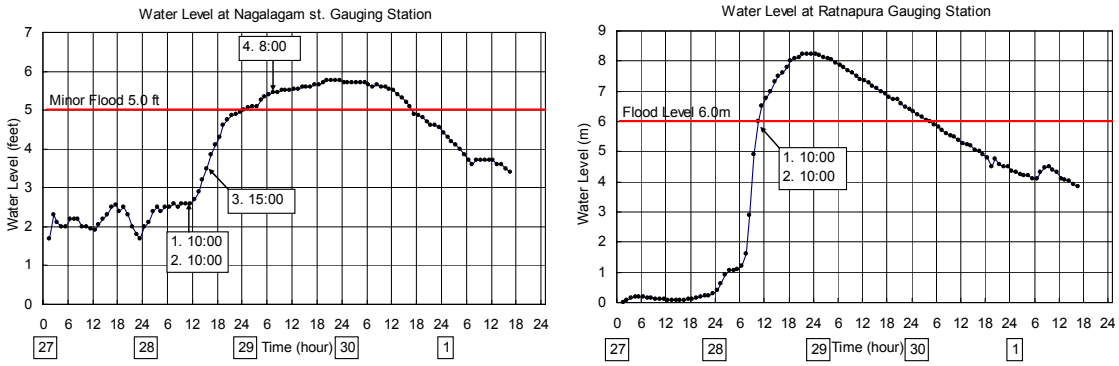


Figure III-22 Relation of Water Level and Issuance of Warning (April / May Flood)

Flood warning for Kelani river was issued before reaching 4 feet (Alert level set by DOI). In Kalu, flood warning was not issued at 4 m (Alert level is 12 feet = about 4 m set by DOI), but issued when the water level reached 6 m (Minor flood level). One of the reasons of this delay would be because the rising speed of the water level was very rapid. Evacuation instruction was issued only by Colombo District. Colombo DDMCU has discussed with GA in advance to issue evacuation instruction when the water level reached 5.45 feet. Colombo DDMCU just followed this rule.

The following figure shows how the flood information of Kelani river was disseminated to Clombo and Gampaha DDMCU.

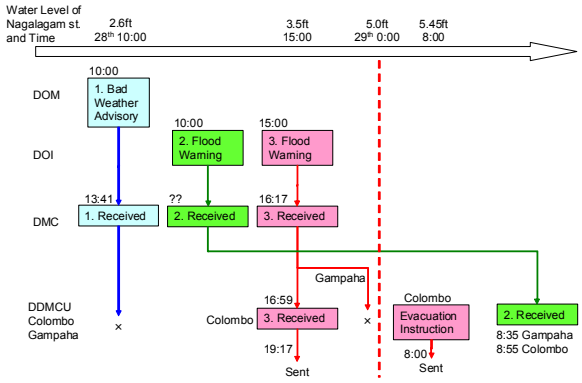


Figure III-23 Condition of Information Dissemination (April / May Flood)

Bad Weather Advisory issued by DOM at 10:00am on 28th was disseminated to DMC at 13:41, but Colombo and Gampaha DDMCU did not receive it. Flood Warning issued by DOI at same time 10:00am was also disseminated to DMC (time was not recorded), but Colombo and Gampaha DDMCU received it on 29th morning. Flood Warning issued by DOI at 15:00pm was disseminated

to DMC at 16:17, to Colombo DDMCU at 16:59, but not to Gampaha DDMCU.

When Colombo DDMCU received Flood Warning, Colombo DM coordinator discussed with GA and Irrigation Engineer of DOI over the phone according to the information transfer exercise. Also, they decided to issue Evacuation Instruction when the water level reached to 5.45 feet. Water level data was monitored by asking directly to the gauging station.

On the other hand, Gampaha DDMCU could not receive Flood Warning by 29th morning. The first information on flood that they received was the inundation information from the community. They could not provide the flood information to community before flood like exercise. Gampaha DM coordinator was confused because GA said evacuation instruction could not be issued without flood warning by DOI even though Gampaha DM coordinator strongly requested it.

"May/June Flood"

2nd Flood occurred on Saturday. Relation between the timing of issuing the following eight warning/evacuation instructions and water level at Kelani and Kalu river are shown below.

1. 31st 05:30 Weather Forecast by DOM
2. 31st 12:00 Flood Warning for Kelani river by DOI
3. 31st 15:00 Flood Warning for Kalu river by DOI
4. 31st 20:00 Flood Warning for Kelani river by DOI
5. 1st 05:30 Weather Forecast by DOM
6. 1st 08:00 Evacuation Instruction by Colombo GA
7. 1st 09:30 Special Weather Advisory by DOM
8. 1st 12:00 Flood Warning for Kelani river by DOI

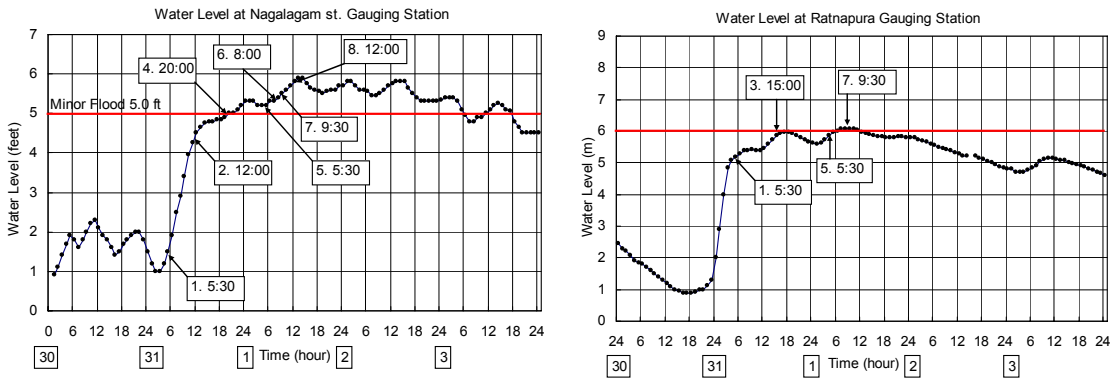


Figure III-24 Relation of Water Level and Issuance of Warning (May / June Flood)

It was at 12:00 noon on 31st that the first flood warning for Kelani was issued by DOI. It was found that a part of community in Gampaha had been already inundated. Evacuation instruction was issued only by Colombo like 1st flood. Flood warning for Kalu was issued when the water level reached 6m like 1st flood.

Condition of information dissemination from technical organization to DDMCU regarding Kelani flood is shown below.

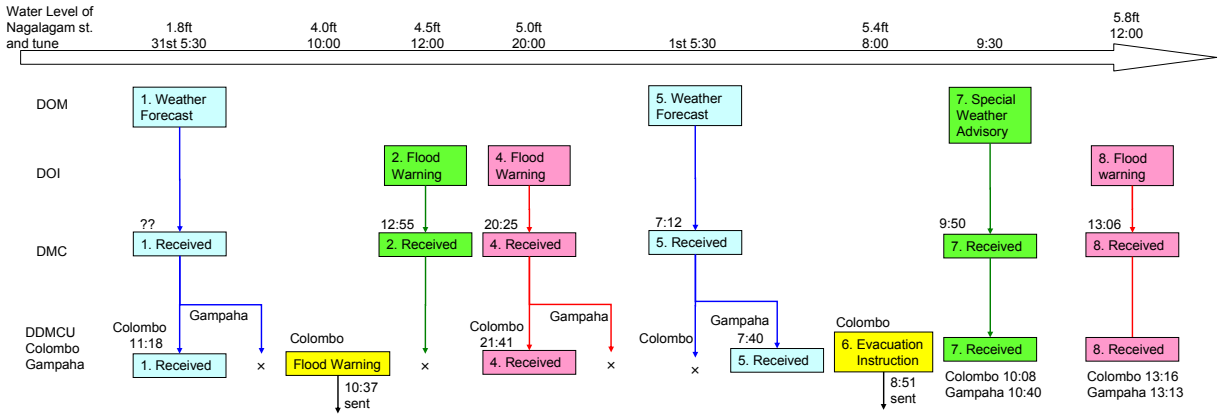


Figure III-25 Condition of Information Dissemination

As mentioned above, a part of Gampaha had been already inundated when DOI issued flood warning. On the other hand, official information from central government was disseminated to Gampaha DDMCU at 7:45am on 1st. Gampaha DDMCU did not receive any information on 31st. Colombo DDMCU continued their activity to collect water level data, and issued flood warning and evacuation instruction based on the discussion with GA and Irrigation Engineer. Special Weather Advisory issued by DOM at 9:30am on 1st and Flood Warning issued at 12:00 noon on 1st were transferred to Colombo and Gampaha DDMCU relatively smoothly.

2) Workshop for Flood EWE System

Workshop to review flood disasters from the point of EWE system was conducted in the beginning of July after two floods. Main participants were officers from DMC, 7 DDMCU (target southwestern districts), DOM, DOI and NBRO.

First of all, officers from DOM and DOI presented the characteristics of two floods. Secondly, inundation map was created and flood conditions, which area was inundated first or which area was heavily affected, etc., was reviewed by each district. Thirdly, participants discussed about the reasons why the damage expanded this time and what should be done for effective flood early warning system.

Figure III-26 Photo of Workshop

3) Findings from Flood Disaster

"Proper Warning Issuance" : DOI did not issue proper flood warning at proper timing at these flood disasters. 24 hours monitoring system, warning criteria, warning contents, and warning procedure will be discussed with DMC.

"Proper Information Dissemination" : DMC centered information dissemination was not conducted properly. It was a big issue that information dissemination from DMC to DDMCU, that must not be missed, was not conducted properly. More efforts are necessary for information dissemination system such as maintenance of equipment, thorough acknowledgement of receiving information and its contents, implementation of exercise, etc.

"Proper Role Allocation" : Role allocation of DOI and DMC will be discussed. If DOI just provides realtime monitoring data of rainfall and water level, DMC can start preparation work even though warning issuance is a little bit delayed. It is necessary to discuss again on the role allocation of DOI and DMC regarding flood EWE system including utilization of Hydrological Information System.

"Voluntary Activity" : It is difficult to expect proper forecasting and flood warning for rapid flood of small river or local area flood of large river, because information from national level organizations such as DOI and DMC is limited to large area flood in large river at present. Therefore, local level voluntary activities by DS, GN and community people are indispensable such as rainfall monitoring, water level monitoring and information exchange between upstream and downstream community.

3.3 Findings from Activities by DMC

(1) Workshop for Developing a National Consensus for Multi-Hazard Early Warning and Dissemination System in Sri Lank

Role allocation and responsibility of related organizations on Early Warning and Dissemination System for adverse climate condition, flood, landslide, epidemics, tsunami and drought were discussed at above workshop held on December 22, 2006. The following recommendations were the output of this discussion.

- Warning Message/Bulletin is divided to "Technical Warnings" and "Public Warnings". Technical Warnings are issued by technical organizations and Public Warnings are issued by DMC. Role allocation for warning preparation and information dissemination is shown below.

Table III-12 Warning Message

Warning Message/Bulletin		Formulation of Warning Messages	Dissemination	
			National Level	Local Level
Part 1	Technical Warnings	Technical Agency should formulate this section on the impending threat indicating the Nature of Disaster, Warning level / Stage-Result of force.	Technical Department	DMC in collaboration with Technical Department at District Level
Part 2	Public Warnings	Part2 should be formulated by the DMC and Mandated Agency and should indicate the likely impact of the disaster on the Population, Infrastructure, Assets, and Environment	DMC	DMC in collaboration with Technical Department at District Level
Part 3	Public Warnings	Part3 of the warning message/ bulletin should be formulated by the DMC and should state clearly the Response Actions, which communities likely to be affected should follow – which communities to evacuate, where to go, which route etc.	DMC	DMC in collaboration with Technical Department at District Level

- Responsible organizations and related organizations are shown below by type of hazard. Organizations shown in the table will discuss about the mechanism to share information among themselves and DMC so that DMC can prepare "Public Warning".

Table III-13 Responsible Organizations

Type of hazard	Related Service Agencies
Adverse Climate Condition	**DOM**, DOA, DOI
Floods	**DOI**, MASL, Agrarian Service Dept.
Landslide	**NBRO**, DOM
Epidemics	**MH**, MRI
Tsunami	**DOM**, GSMB, NARA, SL Navy.
Drought	DOA, DOM, DOI, MASL

This workshop was conducted at the beginning stage of this Study and this result is included in the National Disaster Management Plan (4th draft). On the other hand, discussion on more detailed activities has not gone forward. Warning issuance based on above recommendation has not been conducted yet during actual disaster time, and this system has not been recognized widely as an actual system. There remain some doubts about the effectiveness of the system, because it is not realistic that DMC issues warning or DMC instructs the community level activities.

(2) Community Based Early Warning and Evacuation System

Based on the experience of series of flood disaster from April to July 2008, DMC is planning to establish community based EWE system based on the community level information, in addition to the national level EWE system based on the national level information. To be more precise, DMC is discussing to support monitoring by community people using simplified rain gauge and water level staff gauge, setting warning criteria by each community, and information exchange between upstream and downstream community.

Accuracy of community level EWE system will be improved, if relation of rainfall amount and landslide occurrence, relation of rainfall amount, water level and inundation area, correlation with monitored data of nearby gauging stations by DOI and DOM etc. are studied by community activities. The accuracy of national level EWE system will be also improved if the monitored data by community activity is reported to national level organizations.

(3) Standard Operation Procedure

DMC and DDMCU are continuously discussing on preparing Standard Operation Procedure (SOP). Workshop organized by ADPC was held in July, and all the DM coordinators came to Colombo and had a discussion. The following are the example of SOP presented by Kalutara and Puttalam DM coordinators.

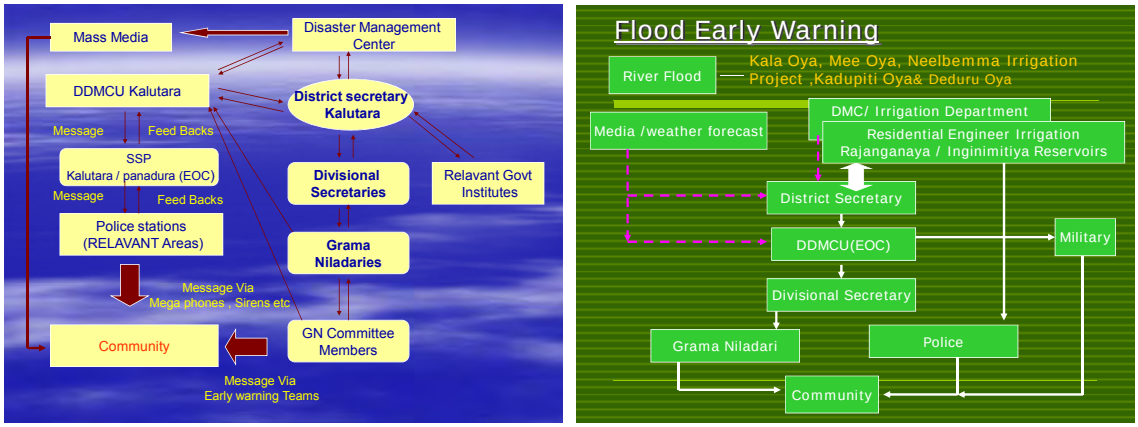


Figure III-27 Example of SOP by DDMCU

Information flow of SOP is almost the same with the information flow planned for exercise in the Study. Issues on present information transfer system raised in this workshop are shown below.

- DS and GN are not working during holiday and night time.
- Communication by telephone, FAX and mobile phone are unstable during emergency period.
- Tools for information dissemination to and inside community, so called last mile communication, are not established.

These issues were raised during the Study and as national issues.

CHAPTER 4 ISSUES ON PRESENT EWE SYSTEM

4.1 Characteristics of Water Related Disaster in Sri Lanka

The characteristics of water related disasters (Flood, Landslide, Tsunami) in Sri Lanka were studied and summarized into following table before raising issues on present EWE system. Flood disasters are divided into two groups. One of those floods occur mainly around downstream of large rivers and rise of water level of this flood is slow (it takes more than about 4 hours from normal level to flood level). The other flood occurs at upstream of rivers or at small rivers and rise of water level is fast (it takes less than about 4 hours)

The following table shows the characteristics of water related disasters in Sri Lanka.

Table III-14 Characteristics of Water Related Disaster

Disaster		Affected Area	Frequency of Occurrence	Monitoring for Forecasting / Warning	Difficulty for Forecasting / Warning	Possibility of False Warning
Flood	Slow	- large area - downstream of large river	several times / year	- Water level - Rainfall amount - Weather forecast	- Relatively easy from water level of upstream - Continuous monitoring and correlation analysis of water level of upstream and downstream are necessary.	Low
	Fast	- local area - upstream of river	several times / year	- Rainfall amount (10 min. or 1 hour) - Weather forecast - Water level	- Relatively difficult - Continuous monitoring of local and short term rainfall is necessary. - Correlation analysis of rainfall and flood is necessary.	High
Landslide		- mountain area in whole country - Very local area	several times / year	- Rainfall amount (10 min. or 1 hour) - Weather forecast - Sign of land slide	- Difficult - Continuous monitoring of local and short term rainfall is necessary. - Correlation analysis of rainfall and land slide is necessary.	Very High
Tsunami		- whole coastal area	rare occurrence	- Information from PTWC and JMA - Tide level	- Relatively easy to know possibility of Tsunami - Difficult to know height of Tsunami.	High (People will understand occurrence of small scale Tsunami as "False Warning")

(1) Flood (Slow)

Flood occurs mainly around downstream of large river. Most of the land of Sri Lanka is low-lying area except for central mountain area, so that this type of flood occurs all over the country. Very large area is affected if this type of flood occurs. Some rivers are flooded during rainy season every year; the southwestern area of Sri Lanka was flooded three times from April to July 2008.

It is relatively easy to forecast flood at downstream and issue flood warning by monitoring water level at upstream and downstream periodically, since there is enough time of flow from upstream to downstream. Accuracy of flood forecasting can be improved and possibility of false warning can be lower by monitoring data continuously for long time and correlating water level at upstream and downstream. Floods in mid-downstream of Kelani, Kalu, Gin, and Nilwara are this type.

(2) Flood (Fast)

Floods occur mainly at upstream of river and small river due to heavy short term rainfall. Since local torrential rainfall occurs frequently at mountain area in Sri Lanka, this type of flood can occur everywhere in mountainous area. On the other hand, damage area is limited, if the rainfall is localized.

It is often the case that there is no time for evacuation if the flood is forecasted based on the water level monitoring, since there is not enough time of flow from upstream to downstream. Basically, it

is necessary to forecast flood from rainfall. For such forecasting, it is necessary to monitor short term rainfall (10 minutes or 1 hour) and water level continuously, and to analyze the relation between rainfall and water level. This type of forecasting is relatively difficult because the number of rainfall gauges to grasp the local and short term rainfall amount is not enough. If the nearby rainfall gauge is substituted for monitoring rainfall amount of different river basin, possibility of false warning or risk of flood occurrence without warning will be increased. Flood in Ratnapura and Palinda Nuwara is this type.

(3) Landslide

Landslides occur somewhere in mountain area every rainy season. The affected area is very local. It is very difficult to forecast the occurrence of landslide, because landslides occur due to many factors such as topography, geology and rainfall amount, etc. One method to forecast landslide is to analyze the relation between rainfall amount and landslide occurrence for long time and continuously, since it is often said that landslides occur due to big amount of cumulative rainfall and short term rainfall. However, possibility of false warning or risk of landslide occurrence without warning will be increased like flood disaster (fast), because the number of rainfall gauges to grasp the local rainfall are not enough and landslides occur not only due to rainfall.

(4) Tsunami

3/4 of coastline of Sri Lanka was heavily affected by Indian Ocean Tsunami on December 2004. There are no other records of tsunami in recent years except for small scale tsunami recorded on September 2007. It can be said that tsunami disaster is a very rare events. Possibility of earthquake occurrence near Sri Lanka is low; therefore it is said that there is enough time from earthquake occurrence to tsunami arrival. If the earthquake occurs near Indonesia like in 2004 and 2007, travel time of tsunami to Sri Lanka is about 3.5 hours. If the occurrence of tsunami is forecasted after the earthquake, PTWC and JMA will issue tsunami information immediately. It is possible for Sri Lankan government to evacuate people before tsunami arrival by receiving information from PTWC and JMA, and disseminating information to related organizations and people. But since forecasting tsunami height is difficult, the possibility of false warning is high like tsunami in 2007.

4.2 Issues on Present EWE System

4.2.1 Present Conditions

(1) Risk Knowledge

Flood: "Standing Order" lists the name of inundated area and road by each flood level, but inundation area was estimated about 15 years ago, and target area is only around downstream of Kelani river. Component 1 of this Study prepared the inundation map of Kelani, Kalu, Gin and Nilwara by simulation, but the accuracy is not enough for issuing warnings and evacuation instructions.

Landslide: NBRO is energetically preparing hazard map. But this hazard map is based on 1/50,000 and 1/10,000 scale topographical map, so that the accuracy is not enough for evacuating people.

Tsunami: Since experience of Indian Ocean Tsunami in 2004 is still fresh, people have high awareness such as "warning issuance = evacuation". However, since hazard map is not prepared for

all of coastal line, awareness can become lower as time goes on.

Common: Community hazard map is prepared by many community activities. It is effective to make people understand their risks in the vulnerable areas.

(2) Monitoring and Warning Service

Although DOM and DOI are monitoring rainfall amount and water level 24 hours basis, it is difficult to forecast disaster with high precision. The reasons are that the number of hydrological monitoring stations is not enough, especially the rainfall gauge stations to grasp local rainfall is not enough, monitoring short term rainfall amount to forecast flash flood and landslide is not enough, data, software and capacity etc. for forecasting is not enough.

Regarding tsunami, information on earthquake occurrence and tsunami is disseminated from PTWC and JMA to important organizations such as DMC and DOM and important officers. It is confirmed that this system worked effectively when the earthquake occurred on September 2007.

(3) Dissemination and Communication

Rules for information dissemination are described in "Standing Order" for downstream of Kelani, and Manual for information dissemination was prepared for disaster management exercise. However, the target area and target disaster of "Standing Order" and "Disaster Management Exercise" are limited.

"Intra-Governmental Network" installed in this Study and "Tsunami Warning Tower" for disseminating information directly to people, etc. are the tools for governmental information dissemination and communication. Sirens and hand speakers are distributed to community level. Proper operation and maintenance of the system and equipment are important.

(4) Response Capability

Governmental Level: Training programs are conducted by donor countries or international organizations, and DMC also conducts training program for staff of local level organizations. This Study is also aiming at capacity development of related people through disaster management exercise and activities of each component, etc. However, the number of participants, training programs, and variety of programs is limited, and action manual is not yet prepared.

Community Level: A lot of community disaster management activities have been conducted oriented by DMC. In this Study, community disaster management activities including evacuation drill were conducted at selected 15 communities. However, the number of target communities is limited and it is often the case that the activity is only one time at each community.

4.2.2 Issues

Issues based on the above present conditions are summarized below.

Table III-15 Issues of Present EWE System

Key Elements	Issues
Role Allocation	- Role allocation for EWE system is not clear.
Risk Knowledge	- Risk assessment and hazard mapping suitable for EWE system are not conducted for all over Sri Lanka. - Detailed topographical map does not exist.
Monitoring & Warning Service	[Monitoring] - Short term monitoring (10 min. to 1 hour data) is not enough. (Flood and Landslide) - Number of monitoring station is not enough. (Flood and Landslide) - Monitored data is not opened to public. (Flood and Landslide) - Proper O&M of Hydrological Information System should be conducted. (Flood and Landslide) - Proper O&M of realtime monitoring system should be conducted. (Flood and Landslide) [Warning Service] - Accurate weather, flood and landslide forecasting is difficult. (Flood and Landslide) - Timely flood warning issuance is difficult. (Flood) - Understandable warning criteria related to inundation area is not prepared. (Flood) - Accuracy of warning criteria should be improved. (Landslide) - Role allocation for issuing warning and evacuation instruction should be discussed. (Tsunami) - Contents of warning message should be discussed. - Timing of warning cancellation should be discussed. - EWE system oriented by government cannot cover local disasters.
Dissemination & Communication	- Information should be disseminated in short time - Exercise is only for selected organizations and communities, and only for Kelani and Kalu flood, and landslide. - Unstable communication during night time and holiday. - Unstable communication during emergency period. - Reliability of governmental information flow is low. - Suitable method for last mile communication is not established. - Proper O&M of Intra-Governmental Network should be conducted. - Proper O&M of Tsunami warning tower should be conducted. (Tsunami)
Response Capability	- Training program for EWE system is not enough. - Emergency Response Manual is not prepared for each organization. - Community level activities are only for selected communities and are not conducted repeatedly. - Exercise is only for selected organizations and communities.

CHAPTER 5 MULTI-HAZARD EWE SYSTEM

In Chapter 5, Multi-Hazard EWE System is planned based on the issues raised in Chapter 4. The plan includes recommendation for role allocation of related organizations, information flow and its tools. In addition to this, the procedure for Hazard Mapping, setting of warning criteria, and methods for O&M of the system and equipments are recommended.

5.1 Multi-Hazard EWE System

Planning principles are shown below.

- Practically operating system (role allocation and information flow, etc.) and Sri Lankan customs shall be respected as much as possible.
- System shall be planned that does not need high technology and expensive equipment as much as possible.
- What shall be done soon shall be planned as short time plan and concrete methods shall be shown.

According to the above principles, after showing the basis of the system "Role Allocation" of related organizations, concrete plans are discussed for four elements: "Risk Knowledge", "Monitoring & Warning Service", "Dissemination & Communication" and "Response Capability"

5.1.1 Role Allocation

Related organizations shall sign an agreement on "Role Allocation" after discussion on responsibility for their own role.

Role allocation of related organizations is categorized by four main elements. The planning principles for role allocation are shown below.

- GA shall issue evacuation instruction / order despite of disaster type: Although there is an opinion that the technical organizations shall issue it for the disasters such as flash flood or tsunami where there is little time for evacuation, GA is appointed to clarify where the responsibility lies.
- Technical organizations shall concentrate on monitoring, forecasting and issuing warning during disaster time: Although there are some technical organizations that are conducting information dissemination and coordination, etc. based on the customs, the role of the technical organizations shall be reduced by DMC and technical organization shall try to conduct proper warning issuance and technical support to related organizations.
- DMC shall conduct many kinds of preparatory activities for proper information dissemination during emergency period and evacuation activities or any kinds of support for related organizations: DMC shall not only coordinate related organizations during emergency period, but also support hazard mapping, installation and O&M of communication system, education of related officers and community people during normal times.

Systems will be continuously operated and improved by related organizations through recognizing their own roles, conducting preparation and activities responsibly. Organization shall not depend on the

awareness of responsible officers, but own the responsibility as an organization to maintain the system even if the officers have taken over. For this purpose, working groups on role allocation shall be established, role allocation shall be discussed, agreement shall be signed by related organizations. Through concrete activities, details of roles will be added and modified.

Table III-16 Plan of Role Allocation

Term	Plan
Short Term	- Launching of Working Group of "Role Allocation" Details of Working Group Member: MDMHR, DMC, Technical Organizations, Administrative Organizations, Ministry of Social Service, Police, Military, Media Chair: MDMHR Secretary: DMC Contents: -Appointment of responsible person in each organization on EWE system -Discussion and agreement on role allocation, information flow, and equipments for information transfer etc. -Clarification of issues and launching of Working Groups for solving issues (selection of member organizations and appointment of responsible person in each organization) - Signing agreement by related organizations Contents of Agreement ・ Responsible person in each organization ・ Role allocation of each organization ・ Member organizations and responsible person in each organization for establishing Working Groups ・ Schedule of discussion by Working Groups

Table III-17 Role Allocation of Each Organization

Organization	Main Role	Risk Knowledge	Monitoring & Warning Service	Dissemination & Communication	Response Capability
DMC / DDMCU	Coordination	- Support for preparation of hazard map	- Collection of disaster information - Advice to national and district level organization (DMC) - Advice to GA and local level organization(DDMCU) - Support for preparation of warning criteria	- Dissemination of disaster information - Operation and maintenance of dissemination and communication equipments	- Coordination of National level organization (DMC) and sub-national level organization (DDMCU) - Preparation of emergency response manual (DMC) - Training of national level organizations (DMC) and local level organization and community people (DDMCU)
GA	Decision Making		- Issuance of evacuation instruction / order	- Convocation of district level DM committee	
DS / GN	Information Dissemination / Collection	- Support for preparation of hazard map	- Collection of disaster information - Support for preparation of warning criteria	- Dissemination of disaster information	- Coordination of local level organization (DS) and Community people (GN) - Training of local level organization and community people
Police	Information Dissemination / Support of Evacuation Activity		Collection of disaster information	- Dissemination of disaster information	- Support evacuation activity
Military	Support of Evacuation Activity		Collection of disaster information	Dissemination of disaster information	- Support evacuation activity
Media	Information Dissemination		Collection of disaster information	- Dissemination of disaster information	- Support evacuation activity
DOI, DOM, NBRO etc.	Technical Support	- Preparation of hazard map	- Monitoring necessary data - Preparation of warning criteria - Issuance of warning	- Technical advice to DMC and DDMCU -	- Technical support for training program

5.1.2 Risk Knowledge

Hazard Map for each disaster shall be prepared to issue proper warning for proper areas

The future goal is to prepare a hazard map showing "which house will be affected and how much" when a certain disaster is forecast. However to prepare such hazard map immediately is difficult, because detailed topographical maps and advanced simulation technology are necessary. Therefore, short term goal is to prepare a hazard map showing "which area will be affected". Methods to prepare a hazard map for each disaster are recommended below.

(1) Flood

1) Method to Prepare Hazard Map

Short / Mid Term method to prepare hazard map is recommended below.

- Affected GN (or community, as detailed as possible) shall be clarified when a flood disaster occurs.
- Starting time of inundation, maximum inundation depth and its time, and end time of inundation shall be interviewed at each GN (or community)
- Above information shall be written on the DS level map with GN boundary. This map shall be prepared by each flood disaster. Information on which GN will be inundated first, and which GN will be easily inundated, will be known by these maps.
- Water level at above time of nearby gauging station shall be studied. Relation of water level and inundation depth can be analyzed by this data. It can be possible to estimate inundation depth and its time if the water level and its time of gauging station are forecast.

Mid / Long Term method is to conduct flood simulation when more detail topographical map is prepared and hydrological data is accumulated.

2) Example at Kelani River

Relation of interview result on flood condition at Malwana Town GN and water level at Hanwella gauging station regarding April/May flood and May/June flood, is shown below.

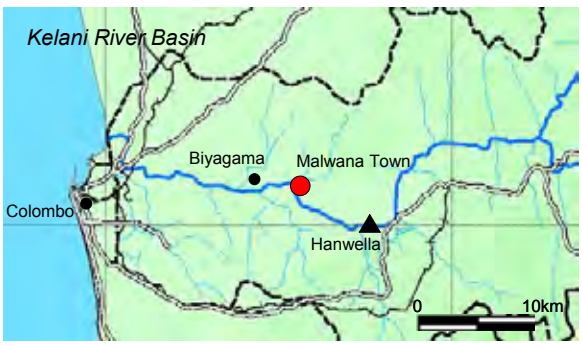


Figure III-28 Location of Malwana Town and Hanwella Gauging Station

Result of interview survey is shown below.

Table III-18 Result of Interview Survey

Flood	Start of Inundation	Peak of Inundation
April / May	28th 17:00 – 18:00	29th 11:00 – 12:00
May / June	31st 10:00 – 12:00	31st 20:00 – 1st 5:00

Result of interview survey is shown on the graph of water level at Hanwella gauging station. It can be said that inundation starts at Malwana Town GN when the water level at Hanwella gauging station reaches 4.5 m. It means that inundation at Malwana Town GN can be forecasted if the water level 4.5 m at Hanwella gauging station is forecast by flood warning.

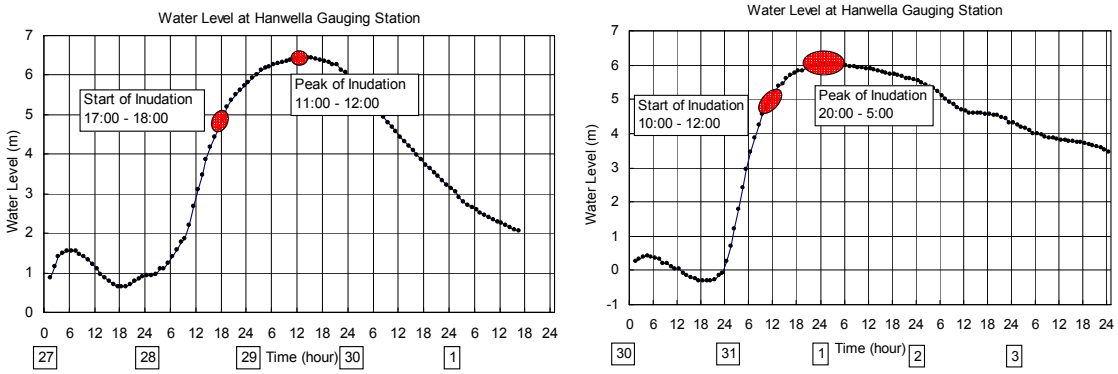


Figure III-29 Comparison of Water Level and Result of Interview Survey

Timing of inundation at easily inundated area can be known by comparing the interview result and water level at nearby gauging station. Short/Mid Term Hazard Map for flood EWE system can be prepared by describing the result of above analysis.

(2) Landslide

NBRO is preparing Hazard Map for landslide by using 1/50,000 and 1/10,000 topographical map. However, more detail topographical map is necessary to show the hazard of each house level. Therefore, it is necessary to clarify GN or community that includes the hazardous area for the time being. Regarding the hazard map inside of GN or community, community level hazard map can be substituted with technical support by DMC and NBRO. Community level hazard map will be upgraded in the Mid / Long Term when more detailed topographical map is prepared.

(3) Tsunami

Schools and temples, not affected by Indian Ocean Tsunami disaster, are defined as evacuation places. Also, people will evacuate, who live in the coastal area which is estimated to be affected from their experiences. At present, almost all the people evacuate because their memory of tsunami is still fresh. However, people will request more detailed information if most of the people forget about tsunami or number of false warning increases. Although the hazard map showing inundation depth at each community or house according to the estimated tsunami height is necessary in the future, more detailed topographical maps and advanced simulation technology are necessary. Therefore it is necessary to prepare the community level hazard map showing maximum inundation area at the time of Indian Ocean Tsunami disaster for the time being.

The following table shows the plan for "Risk Knowledge"

Table III-19 Plan of Risk Knowledge

Disaster	Term	Plan
Common	Short Term	- Launching of Working Group for "Hazard Mapping" and Signing agreement by related organization Details of Working Group Member: DMC, Technical Organizations, Administrative Organizations Chair: DMC Contents: -Type of Hazard Map to be prepared -Role allocation for Hazard Map preparation -Schedule for Hazard Map preparation -Agreement for above discussion Contents of Agreement ・ Role allocation and implementation schedule
Flood	Short / Mid Term	- Identification of risky area and interview survey to people (DMC, DOI) - Comparison of interview result and water level data of nearby gauging station (DOI, DMC)
	Long Term	- Flood simulation by using detailed topographical map and hydrological data (DOI)(technical and financial assistance will be necessary)
Landslide	Short / Mid Term	- Identification of risky area (NBRO) - Community hazard mapping (DMC, NBRO)
	Long Term	- Upgrading community level hazard map by using detailed topomap (NBRO) (technical and financial assistance will be necessary)
Tsunami	Short / Mid Term	- community hazard mapping (DMC, DOM)
	Long Term	- Tsunami simulation (DOM)(technical and financial assistance will be necessary)

5.1.3 Monitoring & Warning Service

Technical Organizations conduct following activities:

- New construction and Automation of Monitoring Station
- Proper O&M of Monitoring Equipment
- Disclosure of Information
- Proper Disaster Forecasting and Setting Proper Warning Criteria
- Discussion on Warning Issuance, Cancellation, and Contents

DMC and Administrative Organizations conduct following activities:

- Supporting above Activities by Technical Organizations
- Establishment of Community Level Voluntary Monitoring System for Local Disaster

(1) New Construction and Automation of Monitoring Station

1) Flood (Slow)

Automation of existing monitoring stations and new construction of monitoring stations to grasp more precise hydrological characteristics shall be conducted. Location of monitoring stations is proposed for Kelani, Kalu, Gin and Nilwara in the Component 1. Monitoring method at new stations shall be

manual monitoring by officers and monitored data shall be collected by telephone in case of emergency like existing system at main stations if possible.

2) Flood (Fast)

Area suffering from flash floods many times and areas affected by 2008 flood shall be prioritized. Automatic rainfall gauges with telemeter system which can monitor short term rainfall amount shall be installed at the location where rainfall amount in the watershed can be grasped as accurate as possible. Also, automatic water level gauge shall be installed at affected areas in the downstream.

3) Landslide

The highest priority activity is to increase the number of rainfall gauge stations. The future goal is to monitor short term rainfall amount at all the GN and DS offices those have hazardous area for landslide. Monitoring rainfall amount at DS and GN is important to make officers aware of disasters.

The following table shows the plan for "Monitoring Station".

Table III-20 Plan of Monitoring & Warning Service (Monitoring Station)

Disaster	Term	Plan
Flood (Slow)	Short Term	- New construction and automation of monitoring stations at Gin and Nilwala river (DOI)(financial assistance will be necessary)
	Mid / Long Term	- Expansion of new construction and automation of monitoring stations to other rivers (DOI)(financial assistance will be necessary)
Flood (Fast)	Short Term	- Listing up of target areas and selection of priority area as model area (DMC, DOI) - Installation of rain gauge and water level gauge at model area as pilot project and start monitoring (DMC, DOI)(technical and financial assistance will be necessary)
	Mid / Long Term	- Expansion of installation of rain gauge and water level gauge to other target areas (DMC, DOI)(financial assistance will be necessary)
Landslide	Short Term	- Start manual monitoring of daily rainfall at all risky DS and GN offices (DMC, NBRO, administrative organizations) - Installation of automatic rain gauge with telemeter system at priority DS and GN offices (DMC, NBRO, administrative organizations)
	Mid / Long Term	- Expansion of installation of automatic rain gauge with telemeter system to other DS and GN offices(DMC, NBRO, administrative organizations)(financial assistance will be necessary)

(2) Operation and Maintenance of Monitoring Equipments

Operation and maintenance are necessary if monitoring stations are newly constructed and equipments are newly installed. Staff costs for manual monitoring, and expenses of purchasing equipment and O&M for automatic monitoring are necessary. Expenses for O&M of the system as well as communication charge are also necessary in case for telemeter system. For the Hydrological Information System that was installed in the Pilot Project, a system was selected to make the cost for O&M as low and easy as possible. It is one method to confirm the effectiveness of automation and cost effectiveness by operating and maintaining this system properly for several years. If there is a budgetary problem for O&M even though the effectiveness of the system is confirmed, there is a possibility of cost burden by DMC, Colombo and Gampaha District who are the beneficiaries from this system.

The following table shows the plan for "O&M of Monitoring Equipment".

Table III-21 Plan of Monitoring & Warning Service (O&M of Monitoring Equipment)

Term	Plan
Short Term	- Launching of Working Group for "Monitoring Station and Equipments" and signing agreement by related organizations Details of Working Group Member: DMC, Technical Organizations, Administrative Organizations Chair: DMC Contents: -Sharing plans of each organization on establishment of monitoring station and equipment -Discussion on issues of establishment of monitoring station, equipment, operation and maintenance -Discussion on role allocation of related organizations -Preparation of action plan for above activity -Agreement for above discussion Contents of Agreement ・ Role allocation and action plan

(3) Disclosure of Information

Monitored data shall be disclosed to public. The disadvantage occurring by data disclosure is very little compared to the advantage gained from disclosure. Related organizations have to avoid expansion of the disaster by the delay of emergency operations due to not disclosing information. However, once technical organizations agree to disclose the data, they own the responsibility to disclose information indefinitely and continuously. Disclosure of data at least once a day for daily rainfall including weekends, 24 hours O&M of the system for telemeter system have to be conducted. The following table shows the plan for "Disclosure of Information".

Table III-22 Plan of Monitoring & Warning Service (Disclosure of Information)

Term	Plan
Short Term	- Launching of Working Group for "Disclosure of Information", and signing agreement by related organizations Details of Working Group Member: DMC, Technical Organizations, Administrative Organizations, Police, Military, Media Chair: DMC Contents: -Discussion on necessity of Information Disclosure -How to disclose what kind of information (preparation of rules) -Issues and solutions for Information Disclosure -Preparation of action plan -Agreement for above discussion Contents of Agreement ・ Rules for Information Disclosure and action plan

(4) Disaster Forecasting and Warning Criteria

1) Forecasting Rainfall Amount

Forecasting the weather especially the rainfall amount that can be the cause of flood and landslide, is a role of DOM. Although the future goal is to provide realtime data and forecast "how much rainfall is expected in how long time", it is difficult to do this by using present equipment. DOM should try to

improve the accuracy of forecasting by using AWS provided by JICA grant aid and installing the Doppler Rader etc. Although the present warning criteria for rainfall is defined by DOM, warning criteria shall be defined in cooperation with DOI and NBRO, etc.

2) Flood (Slow)

The water level at downstream shall be forecast by using the result of correlation analysis between the water level at upstream and downstream. If a large tributary confluents to the main river, correlation analysis with the tributary is also necessary. Although there is a method to forecast flood by simulation in the future, topographical data, cross section data, hydrological data, etc. are not enough at present.

Regarding the defining warning criteria, the water level at gauging station corresponding to the start time of inundation at hazardous area (target water level) shall be analyzed through the activity to prepare hazard map. Warning criteria shall be defined as the water level at upstream gauging station to forecast the target water level at downstream.

Warning Criteria based on above method for Minor Flood at downstream of Kelani (5feet at Nagalagam St.) is shown below. Concrete method is shown in the Supporting Report.

Table III-23 Warning Criteria for Minor Flood at Downstream of Kelani

Level	Station	Water Level
Advisory	Glencourse	52 feet
Warning	Hanwella	4.5 m

3) Flood (Fast)

This type of flood shall be forecast by correlating the rainfall amount at upstream and water level at downstream. There are several methods such as using daily rainfall, hourly rainfall, and simulation. Methods shall be selected according to the availability of data.

Regarding the defining warning criteria, the target water level shall be studied through hazard mapping activity. Warning criteria shall be defined as the rainfall amount at upstream station to forecast the target water level at downstream. Also, the water level can be also defined as the warning criteria, by studying rate of rising of water level.

Warning Criteria based on above method for Minor Flood at Ratnapura (6 m) is shown below. Concrete method is shown in the Supporting Report.

Table III-24 Warning Criteria for Minor Flood at Ratnapura

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

4) Landslide

Although NBRO defined the warning criteria for landslide, this criteria is not based on much data. Therefore, this criteria is defined to be on the safer side, and it means the possibility of false warning is high. Although forecasting landslide is very difficult, the methods in Japan to forecast the debris

flow can be utilized in Sri Lanka. One of the methods is introduced in the Supporting Report. The warning criteria shall be reviewed by continuing short term rainfall monitoring, and analyzing the relations between cumulative rainfall and short term rainfall, and disaster occurrence.

5) Tsunami

Warning shall be issued based on the tsunami information issued by PTWC and JMA like present system. Content of warning is proposed in the next section.

The following table shows the plan for "Disaster Forecasting and Warning Criteria".

Table III-25 Plan of Monitoring & Warning Service
(Disaster Forecasting and Warning Criteria)

Disaster	Term	Plan
Rainfall	Short Term	- Preparation of action plan for accuracy improvement of rainfall forecasting with schedule of facility improvement (DOM)
Flood (Slow)	Short / Mid Term	- Preparation of target water level for all stations of Kelani, Kalu, Gin and Nilwala (DOI, DMC)(technical assistance will be necessary) - Setting warning criteria for stations which has enough data, by correlation analysis of water level at upstream and water level at downstream (DOI) (technical assistance will be necessary)
	Long Term	- Accumulation of data and expansion to other stations and other rivers (DOI, DMC)(technical assistance will be necessary)
Flood (Fast)	Short	- Accumulation of data at model area (DOI, DMC) - Setting warning criteria by correlation analysis of rainfall amount at upstream and water level at downstream (DOI)(technical assistance will be necessary)
	Mid / Long Term	- Expansion to other target areas according to the condition of installation of rain gauge and water level gauge, and condition of accumulation of data (DOI, DMC)(technical assistance will be necessary)
Landslide	Short / Mid Term	- Collection of daily rainfall at nearby stations at the time of landslide (NBRO) - Upgrading warning criteria by correlation analysis of landslide occurrence and daily rainfall (NBRO)(technical assistance will be necessary) - Start same analysis using hourly rainfall data according to installation condition of rain gauge (NBRO)(technical assistance will be necessary)
	Long Term	- Upgrading warning criteria by correlation analysis of landslide occurrence, short term rainfall and cumulative rainfall (NBRO)(technical assistance will be necessary)

(5) Discussion on Warning Issuance, Cancellation, and Contents

1) Flood

DOI shall define the contents of flood warning by discussion with DMC and administrative organizations. Timing of issuance and contents of warning are shown below. Warning shall be issued by each river and each area covered by main gauging stations.

Table III-26 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	- List of Areas to be inundated, estimated time and inundation depth

Category	Timing of Issuance	Necessary Contents
	information	- "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

Contents of warning are shown in detail for short term and long term.

Table III-27 Details of Warning（Flood）

Term	Contents
Short Term	- Present water level at main gauging stations - Whether present water level will rise up or decrease (forecasted water level and its estimated time if possible) - List of DSs that are estimated to be inundated (list of GNs if possible)
Long Term	- Present water level at main gauging stations - Forecast water level at main gauging stations and its estimated time - List of inundation depth at main locations of DS or GN based on the forecast water level

2) Landslide

Landslide warning shall be issued as follows.

- Rain gauge stations from which realtime data or daily data can be obtained, shall be selected as much as possible. And the covered area by each rain gauge station shall be defined. The covered area shall be defined by DS level or GN level.
- GN or communities which are vulnerable to landslide in each DS shall be clarified.
- NBRO shall issue landslide warning specifying the name of DS which is covered by rain gauge station where rainfall amount exceeds the warning criteria. Also, the specified DS will inform the warning message to GN or communities that are clarified by the above action.

NBRO shall define the contents of landslide warning by discussion with DMC and administrative organizations. Timing of issuance and contents of warning are shown below.

Table III-28 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

Category	Timing of Issuance	Necessary Contents
		- 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

Contents of warning are shown in detail.

Table III-29 Details of Warning（Landslide）

Term	Contents
Short Term	- Name of rain gauge stations where rainfall amount exceeds warning criteria, and their rainfall amount - List of DSs that are covered by those rain gauge stations - List of GNs that are identified as risky area (if possible)

3) Tsunami

It is necessary to take action not in a hurry to remember there is enough time regarding tsunami. The following warning shall be issued basically based on the information by PTWC and JMA.

Table III-30 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

4) Common Item

- Title of warning message impacts greatly on the receivers. Contents of the warning message shall be shown in the title for alert level, warning level or evacuation level.
- Actions to be taken such as “wait for next information” or “better to evacuate” etc. shall be written in the warning message. Only GA can state “people are recommended to evacuate”, so that technical organizations shall state “people should take action according to the instructions by GA, because the rainfall amount has reached evacuation level” when necessary to warn strongly.
- Warning Message shall be written in Sinhala and Tamil.

Samples of warning message for flood, landslide and tsunami are shown in the Supporting Report.

The following table shows the plan for “Warning Service”.

Table III-31 Plan of Monitoring & Warning Service (Warning Service)

Term	Plan
Short Term	- Launching of Working Group for "Warning Service" and signing agreement by related organizations Details of Working Group Member: DMC, Technical Organizations, Administrative Organizations, Police, Military, Media Chair: DMC Contents: -Role allocation of related organizations on warning service -Criteria and timing of warning issuance , and contents of warning message -Issues and solutions on warning service -Preparation of action plan -Agreement for above discussion Contents of Agreement ・ Role allocation, warning criteria, timing of issuance, contents of warning, action plan

(6) Establishment of Community Level EWE System

It is very difficult for the technical organizations to collect and provide information on the local disasters of all over the country. Even for the information on the flood of large rivers, it takes certain time for the system to function properly. Therefore, DMC shall promote establishing community level EWE systems and urge people to strengthen their self-help capacity with support of technical and administrative organizations. Communities vulnerable to flood and landslide shall be the main target communities.

In this Study, water level staff gauge is installed to flood vulnerable communities and simplified rainfall gauge with alarm system is installed to landslide vulnerable communities, and voluntary EWE system is operated in those communities. This kind of system shall be expanded.

1) Flood Vulnerable Community

System shall consist of water level monitoring by manual reading and collection of water level or rainfall amount of upstream. The concrete method is shown below.

Table III-32 Method of Community Level EWE System (Flood)

Category	Activity
Monitoring	- Manual reading of water level twice a day - Hourly reading during flood time (if possible) - Record start time of inundation, and max. water level and its time
Warning	[Flood (slow)] - Continuous monitoring and Discussion on warning criteria for voluntary evacuation - Improving accuracy of warning criteria by collecting upstream data from DOI and upstream community [Flood (fast)] - Setting warning criteria by correlation analysis with upstream rainfall data which is collected from DOI and upstream community. - Asking upstream community to provide rainfall amount in case rainfall amount exceeds warning criteria.

2) Landslide Vulnerable Community

System shall be operated by rainfall monitoring by manual reading. Method is shown below.

Table III-33 Method of Community Level EWE System (Landslide)

Category	Activity
Monitoring	- Manual reading of rainfall amount twice a day - Record time of landslide occurrence and rainfall amount
Warning	- Report NBRO and evacuate voluntary if rainfall amount exceeds warning criteria set by NBRO


Figure III-30 Community Level Monitoring Activity

Monitored data shall be submitted to DOI or NBRO periodically, and shall be utilized for governmental EWE system. The following table shows the plan for "community level EWE system".

Table III-34 Plan of Monitoring & Warning Service (Community Level EWE System)

Term	Plan
Short / Mid Term	- Identification of target areas for Community level EWE system (DMC, technical organizations, administrative organizations) - Monitoring of community activities where system is installed during JICA Study and expansion to other target areas (DMC, technical organizations, administrative organizations)(technical assistance will be necessary)

5.1.4 Dissemination & Communication

Following actions shall be conducted cooperatively by related organization.

- Discussion on Information Flow
- Discussion on Information Dissemination and Tools for Communication
- Proper O&M of System and Equipment

(1) Discussion on Information Flow

Information flow plan is shown in the following figure. Planning principles are discussed below.

- DMC shall be the focal point of information dissemination: Responsibility of technical organizations will be reduced as DMC owns the responsibility for information dissemination.
- As a general rule, information flow from national level to community level shall be through GA office – DS office – GN: Although there are some issues on the communication during night time and holidays, more human resource allocation and organization strengthening shall be promoted by having a general rule.

- Supplemental tools for information dissemination from national level to community level shall be strengthened: Information dissemination by Media, Police, and direct dissemination to community from DMC and DDMCU shall be strengthened.
- GA shall convene District Disaster Management Committee to discuss and exchange information with district level technical organizations and police, and make decision on evacuation instruction/order.
- Information flow from GN to Community is basically to come through a representative of community and committee member of GN level Disaster Management Committee, although the system of each GN is somewhat different.

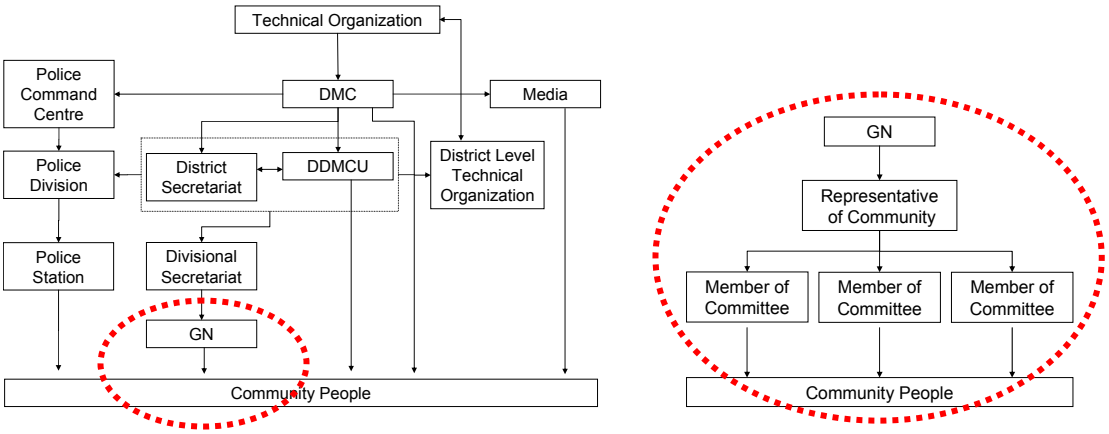


Figure III-31 Information Flow (left: overall, right: from GN to community)

(2) Tools for Information Dissemination

Tools planned for information dissemination are shown in the following figure. Planning principles are discussed below.

- Since official information is a signed letter, FAX shall be used for information dissemination as a general rule. There are other advantages for using FAX: it can be an evidence of definite information dissemination, and misunderstanding can be avoided by written document.
- Telephone and mobile phone shall be used as supplemental methods. If all lines are congested, staff shall move to necessary places to disseminate information.
- Intra-Governmental Network is the system to connect national level organizations and DDMCU, and to communicate with these organizations reliably under any conditions.

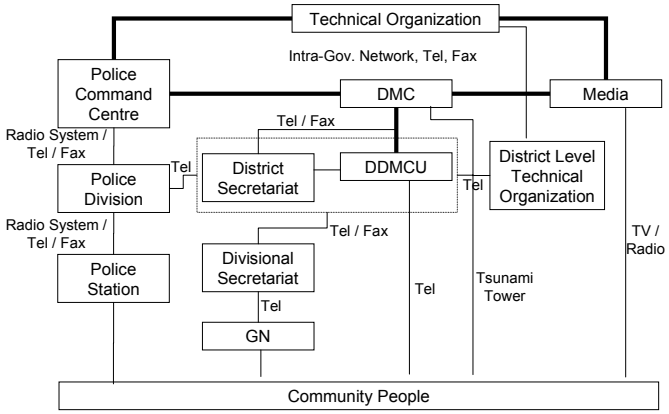


Figure III-32 Equipment for Information Transfer

DMC is distributing loud speakers and sirens to communities positively for "last mile communication". Siren is selected as one of the tools also in the community activities of the Study. The best method shall be selected by each community such as temple bell, loudspeaker car, verbal communication, etc. Car mounted loudspeakers are provided to DS offices in the Pilot Project. There has been no experience that DS office informs people by loudspeaker car except for the exercise. In the future, when role and responsibility of DS office is recognized, it will be an important tool.

(3) Proper O&M of System and Equipments

The above information dissemination system shall be operated under the agreement of related organizations same as role of organizations. Equipment also needs to be properly operated and maintained to be used properly during emergency situation. Rules shall be prepared to allow for 24 hour use such as to check the equipment periodically like once a day by a number of officers.

The following table shows the plan for "dissemination & communication".

Table III-35 Plan of Dissemination & Communication

Term	Plan
Short Term	- Discussion on Information flow, equipments, and rule of O&M etc. in the Working Group for "Role Allocation". Also signing agreement by related organizations

5.1.5 Response Capability

The following actions shall be conducted cooperatively by related organization to conduct above system properly.

- Proper O&M of system and equipment
- Capacity Development of Officers in Charge for Disaster Management
- Capacity Development of Community People
- Coordination Capacity Development of DMC

(1) Proper O&M of System and Equipments

EWE system can not function without cooperation by related organizations. All the related

organizations have to understand their roles, take action properly and fulfill their responsibilities. Plan for proper O&M of system and equipment is shown below.

1) Launching Working Groups and Signing on Agreement

Various working groups shall be launched, agreement shall be signed, and system shall be start to be operated with the participation of related organizations at the initiative of DMC. Working groups shall be repeated periodically and agreements shall be modified if necessary. First of all, working group on "role allocation" shall be launched. In this working group, launching schedule of other working groups and the member organizations of those working groups shall be decided.

2) Preparation of Emergency Response Manual

The exercise manual prepared in the Study shows the actions to be taken by each organization regarding mainly information dissemination. However, there must be information dissemination and also some other necessary emergency response activities for each organization during emergency period. For example, flood defense works by DOI and distribution of rescue boats by DMC, etc. All the emergency response activities shall be consolidated into one manual. DMC shall prepare its emergency response manual as soon as possible, so that other organizations can use it as reference.

3) Periodic Exercises

Periodic implementation of exercises is an effective method to operate and maintain the system properly. Concrete advantages are shown below.

- Lack of experience on actual disaster will be covered.
- Validity of the system is checked and it can be a trigger for hazard mapping, discussion on warning services and manual updating. It also can be a trigger for establishing working groups.
- It can be a good chance to check how to use and to be accustomed to the equipments.

Table III-36 Plan of Response Capability (Proper O&M of System and Equipment)

Term	Plan
Short Term	- Launching of following Working Groups and signing on agreement by related organizations ・ Role Allocation ・ Hazard Mapping ・ Monitoring Station and Equipments ・ Information Disclosure ・ Warning Service ・ Disaster Management Exercise Details of Working Group Member: DMC, Technical Organizations, Police, Military, Media, Administrative Organizations at selected area, etc. Chair: DMC Schedule Once a year Contents: -Type and contents of exercise -Target area -Schedule of preparation -Role allocation of related organizations -Agreement for above discussion Contents of Agreement ・ Type and contents of exercise, target area, role allocation, preparation schedule

Term	Plan
	- Preparation of Emergency Response Manual (DMC at first, other all related organizations) - Periodical Implementation of Disaster Management Exercise (all the related organizations)

(2) Capacity Development of Officers in Charge for Disaster Management

It was found that the capacity of organizations was definitely developed if they repeated the exercise through the information transfer exercise in the Study. Capacity development of officers in charge is planned as follows.

Table III-37 Plan of Response Capability
(Capacity Development of Officers in Charge for Disaster Management)

Term	Plan
Short Term	- Participation to meeting of Working Groups, preparation work of Emergency Operation Manual, Disaster Management Exercises, and Training Program (all the officers in charge for disaster management)

(3) Capacity Development of Community People

EWE system can be successful if the community people take action properly. It highly depends on the capacity of community people whether the "last mile communication" and actions after receiving information, such as evacuation activity after receiving evacuation instruction, are conducted properly or not. Although DMC is making a strong effort for community activities, there is a limitation for the capacity development by only one time activity, because the objective is to take action properly during emergency period. Community activities have to be repeatedly and continuously conducted

Table III-38 Plan of Response Capability (Capacity Development of Community People)

Term	Plan
Short Term	- Continuous Community Activities (DMC, administrative organizations) - Implementation of Evacuation Drill and other exercise (DMC, administrative organizations)

(4) Coordination Capacity Development of DMC

Above activities can not be done by single organization, and have to be conducted in cooperation with related organizations. DMC is responsible for this coordination and capacity of DMC shall be developed through these activities from normal times.

Table III-39 Plan of Response Capability
(Coordination Capacity Development of DMC)

Term	Plan
Short Term	- Implementation of EWE system plan by initiative of DMC (DMC)

5.2 Implementation Schedule

EWE System Plan shown in the previous section is divided into Short Term and Mid/Long Term Plan. Short Term Plan shall be conducted in 2 years, Mid Term Plan in 5 years, and Long Term Plan in 10 years.

Table III-40 Short Term Plan

Category		Plan
Role Allocation		- Launching of Working Group for "Role Allocation" and signing agreement by related organizations
Risk knowledge	Flood	- Identification of risky area and interview survey to people - Comparison of interview result and water level data of nearby gauging station
	Landslide	- Identification of risky area - Community hazard mapping
	Tsunami	- community hazard mapping
	Common	- Launching of Working Group for "Hazard Mapping" and signing agreement by related organizations
Monitoring & Warning Service	Rainfall	- Preparation of action plan for accuracy improvement of rainfall forecasting with schedule of facility improvement
	Flood (slow)	- New construction and automation of monitoring stations at Gin and Nilwala river - Preparation of target water level for all stations of Kelani, Kalu, Gin and Nilwala - Setting warning criteria for stations which has enough data, by correlation analysis of water level at upstream and water level at downstream
	Flood (fast)	- Listing up of target areas and selection of priority area as model area - Installation of rain gauge and water level gauge at model area as pilot project and start monitoring - Accumulation of data at model area - Setting warning criteria by correlation analysis of rainfall amount at upstream and water level at downstream
	Landslide	- Start manual monitoring of daily rainfall at all risky DS and GN offices - Installation of automatic rain gauge with telemeter system at priority DS and GN offices - Collection of daily rainfall at nearby stations at the time of landslide - Upgrading warning criteria by correlation analysis of landslide occurrence and daily rainfall - Start same analysis using hourly rainfall data according to installation condition of rain gauge
	Community EWE System	- Identification of target areas for Community level EWE system - Monitoring of community activities where system is installed during JICA Study and expansion to other target areas
	Common	- Launching of Working Group for "Monitoring Station and Equipments" and singing agreement by related organizations
		- Launching of Working Group for "Information Disclosure", and signing agreement by related organizations
		- Launching of Working Group for "Warning Service" and signing agreement by related organizations
Dissemination & Communication		- Discussion on Information flow, equipments, and rule of O&M etc. in the Working Group for "Role Allocation". And signing agreement by related organizations

Category		Plan
Response Capability	Proper O&M	- Launching of following Working Groups and signing agreement by related organizations ・ Role Allocation ・ Hazard Mapping ・ Monitoring Station and Equipments ・ Information Disclosure ・ Warning Service ・ Disaster Management Exercise - Preparation of Emergency Response Manual - Periodical Implementation of Disaster Management Exercise
	CD of Officers	- Participation to meeting of Working Groups, preparation work of Emergency Operation Manual, Disaster Management Exercises, and Training Programs
	CD of People	- Continuous Community Activities - Implementation of Evacuation Drill and other exercise
	CD of DMC	- Implementation of EWE system plan by initiative of DMC

Table III-41 Mid Term Plan

Category		Plan
Risk knowledge	Flood	- Identification of risky area and interview to people - Comparison with water level data of nearby gauging station
	Landslide	- Identification of risky area - Community hazard mapping
	Tsunami	- community hazard mapping
Monitoring & Warning Service	Flood (slow)	- Expansion of new construction and automation of monitoring stations to other rivers - Preparation of target water level for all stations of Kelani, Kalu, Gin and Nilwala - Setting warning criteria for stations which has enough data, by correlation analysis of water level at upstream and water level at downstream
	Flood (fast)	- Expansion of installation of rain gauge and water level gauge to other target areas - Expansion to other target areas according to the condition of installation of rain gauge and water level gauge, and condition of accumulation of data
	Landslide	- Expansion of installation of automatic rain gauge with telemeter system to other DS and GN offices - Collection of daily rainfall at nearby stations at the time of landslide - Upgrading warning criteria by correlation analysis of landslide occurrence and daily rainfall - Start same analysis using hourly rainfall data according to installation condition of rain gauge
	Community EWE System	- Identification of target areas for Community level EWE system - Monitoring of community activities where system is installed during JICA Study and expansion to other target areas

Table III-42 Long Term Plan

Category		Plan
Risk knowledge	Flood	- Flood simulation by using detailed topographical map and hydrological data
	Landslide	- Upgrading community level hazard map by using detailed topographical map
	Tsunami	- Tsunami simulation
Monitoring & Warning Service	Flood (slow)	- Expansion of new construction and automation of monitoring stations to other rivers - Accumulation of data and expansion to other stations and other rivers
	Flood (fast)	- Expansion of installation of rain gauge and water level gauge to other target areas - Expansion to other target areas according to the condition of installation of rain gauge and water level gauge, and condition of accumulation of data

Category		Plan
	Landslide	- Expansion of installation of automatic rain gauge with telemeter system to other DS and GN offices - Upgrading warning criteria by correlation analysis of landslide occurrence, short term rainfall and cumulative rainfall

CHAPTER 6 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

In Component 2, conceptual planning, pilot project implementation in Kelani and Kalu, and review of actual events were conducted. Based on these activities, Multi-Hazard EWE System was planned.

In the conceptual planning, issues on exiting system were clarified by collecting information and discussion with related organizations, and concept design of ideal EWE system was prepared.

In the pilot project, physical backup was conducted by installing Hydrological Information System and Intra-Governmental Network, and capacity development of officers in charge for disaster management was conducted through disaster management exercises three times.

During the study period for two and a half years, a tsunami warning was issued on September 2007 and this was the first time after Indian Ocean Tsunami disaster. Also, there were several flood disasters from April to July 2008 which were comparable in size to the flood in 2003. These actual events were the good opportunities to evaluate and clarify the issues on planning EWE system.

Multi-Hazard EWE System was planed by five categories: “Role Allocation”, “Risk Knowledge”, “Monitoring & Warning Service”, “Dissemination & Communication” and “Response Capability”. Plans were divided into Short Term, Mid Term and Long Term. Concrete methods were described as much as possible for the short term plan and early implementation is expected.

6.2 Recommendations

The following three points were raised as the present issues in Chapter 1. (Section 1.2, page III-1)

- There are many relevant, and sometimes redundant organizations with unclear mandate.
- Inadequate capacity for forecasting
- Lack of experience to operate the system such as issuance of warning and evacuation instruction, emergency response during disaster situation, etc.

For implementing Multi-Hazard EWE System Plan, implementation of the following activities is strongly recommended to address the above issues.

(1) Signing Agreement on Role Allocation

It was found through the Study that officers in the related organizations can act properly if they are instructed in their roles and rules, especially through the disaster management exercise. Agreement on the role allocation is expected to be singed by Secretary or DG so that officers can carry out their roles responsibly. (details are described in Section 5.1.1)

(2) Information Disclosure and Proper Warning Issuance

It is difficult to forecast disasters precisely, and its capacity shall be developed by accumulating data, installing equipments, and conducting simulation, etc. step by step in the future. On the other hand, disclosure of monitored data and warning issuance by the predefined warning criteria can be done at the present capacity level and must be done. Warnings should be issued before the disaster and should not be subjective. Working groups shall be established as soon as possible and discussion shall be made on what can be done, what cannot be done, and what kind of warning can be issued, etc. Also, rules at present and the action plans to improve the rules shall be prepared. (details are described in Section 5.1.3)

(3) Periodical Implementation of Disaster Management Exercise

Disaster Management Exercise was conducted three times during this Study period. Implementation of exercise is meaningful not only from the point of capacity development of related organizations and their staff, and checking the usage of equipment, but also ffor reviewing the EWE system. Disaster Management Exercise shall be conducted at least once a month. (details are described in Section 5.1.5)

In addition to above recommendations, early implementation of the following activity is recommended for frequent flood disasters.

(4) Establishment of Early Warning and Monitoring System for the Southern Western Four River Basins

Establishment of Early Warning and Monitoring System for the south western four river basins is selected as one of the priority projects in "Part II : Flood Management Planning". This system shall be established as soon as possible by utilizing the experience of the pilot project in Kelani and Kalu river basins, because it takes time to reduce the flood damage by planned structural measures. (details are described in Section 5.1.3 and PART II)

The following table shows the responsible and implementing agency, priority and necessity of assistance for the abovementioned recommendations.

Table III.43 Recommendations

	Recommendation	Responsible Organization	Implementing Organization	Schedule	Necessity of Foreign Assistance
1	Signing Agreement on Role Allocation	DMC	DMC, Technical Organizations, Administrative Organizations, Ministry of Social Service, Police, Military, Media	A	
2	Information Disclosure and Proper Warning Issuance	DMC	DMC, Technical Organizations, Administrative Organizations, Police, Military, Media	A	

	Recommendation	Responsible Organization	Implementing Organization	Schedule	Necessity of Foreign Assistance
3	Periodic Implementation of Disaster Management Exercise	DMC	DMC, Technical Organizations, Administrative Organizations, Ministry of Social Service, Police, Military, Media, Officers from target area, etc.	A	
4	Establishment of Early Warning and Monitoring System for the Southern Western Four River Basins	DOI	DOI, DMC	B～C	Financial assistance for purchasing equipments and establishing system / Technical assistance for defining warning criteria

A: within one year, B: within 2 years, C: within 5 years
Source: JICA Study Team

Part IV:
Community Based Disaster Management

PART IV COMMUNITY BASED DISASTER MANAGEMENT

CHAPTER 1 ACHIEVEMENT OF ACTIVITIES

1.1 General

Enhancing capacities of communities for disaster risk management is one of the very important aspects for reducing negative impacts of disasters. The activities of Component 3 aiming at strengthening community capacities has been conducted as per to the workflow described in Figure IV-1 in close cooperation with the Disaster Management Centre (DMC), as well as the technical counterpart organizations such as Department of Irrigation (DOI) and National Building Research Organization (NBRO).

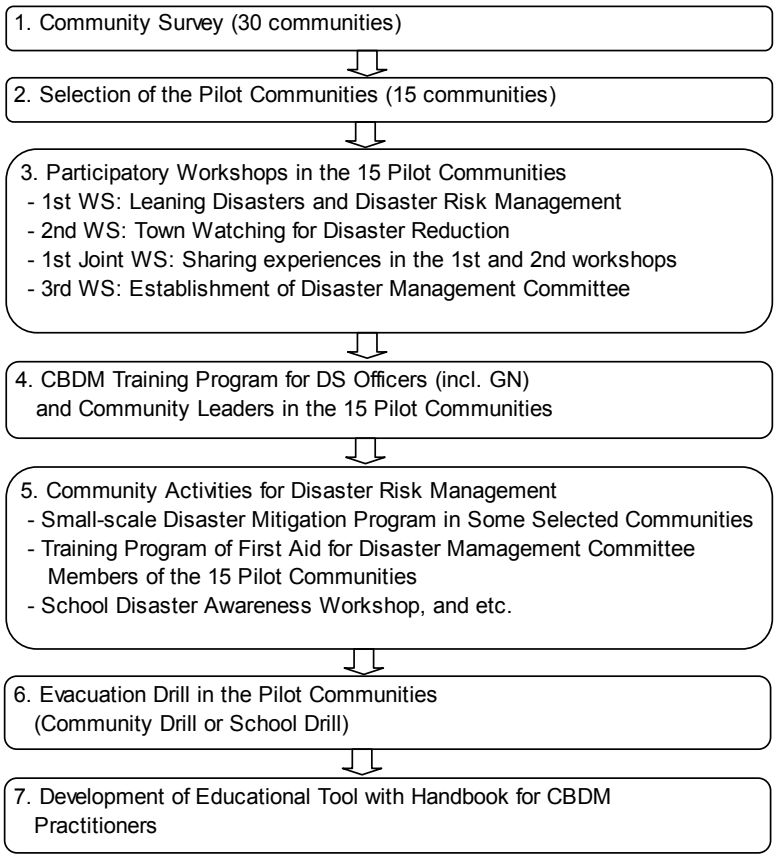


Figure IV-1 Workflow of the Activities of Component 3

1.2 Selection of the Pilot Communities

1.2.1 Preliminary Community Survey

The activities for Component 3 started with a preliminary survey on the communities. The survey was designed for understanding the condition of the communities in disasters and disaster risk management and getting necessary information and data for the selection of the 15 pilot communities to conduct community-based disaster reduction activities in the Study. A total of 30 communities in the Study area were selected from the scale of potential risks to disasters perspectives based on the result of baseline study by the Study team members as well as the recommendation from DMC, DOI, and NBRO. Table IV-1 shows the selected target communities of the survey.

Table IV-1 Target Communities of the Survey

Type of Disasters	Target Areas	#	Target Communities	G.N.	Division	Population (G.N.)*
Flood	Kelani River basin	1	Kittanpahua	Kittanpahua	Kolonnawa	4,705
		2	Biyagama	Biyagama	Biyagama	1,923
		3	Hanwella	Hanwella	Hanwella	1,748
		4	Ranala	Ranala	Kaduwela	N.A.
	Kalu River basin	5	Angammana	Angammana	Ratnapura	N.A.
		6	Mudduwa	Mudduwa	Ratnapura	3,700
		7	Kahangama	Kahangama	Ratnapura	1,958
		8	Dimiyawa	Raddalla	Elapatha	1,053
		9	Ukuwatta	Ukuwatta	Dodangoda	613
		10	Yatawara	Yatawara	Millaniya	598
	Gin River basin	11	Baddegama	Baddegama	Baddegama	2,978
		12	Agaliya	Agaliya	Weliwitiya	3,139
	Nilwala River basin	13	Akuressa	Ihala Aturaliya	Aturaliya	N.A.
		14	Kadduwa	Kadduwa	Malimbada	1,136
Sediment Disasters	Ratnapura District	15	Hapurugala	Niralagama	Pelmadulla	224
		16	Kiribathgala	Wanniyawatta	Nivithigala	619
		17	Helauda	Mahawala	Ratnapura	1,272
		18	Balibathgoda	Haldola	Elapatha	380
	Kalutara District	19	Niggaha	Niggaha	Bulathsinhala	970
		20	Kosgulana	Kukeleganga	Palinda Nuwara	925
		21	Nagalakanda	Kananvila-south	Horana	1,859
		22	Govinna	Govinna	Bulathsinhala	1,075
Tsunami	Matara District	23	Polhena	Polhena	Matara	3,150
		24	Thotamuna	Thotamuna	Matara	N.A.
		25	Gandara South	Gandara	Dondra	N.A.
		26	Kottegoda	Suduwella	Dickwella	1,567
	Ampara District	27	Sinna Ullai	Sinna Ullai	Pothuvil	1,761
		28	(40th Post Area)	Sinnamuttuaru	Alayadiwembu	1,191
		29	(3rd Section)	Vinayagapuram	Thirukkovil	1,600
		30	Akbar	Periyanilavani	Kalmunai	1,217

(Population data is based on the result of the Survey.)*

1.2.2 Method and Contents of the Survey

In each of 30 selected target communities, a questionnaire survey was conducted among a randomly selected sample of 20 households. A total of 600 households completed the survey in the target areas. In addition to the household survey, a questionnaire survey was conducted by interviewers for the Grama Niladari (G.N.) to get baseline data and information on the target communities.

The main contents of the survey were: 1) Structure and management system of the communities, 2) Situation of the recent main disasters and community's disaster response, 3) Existing mechanism of disaster risk management in the communities, 4) Current status of public awareness on disasters and disaster management, and 5) Current situation of school education for disaster risk reduction.

1.2.3 Selection of Pilot Communities

Based on the information and data collected and analyzed in the Survey, 15 pilot communities for conducting disaster reduction activities were selected according to the criteria shown in Table IV-2 and in consultation with DMC, DOI, and NBRO. Table IV-3 lists the 15 selected communities.

Table IV-2 Criteria for the Selection of Pilot Communities

Criteria	Details
(a) Disaster Risks	High disaster risk areas
(b) Leaderships	Leadership capacity Relationships with other organizations/ administrative organizations
(c) Disaster and Risk Management Awareness	Public awareness on disaster risk management Public attitude to ward disaster reduction activities
(d) Mutual Cooperation Spirit	Organizational capacity, social solidarity Awareness of vulnerable people
(e) Social Impact	High expectation of demonstration effect Good reputation as strong communities Various surveys have already been conducted; however, actual project has not been conducted yet.

Table IV-3 Selected 15 Pilot Communities for Community Activities

Type of Disasters	Target Areas	Target Communities	G.N.	Division	District
Flood	Kelani River basin	Kittampahuwa	Kittampahuwa	Kolonnawa	Colombo
		Malwana Town	Malwana Town	Biyagama	Gampaha
	Kalu River basin	Angammana	Angammana	Ratnapura	Ratnapura
		Mudduwa	Mudduwa	Ratnapura	Ratnapura
		Ukwatta	Ukwatta	Dodangoda	Kalutara
	Gin River basin	Baddegama	Baddegama	Baddegama	Galle
	Nilwala River basin	Kadduwa	Kadduwa	Malimbada	Matara
Sediment Disasters	Ratnapura District	Kiribathgala	Wanniyawatta	Nivithigala	Ratnapura
		Helauda	Mahawala	Ratnapura	Ratnapura
	Kalutara District	Niggaha	Niggaha	Bulathsinhala	Kalutara
		Nagalakanda	Kananvila-south	Horana	Kalutara
Tsunami	Matara District	Gandara South	Gandara	Devinuwara	Matara
		Kottegoda	Suduwella	Dickwella	Matara
	Ampara District	Sinna Ullai	Sinna Ullai	Pothuvil	Ampara
		3rd Section	Vinayagapuram	Thirukkovil	Ampara

1.3 Community Participatory Workshops

1.3.1 General

(1) Overall Plan of the Community Participatory Workshops

To contribute to enhancing capacities of the disaster risk management in each of the pilot communities, an overall plan of activities which included five workshops in each of the pilot communities and two joint workshops inviting representatives of the pilot communities, were originally prepared. In the course of implementation of the activities, the planned activities were reviewed and modified in consideration of situation of the progress and priority areas in each community as shown in Figure IV-1.

(2) Objectives of the Community Workshops

Main objectives of the community workshops were as follows: 1) to analyze hazards and vulnerability to disasters of communities, 2) to foster common understanding of risks among all the stakeholders of the communities including local residents and government officials, 3) to identify problems in the communities and measures to be taken for improving disaster risk management, 4) to formulate community disaster risk management plan, and 5) to promote a "culture of disaster prevention" in the communities.

(3) Participants of the Community Workshops

Basically G.N. and 40 residents were invited from each of the 15 communities to participate in each of the workshops. In addition, taking into consideration the importance of the collaboration and involvement of all stakeholders to formulate communities' disaster management plans, the invitation was extended to officers of Divisional Secretary (DS) Office in charge of disaster related activities. District Disaster Management Coordinators (DM Coordinators) and Assistant Coordinators of DMC in the respective districts were requested to participate in the workshops in view of capacity development for conducting the same kind of activities by themselves in the future.

(4) Lecturers of Workshops

Lectures in the workshops were provided by the lecturers in consideration of active involvement of counterpart organizations in the Study as shown in Table IV-4.

Table IV-4 Lecturers in the Workshops

Theme	Type of Disasters	Lecturer
Mechanism of Disasters:	Flood	Officials of DOI
	Sediment Disasters	Mr. R.M.S. Bandara, Head of Landslide Studies and Service Division (LSSD), NBRO, Mr. Dharmasena, LSSD, NBRO
	Tsunami	Dr. Nimal Wijayaratna, Ruhuna University Mr. Ryo Matsumaru, JICA Study Team
Disaster Management System in Sri Lanka	(Flood)	Ms. Lalani Imbulana, Director of Preparedness/Planning, DMC
	(Sediment Disasters)	Mr. K.N. Bandara, Assistant Director of Training/Public Awareness, DMC
	(Tsunami)	Dr. Buddhi Weerasinghe, Director of Training/Public Awareness, DMC
Disaster Management System in Japan (JICA Study Team)	Flood	Mr. Yoshihiro Motoki, Mr. Ryo Matsumaru and Mr. Yoshihiko Uchikura
	Sediment Disasters	Mr. Satoru Tsukamoto
	Tsunami	Mr. Ryo Matsumaru and Ms. Miki Kodama
CBDM		Ms. Miki Kodama

1.3.2 Series of First Community Workshop (February 2007)

(1) Objectives of the First Community Workshop

The first workshop was conducted aiming at understanding risks of disasters in the respective communities and the current situation of community disaster risk management system and response by exposing the participants to a wide range of information on disasters and risk management.

(2) Format of the First Community Workshop

The basic format of the workshops is as shown in Table IV-5. The main activities were as follows:

- Lectures on Disasters and Disaster Risk Management
- Group Work: DIG (Disaster Imagination Game)

Table IV-5 Basic Format of the 1st Workshop

09:00 – 09:20	Opening Ceremony - Oil Lamp Lighting - Remarks by Divisional Secretariat or a representative of DS Office - Remarks by DM Coordinator, DMC or a representative of District Disaster Management Coordinating Unit (DDMCU)
09:20 – 09:40	Introduction of the Workshops provided by JICA Study Program
09:40 – 10:00	Visual Introduction of Disasters (Flood, Sediment Disasters, or Tsunami)
10:00 – 10:30	Lecture on Disaster (Flood, Sediment Disasters, or Tsunami) in Sri Lanka and in the surrounding areas of the community
10:30 – 11:10	Lecture on Disaster Management in Sri Lanka (Focusing on Flood, Sediment Disasters, or Tsunami)
11:10 – 11:40	Lectures on Disaster Management in Japan (Flood, Sediment Disasters, or Tsunami)
11:40 – 12:00	Video Introduction of Community-based Hazard Mapping
13:00 – 15:00	Group Work: DIG (Disaster Imagination Game)
15:15 – 16:30	Presentation & Discussion
16:30 – 16:45	Explanation about next workshop

(3) Summary of Findings from the First Community Workshop

Lectures which were provided in the workshops were rather long and content was found to be too technical at times. However, most of the participants seemed to be interested and paid attention on the explanations provided, especially when visual materials were used.

DIG program basically had active participants. Each group in each of the workshops developed community maps with some disaster related information which they already recognized. Through the workshops, the participants could make vigorous exchange of their opinions on disaster risk management.

Specific findings summarized by each of disaster type are presented below.

1) Workshops in Flood Vulnerable Pilot Communities

The lectures provided in the pilot communities frequently suffering from flood were very informative focusing on the flood situation in the area in cooperation with DMC, DOI and JICA Study Team. In addition, some of the participants pointed out based on their learning through the workshop program that effective delivery of early warning information should be urgently considered.

2) Workshops in Sediment Disaster Vulnerable Pilot Communities

In the pilot communities prone to sediment disasters, informative and practical lectures were provided with very positive contribution from NBRO. Discussion through the workshops made clear that one of the main problems in minimizing damage by sediment disasters in the communities was the lack of

enough funding. In some communities, needs for improvement of drainage system or bridge for safe evacuation were identified.

3) Workshops in Tsunami Vulnerable Pilot Communities

The program was enthusiastically participated in since this type of the workshop had never been conducted in the communities in Ampara district. On the other hand, the participants in the communities in Matara district were less interested in the program since similar activities were conducted by other aid agencies before.

Figure IV-2 The Lectures in the First Workshops (Flood/ Sediment Disasters/ Tsunami)

(4) Review of the First Community Workshop Activities

The first workshops in the 15 pilot communities were basically well coordinated to achieve the set objectives. However, the following points were recognized to be improved:

- Closer coordination with District Disaster Management Coordinators (DDMC) who have leading roles to promote disaster risk management activities at local level
- More involvement from G.N. level disaster management committees which were or will be established by DMC in order to avoid duplication works.
- More participation from the officers of D.S. offices who have responsibility to take necessary actions for solving problems in communities and improving people's lives.
- More active involvement from community leaders in each community for promoting participation of the persons who are in the position to help realize the actions to be planned.
- Enhancing better understanding among officials of DOI about importance of their involvement in community-based activities for considering effective disaster risk management.

1.3.3 Series of Second Community Workshop (May-June 2007)

(1) Objectives of the Second Community Workshop

The second community participatory workshop in each of the 15 pilot communities was conducted to establish community evacuation plans in the respective communities.

(2) Format of the Second Community Workshop

The basic design of the workshop is shown in Table IV-6. The main activities were as follows.

- Town Watching (Field Survey)
- Mapping and Discussion

Table IV-6 Basic Format of the Second Community Workshop

Time	Activities
08:30 – 09:00	Opening/ Introduction of Today's Program
09:00 – 10:30	Town Watching (Field Survey) / Slope Watching
10:45 – 12:15	Mapping & Discussion
13:15 – 14:45	Presentation & Discussion
14:45 – 15:00	Explanation about the next workshop

(3) Summary of Findings from the Second Community Workshop

1) Town Watching in Flood Vulnerable Pilot Communities

Town watching activities in the seven flood-vulnerable pilot communities mainly focused on observation of the condition of river banks, canals, drainages, and water gates. In many communities, poor condition of smooth water flow were observed or reported by the residents due to blockages or small capacities of canals and drainages.

2) Town Watching in Sediment Disaster Vulnerable Pilot Communities

Town watching activities in the four sediment disaster-vulnerable pilot communities mainly focused on observation of slope condition of their living areas. NBRO officers provided an on-site explanation to the participants on the risks of the slopes, as well as information on the pre-disaster signs. In some communities, they found out that some community members will have difficulty evacuating safely after some period of heavy rain.

Figure IV-3 Town Watching (Flood/ Sediment Disasters/ Tsunami)

3) Town Watching in Tsunami Vulnerable Pilot Communities

In the four Tsunami-vulnerable pilot communities, town watching activities mainly focused on observation of evacuation routes and sites and early warning facilities. They checked the areas inundated by the Tsunami on 26 December 2004 and confirmed the safe evacuation routes.

4) Hazard Mapping

Based on observations in the town watching activities, the participants in each of the 15 workshops drafted an evacuation plan on their respective community maps including the necessary information such as evacuation places, flooded areas based on past records of flood or Tsunami, evacuation route and direction, as well as the current problems and issues to be addressed for safe evacuation.

Figure IV-4 Presentation of Developed Hazard Maps (Flood/Sediment Disasters/Tsunami)

5) Group Discussion

During and after mapping, the participants discussed main problems and possible solutions for safe evacuation and disaster reduction. Outlines of the discussed points are summarized below in each of disaster types. More detailed summary of discussion is presented in the Supporting Report III.

A) Flood Vulnerable Pilot Communities

One of the main issues was inappropriate water flow due to poor condition of canals or drainages in the areas. For the people living in the areas where they suffer flood disaster every year, improvement for better water flow management seemed to be the most serious concern.

B) Sediment Disaster Vulnerable Pilot Communities

Figure IV-5 Explanation on the Rain Gauge and Observation of Rainfall

One of the most critical issues identified is still that some people are still living in the high risk areas. In addition, dangerous spots due to easy flooding in case of heavy rain prevent safe evacuation of the people in some areas. Early warning system appropriate to the communities should be established for both of these groups. In consideration of the conditions, a simple rain gauge was provided and installed in each of the four pilot communities as one of the supporting equipments for early warning. Representatives of the community members started observation and recording after the workshops.

C) Tsunami Vulnerable Pilot Communities

People in the Tsunami-vulnerable pilot communities learned from past disaster experiences the importance of the early warning and prompt evacuation. Thus, the discussion mainly focused on proper information dissemination in their communities. The main issues pointed out were the lack of equipment and transportation facilities necessary for prompt information transfer.

(4) Review of the Second Community Workshop Activities

Through the activities in the Second Community Workshops in the 15 pilot communities, the following points were identified to be considered in future CBDM activities.

- Importance of proper risk recognition and risk communication among stakeholders
- Enhancement of group action by communities themselves to solve or minimize the problems
- Active involvement of G.N. to the activities
- Further coordination with currently developing DMC's strategy for CBDM activities

1.3.4 First Joint Workshop

(1) Objectives of the First Joint Workshop

The First Joint Workshop was conducted on 19 October 2007 for the purposes of: i) sharing information among stakeholders in each pilot community and also among the disaster vulnerable communities in Sri Lanka; ii) discussing a practical and appropriate action plan for disaster risk management in each community and, iii) initiating preparation for the mock drill in each community.

(2) Participants of the First Joint Workshop

The persons invited to the Workshop were as follows: one or two representatives from the pilot communities, G.N. and one DS officers in charge of each of the 15 pilot communities, and DM Coordinators and an Assistant Coordinators from the respective disrticts.

(3) Program of the First Joint Workshop

The program of the workshop is shown in Table IV-7.

(4) Summary of Findings from the First Joint Workshop

1) Presentation on their Past Activities under the Study Program

The participants were divided into four groups according to the types of major disasters in their areas, and a representative from each of the 15 pilot communities made a summary presentation of their past activities in the Study program. After the plenary presentation of group discussions, DMC presented on the DMC's initiatives and plans to deal with some of the problems presented by the participants.

Table IV-7 Program of the First Joint Workshop

Time	Contents
09:55 – 10:15	Opening - Remarks by Dr. Buddhi Weerasinghe, Director, DMC - Remarks by Ms. Yasuko Nishino, Deputy Director, JICA Sri Lanka Office - Remarks by Mr. Ryo Matsumaru, JICA Study Team
10:15 – 10:30	Introduction of Community Workshops in the Study/ Purpose of Joint Workshop by Ms. Miki Kodama, JICA Study Team
10:30 – 12:30	Presentation by community members on past activities in the Study program 10:30 – 11:30 Group presentation / 11:30 – 12:00 Plenary presentation
12:30– 12:45	Support Activities for Community Disaster Risk Management of the DDMCU focusing on the G.N. Level Disaster Preparedness and Response Plan by Ms. Lalani Imbulana, Director, DMC
12:45 – 13:00	Brief explanation of the current status of establishment & activities of the G.N. Level Disaster Management Committees by Kittampahuwa G.N.
14:00 – 14:30	Introduction of Good Practices of Community Activities for Disaster Risk Management in Japan by Ms. Miki Kodama, JICA Study Team
14:30 – 15:30	Group discussion & Plenary Presentation for promoting CBDM activities
15:30 – 15:45	Presentation on Importance of Early Warning & Evacuation Drill and Explanation of the Planned Flow of Warning Information in case of flood, landslide and Tsunami in Sri Lanka by Mr. Ryo Matsumaru, JICA Study Team
15:45 – 17:45	Group works among the related members (District DM Coordinator – G.N.. – community representative(s)) on the evacuation plan in each of the target communities & Plenary Presentation
17:45 – 17:50	Closing - Schedule of the 3rd community workshop & disaster management drill

2) Lectures & Group Discussion

Figure IV-6 Lectures and Group Discussion in the Joint Workshop

At first, lectures outlined support activities by DMC towards the enhancement of community disaster risk management focusing of GN level disaster risk management plan, various best practices of community activities for disaster risk management in Japan, and importance of early warning and periodic evacuation drills were presented.

Based on the new information provided from the presentations, a group discussion was conducted. Table IV-8 shows some of the suggestions on how to promote CBDM activities in villages.

The main focus of the discussion on early warning was the disaster information flow from the DMC, DS, G.N. to the community. The community is used to the bottom-up approach in informing the government about disaster situation in their respective area. However, the JICA Study Team also emphasized the importance of the top-bottom information flow for the provision of accurate early warning and dissemination to all members of the community.

Table IV-8 Suggestions to Promote CBDM Activities in the Communities

- Conduct art competitions on disaster management - Conduct school children awareness programs - Incorporate disaster reduction related activities into New Year sports festivals - Provide practical trainings and drills - Choose the best G.N. division that has the highest level of awareness on disasters - Make brochures and posters about disasters by community members drawing

(5) Review of the First Joint Workshop Activities

The expected result of the Joint workshop was successfully achieved by enhancing level of awareness of most of the G.N.s and community representatives. Thus, active involvement in the Study program from the next workshop will be assured and it is anticipated that they will be key in the effective implementation of the program activities.

1.3.5 Series of Third Community Workshop (October-November 2007)

(1) Objectives of the Third Community Workshops

The objectives of the series of Third Community Workshop were as follows:

- To formulate community disaster risk management plan
- To prepare and plan community evacuation drill

(2) Format of the Third Community Workshop

The basic format of the Third Community Workshop is shown in Table IV-9.

Table IV-9 Basic Format of the Third Community Workshop

Time	Contents
09:00 – 09:20	Opening / Introduction
09:20 – 09:40	Introduction of the Community Disaster Management Committee and their activities –Japanese Experiences- by JICA Study Team
09:40 – 09:50	Explanation about G.N. Level Disaster Management Committee & Subcommittee
09:50 – 11:10	Group Discussion & Plenary Presentation on: Forming/Activation/Promotion of the G.N. Level Disaster Management Subcommittees Action plan for realization of the objectives of committee
11:10 – 11:40	Explanation about Early Warning & Evacuation Drill
11:40 – 12:10	Discussion on Current Disaster Information System in Community & Future Improvement
13:00 – 15:00	Group Works/Discussion on Early Warning & Evacuation - Information Flow (how to and who get information, how to and who disseminate information, what is required) - Planning of the disaster management drill - Finalization of Community's hazard map (evacuation site & route) in one map - Support of Evacuation (vulnerable people, counting) - Action plan for preparation

(3) Summary of Findings from the Third Community Workshop

The summary of the Third Community Workshop is as follows:

1) Establishment of G.N. level disaster management committee

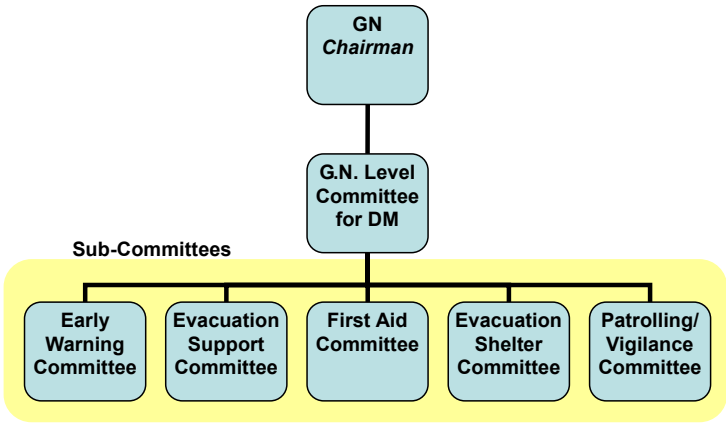


Figure IV-7 Composition of G.N. Level Disaster Management Committee

Current initiatives to establish G.N. level disaster management committee (Figure IV-7) was introduced, and the creation or activation of the subcommittees was particularly emphasized during the workshop. The condition of the formation of subcommittees in each of the 15 pilot communities is shown in the Table IV-10.

Table IV-10 Status of Formation of the Subcommittees in each Pilot Community

Disaster Types	District	Communities	Status of Formation of Subcommittee
Flood	Colombo	Kittampahuwa	Will be created on 13 January 2008
	Gampaha	Biyagama	Need Further Coordination
	Ratnapura	Angammana	Reorganized in the WS by utilizing the appointed members by DMC and Red Cross activities
	Ratnapura	Mudduwa	Temporary reappointed in the WS, and need for official endorsement
	Kalutara	Ukwatta	Formed in the WS
	Galle	Baddegama	Formed in the WS
	Matara	Kadduwa	Already formed by DMC and activated in the WS
Sediment Disasters	Ratnapura	Helauda	Reorganized and activated in the WS
	Ratnapura	Kiribathgala	Formed in the WS
	Kalutara	Niggaha	Formed in the WS
	Kalutara	Nagalakanda	Need Further Coordination
Tsunami	Matara	Kottegoda	Need Further Coordination
	Matara	Gandara	Formed in the WS
	Ampara	Sinna Ullai	Already formed by DMC
	Ampara	Vinayagapuram	Already formed by DMC

2) Consideration of early warning system in the community and evacuation plan

After the presentation introducing the importance of early warning and evacuation drill, a plenary discussion was conducted on current disaster information delivery system in the communities. Based on the current planned early warning dissemination system by DMC, community members considered appropriate information flow and methods for the communities to disseminate early waning information such as that shown in Figure IV-8.

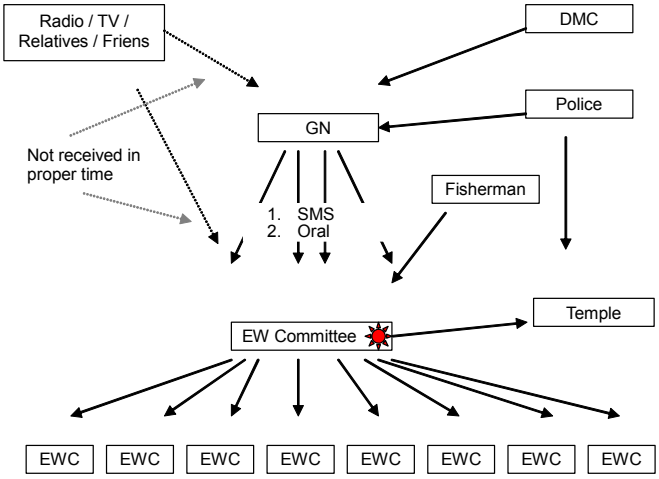


Figure IV-8 Basic Information Flow at Community Level

3) Preparation for Evacuation Drill

Discussion on the preparation for evacuation drills were conducted in the communities where the G.N. level disaster management subcommittees were successfully formed or activated. After ensuring adequateness of the communities' evacuation routes and sites, the participants discussed and identified the effective and realistic coordination required to conduct the drill including role allocation of the committee members.


Figure IV-9 Discussion for Arrangement of Evacuation Drill

4) Review of the Third Community Workshop Activities

Discussions during the Third Community Workshop in each of the 15 pilot communities showed varying degrees of condition of preparedness to and people's interests on disaster risk management, current disaster situation and level of participation of the members who play important roles in the respective communities. Considering this situation, the design of and activities in the Fourth Community Workshop scheduled in February 2008 should be developed, depending on progress of each community.

1.3.6 Significant Effect of Installed Rain Gauge in one of the Pilot Communities

Rain gauge equipment was installed in the sediment disaster vulnerable pilot communities and observation & recording of data with the equipment have been ongoing.

At midnight of 22 November 2007, some parts of Nagalakanda village, one of the pilot communities, were affected by a landslide triggered by heavy downfall of rain. The community representative who observes the rainfall reported to NBRO that the recorded amount for a half day period exceeded 150 mm. Thus,

based on the formulated strategies, people in the village were able to evacuate to a pre-decided gathering point before the event occurred.

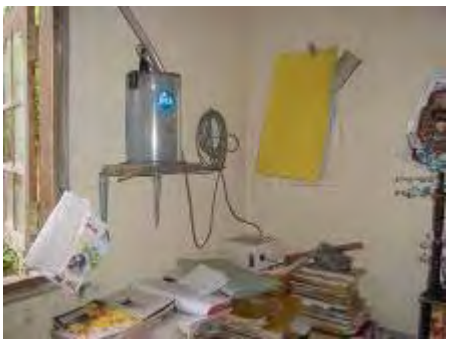




Figure IV-10 Installed Rain Gauge Equipment and Rainfall Records by Residents

1.3.7 Reconsideration and Modification of the Plan of CBDM Activities in the Study

(1) Interim Review of CBDM Activities in Each Pilot Community

In November 2007 after a year had passed since the CBDM activities started in each pilot community, an interim evaluation of CBDM activities in the Study was made.

Differences of the progress on the planned activities among the 15 pilot communities were revealed by the review. The conditions differ for each community; however, basically, in the communities with strong community ties and/or strong leadership, the activities were smoothly conducted. In addition, the G.N.'s active involvement assured people's active participation.

It was recognized that reconsideration of the plan of the activities in each of the communities based on further review at this stage is needed for effective implementation of the program.

(2) Evaluation of the Past CBDM Activities in Each Pilot Community

Based on the results of interim review, further evaluation of the past CBDM activities in each pilot community was conducted in February 2008. Summarization of the condition of the participation and progress of the activities in the workshop of JICA Study is presented in Supporting Report III. Main points identified as important factors to improve CBDRM activities are as follows:

- Active involvement of community leaders led good progress of the planned activities.
- Official endorsement of the program was one of the important factors to ensure pragmatic discussion in the workshop.
- Solidarity of community is one of the important keys driving promotion of CBDM activities.
- Severity of disaster situation or experience of severe disaster in the past made community's participation more active.
- Consideration of approach to children to overcome resistance of adults stemming from past practices in case of disasters.

(3) Proposed Activities for the Next Step

Based on the above mentioned findings, the following activities are proposed for the next phase in the Study.

- Activities for improving local government officials involvement
- Activities for further progress of community activities
- Activities for promoting CBDM through enhancement of school community-awareness
- Originally planned activities of evacuation drill with some modification in the implementation method for the communities which made good progress in past programs
- Activities for activating the formed G.N. level disaster management committee
- Special program for the community with controversial issues to proceed to the next step

1.4 Community Activities for Disaster Risk Management

1.4.1 General

Based on the results of evaluation of the activities, the following community activities were decided to be conducted in consideration of the condition of the progress of activities in each pilot community.

- Evacuation Drill combined with the Comprehensive Disaster Management Exercise
- 2-day Training Program for Government Officers in DS Offices (DS) and Community Leaders of the 15 Pilot Communities
- Small-scale Disaster Mitigation Program for the Selected Flood Vulnerable Pilot Communities
- Small-scale Disaster Mitigation Programs for the Selected Sediment Disasters Vulnerable Pilot Communities
- Consultation Meeting on Flood Bund Gate
- One-day School Children Awareness Workshop in Kalutara District
- School Evacuation Drill in Cooperation with Communities
- One day First Aid Training for G.N. Level DM Committee Members at each District

1.4.2 Evacuation Drill in the Comprehensive Disaster Management Exercise

(1) Objectives of the Evacuation Drill

Evacuation drills in some selected pilot communities were conducted as one of the important activities of the Comprehensive Disaster Management Exercise held on 26 February 2008 and 16 October 2008. The objectives of the evacuation drill in the communities were:

- To make sure prompt and proper actions in case of disasters
- To review the community's disaster management plan, especially the flow of prompt information dissemination to all community members
- To foster collaboration among community members
- To improve disaster management capacities in communities.

(2) Selection of the Communities for Conducting Evacuation Drills

Four communities were selected for the drill on 26 February 2008 and seven communities were selected for the one on 16 October 2008 based on the criteria shown in Table IV-11.

Table IV-11 Criteria for Selecting the Communities to Conduct the Drill

Drill	Selection Criteria
Evacuation Drill on 26 February 2008	a) Progress of the activities in the Study has been relatively smooth, b) G.N. level DM committees have already been formed, and c) The sites are located in target divisions of the Comprehensive Disaster Management Exercise in the Kelani or Kalu river basin.
Evacuation Drill on 16 October 2008	a) The sites are located in target divisions of the Comprehensive Disaster Management Exercise in the Kalu river basin b) Evacuation drill was not conducted in February 2008 *Helauda and Baddegama were included as exceptional sample.

Table IV-12 Pilot Communities Selected for the Evacuation Drill and Numbers of Participants

	District	Division	G.N.	Disaster Type	No. of Participants
Evacuation Drill on 26 February 2008	Colombo	Kolonnawa	Kittampahuwa	Flood	150
	Gampaha	Biyagama	Malwana	Flood	30
	Ratnapura	Ratnapura	Angammana	Flood	75
			Helauda	Sediment Disasters	160
Evacuation Drill on 16 October 2008	Ratnapura	Ratnapura	Mudduwa	Flood	22
			Mahawela (Helauda)	Sediment Disasters	113
		Nivithigala	Wanniyawatta (Kiribathgala)	Sediment Disasters	62
	Kalutara	Dodangoda	Ukwatta	Flood	103
		Horana	Kananvila South	Sediment Disasters	68
		Bulathsinhala	Niggaha	Sediment Disasters	112
	Galle	Baddegama	Baddegama Town	Flood	33

Numbers of the participants to evacuate to the designated evacuation places in the target communities in the drill were decided by the decision of each of the G.N.-level Disaster Management committees in consultation with JICA Study team members.

(3) Design of the Evacuation Drill

The basic design of the evacuation drill is shown in Table IV-13.

Table IV-13 Basic Design of Community Evacuation Drill

Time	Activities
<On day before>	
	Pre-Meeting for confirmation of flow of information dissemination and roles by G.N. level disaster management committee members
	Pre-announcement to all the community members about conducting the drill
<On the day>	
Around 11:00	G.N. receives “Evacuation Instruction”
Approx. 11:00 – 11:10	G.N. informs to G.N. Level Disaster Management Committee (Early Warning Sub Committee) about the information
Approx. 11:10 – 11:20	Wide dissemination of the information (Designated way: Temple bells, Mosque speaker, Knock the door of the houses, Oral communication, etc.)
Approx. 11:10 – 11:40	Evacuation to the designated evacuation site - Head counting / Record of evacuation time
Around 12:00	Evaluation of evacuation activities
(12:00 -)	(First Aid Training)

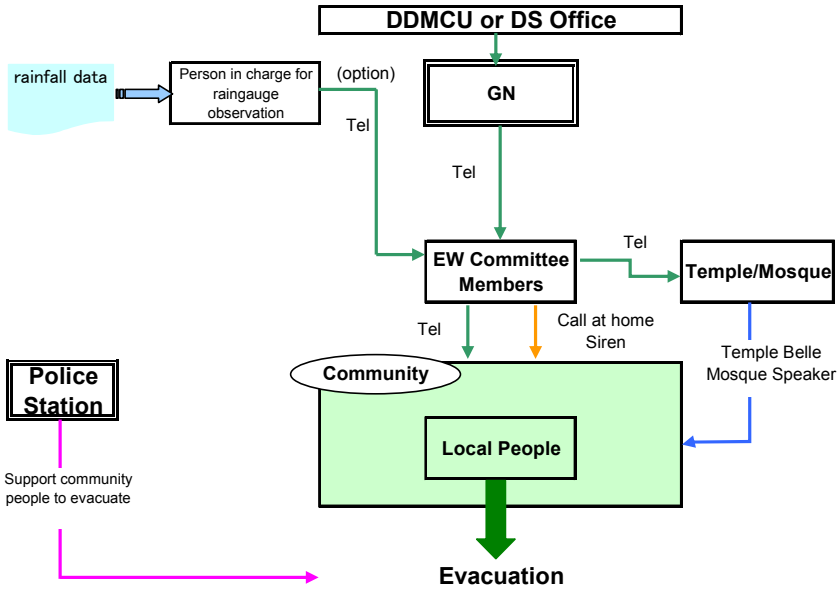


Figure IV-11 Basic Information Flow for Early Warning Information Dissemination

(4) Summary of Findings from the Evacuation Drill

1) Review of Preparation by G.N. and G.N. Level Disaster Management Committee

A) Pre-Meeting

Pre-meetings were held in all of the target communities attended by the committee members, community leaders, G.N.s, officers of DS, representatives of DDMCU, and JICA Study team on at least one day prior to the drill. Procedure of the drill and the designated flow of the information dissemination were confirmed.

B) Pre-announcement to community members about conducting drill

In all the targeted communities, pre-announcement was properly done by G.N.s or committee members on day before the drill. Owing to this arrangement, there was no confusion or panic caused by the drill implementation.

C) Preparation of the lists of the contact for dissemination of early warning information

In most of the targeted communities, the list of the contacts for dissemination of early warning information were not well prepared. They were not in the written or temporarily prepared for this drill in handwriting.

D) Preparation of the community hazard maps

Some G.N.s in the target communities for the drill on 26 February kept the draft community hazard maps developed through the past workshops in the JICA Study in their offices and utilized them for evacuation planning of the drill. Also, boards of community hazard maps which were developed through the community activities in each pilot community were located in the target communities before the day of the drill on 16 October.

Figure IV-12 Preparation of Community Hazard Maps: Helauda (left)/ Baddegama (right)

2) Review of the Actions Taken in the Evacuation Drill

A) Early Warning Information Dissemination to Committee Members

Basically, the information dissemination after G.N. received the early warning message from DS offices was smoothly conducted without any big problem in the drill on 26 February. While, in the drill on 16 October, delay of information transfer from DMC to DDMCU or DDMCU to DS offices due to the communication problem of FAX machines and others caused some confusion in the coordination of the process of drill at the community level.

B) Wide Dissemination of Early Warning Information to Community Members

Temple bells, mosque speakers, or sirens were basically used for wide dissemination of early warning information to community members. Within a few minutes after G.N. or early warning committee members received the information, an early warning message was delivered to the community members through ringing bells, speaker, or sirens in those communities.

C) Evacuation Action Taken by Community Members

Figure IV-13 Evacuation of the Community Members to the Evacuation Site

In all of the target communities, people wanted to join the drill smoothly and promptly evacuated to the designated sites for evacuation. Most of the people understood the action to be taken after hearing the information. However, in some communities in the first drill on 26 February, people gathered at the evacuation sites before starting the information dissemination due to misunderstanding of the purpose of evacuation drill. In the second drill on 16 October, this experience was reviewed by the people and the need to take evacuation action only after hearing the evacuation information by the designated ways was reconfirmed in the pre-meetings as well as pre-announcement to community members.

3) Arrangement of Head Counting and Confirmation of the Evacuees

In some communities, more than three persons were allocated for recording the names and time to reached the evacuation site, and so they could avoid heavy congestion near the recording places although the attendees exceeded 100.

Table IV-14 Time Required for Completion of Evacuation

	G.N.	Disaster Type	No. of Participants	Time required for evacuation
Evacuation Drill on 26 February 2008	Kittampahuwa	Flood	150	N.A.
	Malwana	Flood	30	20 minutes
	Angammana	Flood	75	40 minutes
	Helauda	Sediment Disasters	160	25 minutes
Evacuation Drill on 16 October 2008	Mudduwa	Flood	22	78 minutes
	Mahawela (Helauda)	Sediment Disasters	113	43 minutes
	Wanniyawatta (Kiribathgala)	Sediment Disasters	62	37 minutes
	Ukwatta	Flood	103	36 minutes
	Kananvila South	Sediment Disasters	68	36 minutes
	Niggaha	Sediment Disasters	112	51 minutes
	Baddegama Town	Flood	33	55 minutes

4) Other remarkable arrangements for the drill in the communities

In Helauda, the disaster management committee was well organized, and discussion for the activation of the committee in the third workshop in the Study was also very fruitful. Based on the discussion in the workshop and pre-meeting for the drill, they spontaneously conducted demonstration activities of some subcommittees. Similarly, in Ukuwatta, the shelter management committee members prepared signs to indicate necessary facilities in the evacuation site such as places for drinking water, toilet, and garbage dump.

Figure IV-14 Demonstration Activities/ Indication Sign in Evacuation Site by Subcommittee Members

(5) Evaluation of the Drill

1) Evaluation Meeting after the Drill

After all the intended evacuees reached the designated evacuation site, an evaluation meeting for debriefing of the participants was conducted in each of the target communities. In the drill on 16 October, owing to an approximately one-hour delay of information transfer due to communication problem at district or division level, some of the target communities started the evacuation before receiving the evacuation instruction.

Figure IV-15 Evaluation Meeting in Helauda (left) and Angammana (right)

Although there was abovementioned unfortunate mistake for the people in some communities, the following results were achieved through the both of the drills;

- People could learn how to receive official information on disaster risks and disseminate it to all community members by participating in the Comprehensive Disaster Management Exercise.
- People could identify the problems of current information dissemination systems in each of the communities and consider possible solution for improving the situation.
- People could understand what kinds of arrangements are required in the evacuation site.
- People reviewed the roles of subcommittees of G.N. level DM committee.
- G.N.s understood their important roles to deliver information for safe evacuation.

1.4.3 Training Program for Government Officers in DS Offices and Community Leaders of the 15 Pilot Communities

(1) Objectives of the Training Program for DS Officers and Community Leaders

The main objective of the training is to raise awareness of local government officers on the importance of community activities for disaster risk management, which is one of the important aspects for sustainable community disaster risk management activities. In addition, the training aimed at making close relationships for effective risk communication for the communities.

(2) Program of the Training for DS Officers and Community Leaders

Table IV-15 shows the program of the training for DS officers and community leaders. The following sessions were provided:

- Session 1: Lectures on current disaster risk management in Sri Lanka
- Session 2: Risk communication among stakeholders using disaster management game "Crossroad"
- Session 3: Completion work of community-based hazard map
- Session 4: Discussion on importance of early warning
- Session 5: Development of action plan for their own communities

(3) Summary of Findings from the Training for DS officers and Community Leaders

The lectures, delivered by major technical organizations for disaster risk management in Sri Lanka, were very informative and useful for the participants to consider improvement of their activities for disaster risk management.

Table IV-15 Program of the Training for DS Officers and Community Leaders

<Day 1> Tuesday, 15 July 2008	
09:00 – 09:30	Opening Session - Remarks by Mrs. Lalani Imbulana, Director of Preparedness & Planning, DMC - Remarks by Mr. Ryo Matsumaru, JICA Study Team
09:30 – 10:00	Introduction of the Training Program - Brief explanation of JICA Study (progress and plan for FY2008) by Ms. Miki Kodama, JICA Study Team - Objectives of the today's program by Mr. Palitha Bandara, Assistant Director. Training, DMC
10:15 – 10:45	Session 1-1: Recent Progress of Disaster Risk Management System in Sri Lanka focusing on community's disaster management by Mrs. Lalani Imbulana, DMC
10:45 – 12:15	Session 1-2: Recent Progress of Disaster Risk Management [Presentations and Q&A]
(10:45 – 11:15)	- Weather related disaster & Tsunami early warning by Mr. S.R. Jayasekara DOM
(11:15 – 11:45)	- Flood disaster management by Mr. Ajith Gunasekara, DOI
(11:45 – 12:15)	- Sediment disaster management by Mr. R.M.S. Bandara, NBRO
13:30 – 15:00	Session 2-1: Group Discussion "How you act in case of emergency" using DM Game "Crossroad"
15:15 – 15:45	Session 2-2: Video Presentation & Discussion - Facing Disasters Making Decision: The gender dimensions of disaster management
15:45 – 16:45	Session 2-3: Plenary Session for the Result of Group Discussion Facilitator: by Mr. Buddika Happuarachchi, Practical Action

<Day 2> Wednesday, 16 July 2008	
09:15 – 10:45	Session 3: Finishing work for community hazard map for disaster risk management with early warning information
11:00 – 12:30	Session 4: Importance of Early Warning System (Group Session) [Tsunami & Landslide Group] - Picture Story: Tsunami (15 min) & Video: Landslide (25 min.) - Discussion on Early Warning at the time of Tsunami warning in September 2007 & heavy rain situation in April & May 2008 Coordinated by Mr. Ryo Matsumaru, JICA Study Team [Flood Group] - Discussion on Recent Flood Disaster & Early Warning Coordinated by Mr. Yoshihiko Uchikura, JICA Study Team and Mrs. Lalani Imbulana, DMC
13:30 – 14:30	Session 3 (Cont.): Finishing work for community hazard map
14:30 – 16:00	Session 5: Group discussion for development of action plan to improve current situation of disaster risk management for each pilot community Committee Formation/ Early Warning System/ Safe Evacuation Place
16:00 – 16:30	Closing Session - Summary of the training program by Mr. Buddika Hapuarachchi, Practical Action - Introduction of future programs by Ms. Miki Kodama, JICA Study Team - Closing remarks by JICA Study Team by Mr. Ryo Matsumaru, JICA Study Team - Closing remarks by DMC by Mrs. Lalani Imbulana, Dir. Preparedness & Planning, DMC

Based on the evaluation of the program by the participants which was conducted at the end of the training, the talk of DOM officer received high recognition. His explanation was done with some jokes and easy-understandable concrete examples. Capacity development of officers of technical organizations for disaster risk management to prepare further good lectures appropriate to the level of the participants is also important for enhancing awareness of the people in Sri Lanka.


Figure IV-16 Lectures by DOM (left) / by NBRO (right)

The discussion during disaster management game "Crossroad" was enthusiastically made by all of the participants. The game provided the participants with opportunities to think that there is no single right answer for decisions because of the different circumstances with uncertain factors, and they shared opinions of others from different points of view.


Figure IV-17 Active Discussion in the "Crossroad" Game

Discussion on early warning was made based on their recent experience of disasters. Since the memory of the disasters was still fresh especially in case of floods which affected wide areas of nation from April to May 2008, the participants made concrete and intense discussion on the issues and challenges for better arrangement of early warning system.

(4) Review of the Training Activities

The originally intended objectives were achieved through the training activities. The stakeholders for each of the 15 pilot communities could make close communication and share their own ideas and opinion through the program. The created good circumstances will make future CBDM activities go more smoothly and effectively in each of the pilot communities.

1.4.4 Small-scale Disaster Mitigation Program

(1) General

In the communities where the progress of community activities has been very smooth and successful, people showed strong desire for conducting disaster risk mitigation activities. To support their

motivation for improving current condition, small-scale disaster mitigation programs were conducted in some selected flood and sediment disaster vulnerable communities as pilot cases.

(2) Program for the Selected Flood Vulnerable Pilot Communities

1) Objectives of the Program

Through the activities in the Study, the people in the pilot communities vulnerable to floods in Colombo and Gampaha identified the need for making continuous efforts to mitigate negative impacts of disasters. The work to install river water level gauges and establish continuous observation system of river water by community members was proposed for providing more prompt early warning information to the residents in risk areas. The mitigation program was conducted for leading and participating residents in manner aiming at enhancing people's awareness through the work.

2) Format of the Program

The program included the following set of activities:

- A small consultative meeting with leading members of the communities
- Installation of the gauge with community members
- A half day training program for reading gauges and continuous observation activities
- Observation by community members

3) Summary of Findings from the Program Activities

At first, Consultative meeting was conducted with participation of many more residents than the intended numbers. They listened carefully to the explanation of the need for continuous observation and they decided to install the gauges and conduct regular monitoring by the community.

Figure IV-18 Consultative Meeting (left)/ Training for Reading Gauges (right)

The community members were also actively involved for the installation work. When the gauge was installed, the people in Malwana requested to lay a more stable foundation in consideration of rapid current at the place of installation.

The training program conducted after installation of the gauges was very useful and pragmatic for starting observation. An engineer of DOI made detailed explanation on reading calibration and gave a small amount of training for the main person in charge of observation.

4) Review of the Program Activities

Due to serious conditions faced in the recent flood in April and May 2008, the participants interest and expectation for the activities were very high. The residents should make continuous efforts for

long time until they can formulate significant criteria based on the observed data. Further cooperation for sustainable monitoring activities among the residents is required.

(3) Program for the Selected Sediment Disasters Vulnerable Pilot Communities

1) General

Through three community workshops conducted in 2007, the participants in the pilot communities vulnerable to sediment disasters in Rathnapura developed plans to improve their current situation and they proposed some mitigation measures to prepare for future disasters. After DMC and JICA study team reviewed the proposals, small-scale mitigation program for sediment disasters was conducted in Helauda and Kiribathgala with technical and financial support from DMC, NBRO and the JICA Study Team.

2) Rehabilitation and Maintenance of Drainage Canal in Helauda (Mahawala G.N.)

A) Outline of the Program

The community in Helauda proposed to restore a drainage canal to improve the drainage condition in the area, which is effective to reduce the landslide risk. The mitigation program was conducted by residents active involvement with technical support from NBRO, DS, Municipal Council and DDMCU. After they identified masons and other non skilled laborers from the area and prepared all the necessary materials, they performed the construction work under technical advice by NBRO, DS office and Municipal Council.

Figure IV-19 Cleaning of the Drainage Canal (left) / The Improved Drainage Canal

B) Review of the Program Activities

The drainage canal was rehabilitated within one month after they have started construction works. The laborers for the works were voluntarily provided from the community members. After successful completion of the improvement works, water leakage at the bottom side of the drainage area was drastically reduced. One of the reasons for the success of the program was the leaders strong will and good coordination to lead the community members to have active involvement in the program.

3) Improvement of Safe Evacuation Routes in Kiribathgala (Wanniyawatta G.N.)

A) Outline of the Program

Community in Kiribathgala proposed to construct a crossing for securing evacuation routes from the risk areas of sediment disaster in the community based on the findings in the hazard mapping program

in the Study. After careful examination and consultation with NBRO, JICA Study Team decided to support the construction of the crossing and improvement of access pathway for the evacuation routes based on the technical considerations for safe land conditions.

At the beginning of the program, a consultation meeting was conducted among the community members with officers of NBRO, DDMCU, and DS office. Then, the construction work was performed by voluntary labor of community members with technical support of NBRO and DS office.

Figure IV-20 Construction Work/ Crossing before improvement (center)/ after improvement (right)

B) Review of the Program Activities

The crossing was completed within one month after starting the construction work. One of the reasons for the prompt and successful completion of work was the community's solidarity and good coordination under the leader and young leader to lead the community members to be actively involved in the program.

1.4.5 Consultative Meeting on Flood Bund Gate

(1) Outlines of the Consultative Meetings on Flood Bund Gate

In the course of workshops in Kadduwa under JICA Study, the workshop organizing team of DMC and the JICA Study team realized that there is a big controversial issue on flood bund (BR16) among the residents of upstream and downstream and it is difficult to proceed with the activities without discussing the matter. Therefore, the organizing team decided to hold consultative meetings inviting representatives of residents from both upstream and downstream, and a DOI officer who explained the current flood protection system and future improvement plan of DOI and the Sri Lankan Government.

The sequence of consultative meetings is shown in the Table IV-16. The third meeting was coordinated by District Secretary of Matara with much wider participation of stakeholders.

Table IV-16 Sequence of the Consultative Meetings

No./Date	Participants
1st Meeting (September 1)	Representatives of residents in the area of downstream
2nd Meeting (September 11)	Representatives of residents in the area of upstream
3rd Meeting (September 26)	Both residents of upstream and downstream and much wider participation


Figure IV-21 2nd Meeting among Upstream Residents (left)/ 3rd Meeting for Both Residents (right)

(2) Review of the Consultative Meetings

At first, the meetings were separately conducted targeting each of the representatives of residents in upstream and downstream. The participants learned the background information of the flood bunds located in the Nilwara river basin from DOI engineers and discussed solution of current adverse condition with keen interest. Then, a meeting inviting both types of residents was conducted under coordination of District Secretary. In the meeting, enthusiastic discussion was made outlining the views and opinions of both types of residents. Then, the talks proceeded to explore an overall plan for resolution considering the more fundamental causes of floods. In the meeting, the people could not reach final conclusion; however, they have decided to continue the discussion for seeking a good solution. The series of meetings were very good opportunity for the people in the communities situated in flood risk areas to discuss comprehensive solution for flood disasters in the catchment areas of the Nilwala River.

1.4.6 One-day School Children Awareness Workshop in Kalutara District

(1) Objectives of the School Children Awareness Workshop

The workshop program was conducted on 8 July 2008 aiming at:

- Enhancing understanding of school children on the disaster risks around them and providing opportunity for them to learn how to prepare for disasters
- Disseminating knowledge on disaster preparedness learned from the program to parents and adults through the participants
- Encouraging advance level students to take this subject as a project

The workshop targeted around 200 students from 16 schools located in the landslide vulnerable areas in Palinda Nuwara, Kalutara District.

(2) Program of the School Children Awareness Workshop

The workshop was jointly organized by DMC, NBRO, and JICA Study Team as shown in Table IV-17.

Table IV-17 Program of School Children Awareness Workshop

Time	Program
08:30 – 09:00	Opening - Welcome Speech by Mr. Sirisoma Lokuwithana, Divisional Secretary - Remarks by Mrs. Lalani Imbulana, DMC - Remarks by Mrs. Pathmini Wijesinghe, Zonal Department of Education - Remarks by Mr. Ryo Matsumaru, JICA Study Team
09:00 – 09:15	Introduction of the Workshop by Mr. R.M.S. Bandara, NBRO - Objectives of today's program
09:15 – 11:35	"Let's learn disasters and disaster risk management in Sri Lanka" from disaster management experts
(09:15 – 09:50)	- Disaster Risk Management System in Sri Lanka by Mrs. Lalani Imbulana, DMC
(09:50 – 10:25)	- Weather related disaster & Tsunami early warning by Mr. Jayasekara, DOM
(10:25 – 11:00)	- Flood disaster management by Mr. W.N. Silva, Irrigation Engineer, Kalutara, DOI
(11:00 – 11:35)	- Sediment disaster management by Mr. Mr. Manikupura, NBRO
11:35 – 12:00	Explanation of Field Trip & Homework by NBRO
13:00 – 16:00	Field Trip to landslide prone areas, instructed by NBRO - Group Study (40 persons x 5 groups) escorted by a NBRO officer in one group

Figure IV-22 Participating School Children in the Workshop

Figure IV-23 Lectures on Disasters (left)/ Field Visit to Landslide Prone Area (right)

(3) Review of the School Children Awareness Workshop Activities

The workshop was successfully completed and the topics were of great interest to students. It is expected that the participating students will share their knowledge with their friends in the school as well as parents and adults in their communities. Through the workshop activities, the following points were identified as recommendations for future efforts for disaster reduction.

- Improving the awareness among the school children is considered as one of the most effective way of preventing disaster risks in the country. It is important to use all possible avenues to reach school children and build their knowledge and awareness on disaster risks and risk reduction.
- Childrens newspapers and books could be considered as one of the effective measures to reach school children. It is important to promote contents on disaster risk reduction in childrens educational media.
- Students engaging in project activities as a part of their formal education could be promoted to work on different disasters. Regional officers of the relevant agencies could be linked to provide guidance to the students.

1.4.7 School Evacuation Drill in Cooperation with Communities

(1) Objectives of the School Evacuation Drill

The three workshops conducted in the Tsunami vulnerable pilot communities in 2007 underlined the need for approaching school children to promote disaster reduction in the communities due to less interest of residents to CBDM activities.

The school evacuation drill was jointly organized by DMC and JICA Study Team in cooperation with Department of Education as a school children awareness program in October and November 2008. The main objectives of the drill are to make better understanding of importance of prompt evacuation in case of Tsunami and necessary pre-arrangement for school children's safety.

(2) Basic Format of the School Evacuation Drill in Cooperation with Communities

The basic format of the program is shown in Table IV-18. However, through the consultation with people concerned in the target school in Gandara South, an awareness workshop inviting parents was conducted in the school as shown in Table IV-19. This was because the school is located in a safe area from Tsunami and evacuation place for the communities is not the school.

(3) Outline of the Activities in the Program

The program of the evacuation drill was basically conducted based on the draft "National Guidelines for School Disaster Safety" developed by Ministry of Education and National Institute of Education with the support of German Technical Cooperation (GTZ). DMC is going to promote the school awareness activities according to the Guidelines.

In addition, representatives of the parents were invited to observe the drill and join the awareness program after the drill.

Table IV-18 Basic Format of Program of the School Evacuation Drill

<Before the Drill Day>	
Pre-Meeting by Teachers & Representatives of Communities	
<On the Drill Day>	
08:00 – 08:30	Advance Guidance to School Children of Target Classes by Teachers - Registration of Attendance - Explanation of Evacuation Drill *Teachers of non-targeted classes should also explain about drill to avoid the panic of school children
09:00 – 10:00	Evacuation Drill *Refreshment after completion of head counting
10:30 – 12:00	Evaluation & Awareness Program
(10:30 – 10:40)	- Principal's Review of the Drill
(10:40 – 11:00)	- Evaluators' Recap and Review of the Drill
(11:00 – 11:20)	- Lecture: What is Tsunami & Importance of Prompt Evacuation by DM Coordinator
(11:20 – 11:30)	- Q&A
(11:30 – 12:00)	- Practical exercise for understanding of effective disaster risk management

Table IV-19 Program in Gandara South, Matara District

Time	Program
11:30 – 11:45	Opening Address
	by Mrs. M.M. Peramesal, Acting Principal Capt. Saman Balasooriya, Matara District DM Coordinator
11:45 – 12:00	Keynote Message by Mr. Ryo Matsumaru, JICA Study Team
12:00 – 12:40	Lecture on Tsunami and Q&A "What is Tsunami & Importance of Prompt Evacuation" by Capt. Saman Balasooriya, DM Coordinator Matara
12:40 – 13:00	Picture Show "Inamurano-hi Story" "Let's discuss what we should do to reduce Tsunami damage"
13:00 – 13:30	Practical Exercise for understanding of effective disaster risk management

1) Pre-Meeting

The activities of the program started by preparatory meetings conducted prior to implementation of the drill in each of the target schools. In the meetings, the following topics were discussed.

- Forming a school disaster management committee.
- Acquiring the information of conditions of school by the Committee members
- Determining safe places for evacuation and evaluating how many persons can be accommodated
- Developing a school evacuation plan including early warning dissemination system, and evacuation routes from each classroom considering the traffic

The result of discussion in each school is summarized in Figure IV-24.

While Gandara Primary School is located in a Tsunami safe area, the teachers discussed how to inform the children's safety to the parents. Figure IV-25 shows the plan considered in the discussion.

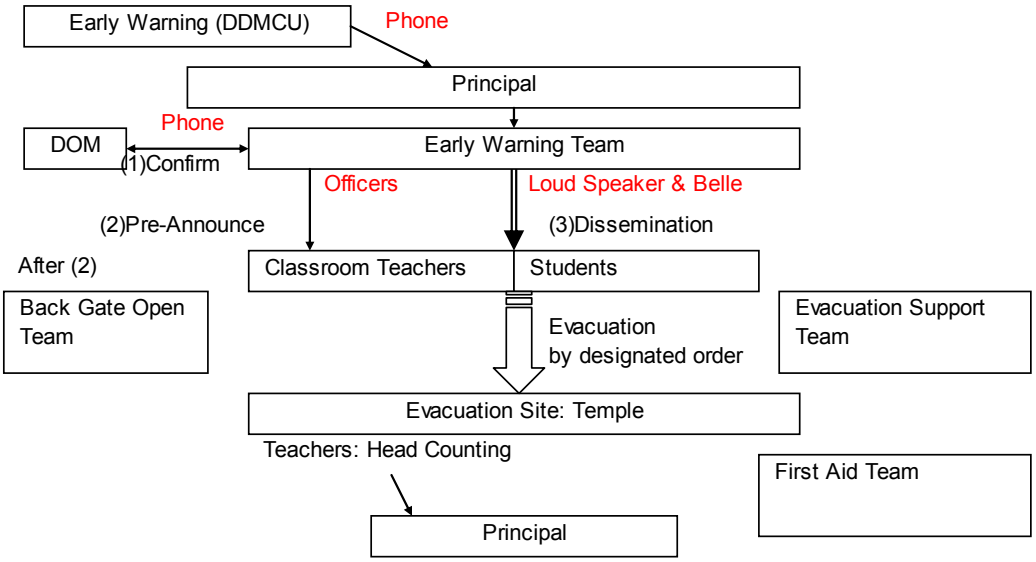


Figure IV-24 Designated Flow of Activities and Role Allocation Talalla Maha Vidyalaya, Matara

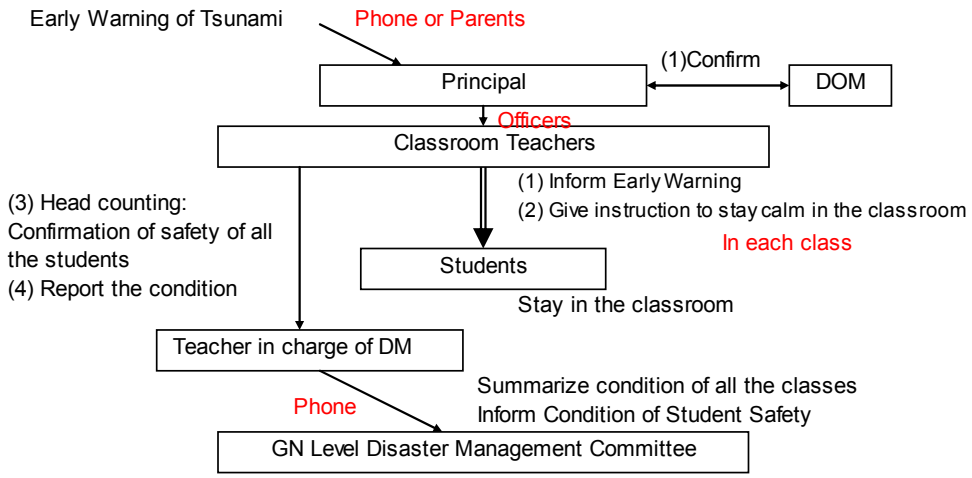


Figure IV-25 Designated Actions in case of Issuance of Tsunami Early Waning

Figure IV-26 Preparation Meeting among Teachers in Kottegoda (left)/ in Vinayagapuram (right)

2) Evacuation Drill

The flow of the actions taken in the drill are shown in Table IV-20.

Table IV-20 Basic Flow of the Actions in Evacuation Drill

Time (estimated)	Action
am 08:00 – 08:30	Advance guidance to school children - Explanation of the drill, Registration of attendance
am 08:15	Occurrence of Earthquake in the Indian Ocean (assumption)
am 08:55	DOM announces Tsunami early warning message by several medium (assumption)
am 09:00	School receives/notices early warning message for Tsunami (*in the drill, DDMCU gives information by phone)
am 09:02	[Early Warning Team] Confirm the information with Department of Meteorology Inform to school teachers of each classroom by administrative staff
am 09:05	[Early Warning Team] 1) Ringing bell for emergency alert and announce 2) Announce "Evacuation drill, Evacuation drill. Tsunami warning is issued. All students, evacuate under the supervision of teacher" 3) Open the back gate
am 09:06	[Classroom Teachers] Instruct "Everyone, Tsunami warning has been issued. We are evacuating to the temple (the designated evacuation place) immediately. Keep < P. R. S. B. > in mind." Teachers assemble the students to the school ground and lead the way to evacuation site with the attendance book of the class. [Students & Teacher] Start evacuation
after reaching to the evacuation site	[Classroom Teachers] Head count of the students and school staff members -> report to Evacuation Support Team the result of counting [Evacuation Support Team] Verification of people-count -> report to principal
around 09:50	[Principal] Make announcement of safe evacuation of all the students and teachers -> Distribution of refreshment. Everybody move to school.
move to school hall	Principal's review and evaluators' recap & review

Figure IV-27 Evacuation Action in Kottegoda (left)/ in Sinna Ullai (center)/ in Vinayagapuram (right)

3) Evaluation of the Actions and Awareness Program

After all the students and teachers were safely evacuated to the designated evacuation place and head counting was completed, an evaluation session and awareness program was carried out. In the awareness program, active participation of the observing parents was also requested.

Figure IV-28 Awareness Program in Kottegoda (left)/ in Sinna Ullai (center)/ in Vinayagapuram (right)

Similarly, in Gandara Primary School, where they did not conduct evacuation drill, the participants learned Tsunami mechanism and risk reduction by lectures and the importance to pay much attention to deliver accurate information by practical exercise. In addition, the explanation for the safety arrangement during Tsunami warning in the school was introduced. The participants, especially the parents understood that the school location is safe from Tsunami, and they do not need to worry about their children when they are in the school.

Figure IV-29 Pre-meeting among Teachers (left)/ Awareness Program with Parents' Participation

(4) Review of the Activities in School Evacuation Drill

Basically, evacuation drill in each of the schools in the target areas was conducted in a coordinated manner without any major trouble. Students could make smooth evacuation in the designated way with the guidance of teachers. Observing parents could have confidence of safety arrangement of the school and understand that they do not need to worry about their children in case of disasters.

In most of the schools, the drills were passively organized by the teachers with the support of DDMCU and the JICA Study team. It is required to provide the teachers with the opportunity to learn disaster risk management so as to implement evacuation drill only by themselves in the near future.

1.4.8 One day First Aid Training for G.N. Level DM Committee Members at each District

(1) Objectives of the First Aid Training

The JICA Study team recognized that the members of G.N. level disaster management committees need to enhance their technical knowledge. At the same time, it is necessary to provide leaning opportunity for those keenly aware of their responsibility as disaster management committee members.

(2) Outline of the Training

The training was conducted in each of the following groups inviting around 5-10 members from each G.N. level disaster management committee members on one day in August-October 2008:

District	Pilot Communities
Colombo & Gampaha	Kittampahuwa, Malwana Town
Ratnapura	Anganmana, Helauda, Kiribathgala, Mudduwa
Kalutara	Niggaha, Nagalakanda, Ukuwatta
Matara & Galle	Kadduwa, Gandara, Kottegoda, Baddegama
Ampara	Sinna Ullai, Vinayagapuram

In the training, experts of Red Cross or St. John Ambulance gave a lecture including demonstration and practical exercises. The community members actively learned basics for treating the injured and participated in the exercise to use the First Aid kits and tools.

Figure IV-30 First Aid Training in Each District

(3) Review of the Training Activities

Through the participation in the training, the participated committee members became more active to consider disaster risk management in their own communities.

1.5 Disaster Reduction Education in Sri Lanka

1.5.1 Disaster Reduction Education in School

(1) Disaster Reduction Education in Schools

As the rate of completion of basic stage education is relatively high in Sri Lanka, disaster reduction education in school should certainly be effective.

However, before the Tsunami disaster in 2004, disaster reduction education in schools was not well considered. As mentioned in the Road Map, the promotion of disaster reduction education in schools

is recently considered as one of the important elements for public awareness based on the experience in the Tsunami disaster.

(2) Disaster Risk Reduction Topics in the Current School Curricula

Some progress has been achieved in integrating disaster risk reduction into school curricula, as indicated by its inclusion in some student textbooks. Detailed conditions are presented in Supporting Report III.

(3) Institutional Arrangement for Integrating Disaster Reduction into School Curriculum

Incorporating topics on disaster reduction and management in school curriculum has been initiated and is already in the process of implementation by the Ministry of Education, National Institute of Education (NIE) and National Science Foundation with the support of GTZ.

GTZ has also been assisting the implementation of teacher training. In addition, teacher guidance and tool kit for supplementary materials for new curricula will be developed in time with GTZ support.

(4) Supplementary Materials for School Library

DMC has conducted a training program for teachers and has developed some supplementary educational materials for various types of disasters for easy understanding of school children. The materials were developed for Cyclone, Flood & Thunder, Landslide, Seashore Erosion, and Drought for the Primary Level with the support by the Canadian International Development Agency (CIDA) and Practical Action.

(5) Materials on Landslide

NBRO plays a critical role for landslide disaster reduction. In August 2000, NBRO published a pamphlet series on “Landslide in Focus” for government officials and students, in English, Sinhalese, and Tamil, with assistance from UNDP. The pamphlet demonstrates the mechanism of the landslide using the simple phenomena, and introduces descriptions of past landslides in Sri Lanka.

(6) Current Status of Disaster Education

As discussed, various activities have been implemented for disaster reduction education through the support of donors, especially after the 2004 Tsunami disaster.

Regarding formal education, the Ministry of Education, NIE and GTZ have together made a great first step towards integrating disaster reduction into the formal school curriculum such as in “Geography” for Secondary Level, even though it is not a compulsory subject. It is therefore suggested that disaster reduction be integrated into the compulsory subjects such as “Science”.

Also, even though DMC has contributed remarkably by distributing supplementary materials in the school library for Primary Level, it is suggested that disaster reduction be taught in the classrooms of the Primary Level.

Furthermore, even though first aid is introduced as a “Physical Education” subject, the community workshop participants expressed the need for training on first aid, especially in the rural communities where there are no hospitals or permanent nurses.

1.5.2 Public Awareness

(1) Current Initiative for Promoting Public Awareness by DMC

Public Awareness is one of the important pillars of the DMC activities. The 4th Draft of National Disaster Management Plan states that training programs for enhancing public awareness should be provided for the following target audiences. The trainings are not scheduled as a regular program at this moment.

(a) DMC staff and affiliated members
(b) Technical personnel and professionals of different categories
(c) G.N.s
(d) Community at G.N. division level
(e) School teachers

(2) Other Notable Activities for Public Awareness

Besides the DMC's activities, several disaster awareness programs are provided by various key players. NBRO has especially been providing many programs on landslide risk management for various stakeholders in collaboration with other organizations.

In addition, DMC tries to make effective utilization of NGOs for community level awareness program. For this purpose, DMC had tried to reach a consensus on the appropriate CBDM approach/modality to initiate large scale CBDM activity among the relevant organizations. Based on the discussion among the players, "Community Based Disaster Management – Modalities and Guideline" was developed in May 2008 and shared for standardizing community activities.

(3) Material for Public Awareness Currently Used in DMC

To support public awareness activities, various pamphlets and posters for disaster education for general public have been produced by DMC and NBRO, with assistance from various donors. DMC, in cooperation with NBRO and support from UNDP and Swedish International Development Cooperation Agency, has developed brochures on 5 kinds of disasters: Cyclone, Thunder, Landslide, Tsunami and Flood. DMC also produced posters with support from the GTZ, and these are largely used for workshops and seminars for general public and government officials.

(4) Consideration for Further Enhanced Public Awareness Activities

DMC has used a series of leaflets for public awareness on possible disasters in Sri Lanka and the risk management for them. They include much useful information; however, the design of the leaflets is a bit complicated and difficult to be read by poorly-educated people. Currently there are no standardized educational tools to be utilized in the CBDM activities. Development of public awareness materials in a more user-friendly format with illustrations can attend to the needs of DMC and the public.

1.6 Development of Educational Tool for CBDM Activities

1.6.1 Development of Educational Tool

(1) Background

As reviewed in the section 1.5.2, DMC developed "Community Based Disaster Management – Modalities and Guideline" with professional contribution from the National Advisory Committee for CBDRM, including members from Practical Action, Sri Lanka Red Cross, UNDP Sri Lanka, and others. The document provides necessary information for a common approach to conduct CBDRM activities in the country. Meanwhile, educational materials easily utilized by the practitioners of the CBDRM activities have not been well developed. To ensure common activities in the country, it is required to develop easy-tonderstande educational material for CBDRM in consideration of use under local conditions.

(2) Development of "Fliptation" for CBDRM

Considering the abovementioned conditions, an educational tool for the CBDRM named "Fliptation" was developed under the JICA Study program. "Fliptation" is a combination word of flip chart and presentation. Like making presentation using PowerPoint materials, the lectures use the "Fliptation" in the CBDRM activities. As mentioned above, the main objective of the "Fliptation" is to make practitioners efforts for conducting CBDRM activities easier and provide standardized and easy-to-understand educational materials for CBDRM activities. Also it aims to ensure dissemination of appropriate knowledge about disaster mechanism and CBDM processes to community people.

The "Fliptation" is a set of flip charts printed on A1 size durable materials which can be easily carried to the local community and presented to a group of people without having to worrying about availability of electricity in the venue. It consists of front pages which have short description with illustrations and pictures for showing to the people, and back pages which have scripts for explanation for use by lecturers. In addition, a handbook including of more detailed explanation on the contents of "Fliptation" which can be utilized for preparation of lecture.

(3) Contents of "Fliptation"

The "Fliptaiton" for CBDRM is composed of 2 kinds of editions and the main contents are as shown in Table IV-21. The contents were developed based on the experiences and lessons learned through the Study activities in consultation with DMC, DOI, and NBRO. Draft contents were also reviewed in the CBDRM Seminar conducted on 5 December 2008 to reflect practitioners' opinions and ideas. The developed "Fliptation" for CBDRM is presented in Data Book.

Table IV-21 Main Contents of "Fliptation"

Theme	Main Contents	Page
CBDRM Activities	- Outline of CBDRM Activities - Importance of Knowing Risks in the Community - Community-based Hazard Mapping Activities - Formation of Disaster Management Committee - Disaster Management Drill - Disaster Risk Management Plan	Total 20 pages
Mechanism of Disasters and Disaster Reduction - Volume 1: Flood - Volume 2: Sediment Disasters - Volume 3: Tsunami	- Mechanism of Disasters - Major Historical Disasters in Sri Lanka - Structural Measures to Mitigate Disaster Damages - Non-structural Measures to Mitigate Adverse Impact of Disasters	10 pages for each volume

Figure IV-31 Developed "Fliptation" for CBDRM (CBDRM/Flood/Sediment Disasters/Tsunami)

The developed "Fliptation" for CBDRM and its handbook is expected to be periodically revised and modified by DMC based on the experiences in their practices of future CBDRM activities.

1.6.2 Seminar for Effective Utilization of the Developed Educational Tools

(1) Objectives of the CBDRM Seminar

CBDRM Seminar for providing more enhanced community activities – sharing experience and know-how of the JICA Study was jointly organized by DMC and the JICA Study Team on 5 December 2008. The main objective of the seminar was to promote more enhanced CBDRM activities in the disaster vulnerable areas in Sri Lanka.

The seminar was conducted targeting DM Coordinators & Assistant Coordinators and government officers in DS to familiarize basic knowledge of CBDRM and the "Fliptation" to promote CBDRM activities in their own responsible areas. In total, around 70 persons attended the Seminar.

(2) Program of the CBDRM Seminar

The program of the Seminar is shown in Table IV-22.

Table IV-22 Program of CBDRM Seminar

Time	Program
08:30 – 09:00	Opening Ceremony Remarks by Major General Gamini Hettiarachchi, Director General, DMC Remarks by Mr. Ryo Matsumaru, Deputy Team Leader, JICA Study Team
09:00 – 09:30	Introduction of the Seminar - Brief explanation about CBDRM Activities in the JICA Study by Ms. Miki Kodama, JICA Study Team - Introductory presentation of CBDRM by Mr. I.A.K. Ranaweera, (DM Coordinator in Matale), Trainees of CBDRM in Japan
09:45 – 12:00	Session 1: Guide to community-based disaster risk management (CBDRM) activities - Basic outline of "Fliptation for CBDRM" by Ms. Chiho Ochiai, JICA Study Team - Model lectures utilized the "Fliptation" CBDRM by Mrs. Lalani Imbulana, DMC Sediment Disaster by Ms. Kumari Weerasinghe, NBRO - Group Work: Trial lecture utilized "Fliptation" for CBDRM & review
13:00 – 14:00	Session 1 (cont.) Presentation of Group Work
14:00 – 15:30	Session 2: Community-based Hazard Mapping (table-top exercise by group)
15:45 – 17:00	Session 3: Group Discussion "How do you act in case of emergency" using DM Game "Cross Road"
17:00 – 17:30	Closing Session Remarks by Mrs. Lalani Imbulana, DMC Remarks by Ms. Miki Inaoka, a representative of JICA Sri Lanka office

(3) Summary of Findings from the CBDRM Seminar

In the introduction session, the participants were exposed to many examples of CBDRM activities conducted under the Study program. The participants could have concrete images of the activities through the presentation which introduced the activities with many pictures.

In the Session 1, the participants were enthusiastically involved in the discussion on the "Fliptation". Many opinions and ideas to improve the "Fliptation" were brought up in the group work. The participants recognized more clearly the concept and process of CBDRM though the model lecture and the discussion.

In the session 2, the participants had a hard time to develop a hazard map in the tabletop exercise. They were requested to draw a map by using house maps, the aerial photos of the areas and technically prepared hazard maps without field survey. As a basis for the hazard mapping activities in communities, they need to have more deep understanding of the technical data for mapping.

Disaster management game "Crossroad" in the Session 3 led all of the participants to enthusiastic discussion. Through the session, the participants learned various viewpoints for the actions to be taken in case of emergency and for disaster risk management. Similarly they understood the effectiveness to use such a tool for making active discussion and getting all the participants opinions.

Figure IV-32 Model lectures using the "Fliptation" of CBDRM (left)/ Sediment Disaster (right)

Figure IV-33 Group discussion on "Fliptation"/ Active Discussion in the "Crossroad" Game (right)

(4) Review of the CBDRM Seminar

All the activities in the Seminar were smoothly conducted with active participation of the participants. Especially, in the session 1 which discussed the "Fliptation", the participants expressed constructive opinions and ideas for improvement, much more than expected. The "Fliptation" for CBDRM will be finalized by incorporating some significant suggestions after reviewing all of them.

Some expected participants could not attend the seminar due to the approaching cyclone; however, from most of the districts, at least one person participated in the seminar. By sharing the knowledge leaned by the participants, it is expected that the CBDRM activities in the country will be enhanced.

CHAPTER 2 CONCLUSIONS AND RECOMMENDATIONS

All the planned community activities in the Study were completed without any major issues or problems in close cooperation with the counterpart organizations and concluded with tangible achievement. Persons involved in the activities could develop their capacities to deal with CBDRM activities at each of the levels of their responsibilities. The following points are reviewed and recommended for further improvement of CBDRM activities in Sri Lanka.

(1) Enhancing Capacities of Local Authorities and Local Bureaucracies for Sustainable CBDRM Activities

Through the CBDRM activities in the target areas of the Study, mainly focusing on the activities in the 15 pilot communities, it was recognized that the system to sustain CBDRM activities in communities is still weak in Sri Lanka. Under the initiatives of DMC and efforts by DDMCU, more CBDRM activities have been provided to the communities in the disaster vulnerable areas in a coordinated manner. However, since the areas that each of DDMCU is responsible for is quite wide, it is difficult or impossible for them to follow-up all the activities in all the disaster vulnerable communities in their districts. Even though we can enhance awareness of the importance of CBDRM in the communities and their own activities become more active, due to the constraint of the financial resources or the other priority matters, the efforts of the communities tend to be easily interrupted and/or aborted. To avoid those unfortunate situations and to support the communities efforts continuously, it is required to have more involvement and initiatives of local authorities under Provincial Council such as Urban Council, Municipal Council, and Pradeshiya Sabha, and local bureaucracy under District Secretariat such as Divisional Secretariat, and Grama Niladhari. More regular training sessions on CBDRM should be provided to the officers of local authorities and bureaucracy. Ideally, as seen in Ratnapura division, it is desirable that officers in charge of disaster risk

management are appointed to one of the positions in the local government offices.

(2) Promotion of Activities which Needs Continuous Actions of Community Members for Ensuring Sustainability

As seen in the cases of the communities where the Study program provided equipment for observation of rainfall or river water level with the training how to operate it and manage the records of observed data, activities requiring their regular actions are very effective to ensure sustainable CBDRM and enhance awareness in the communities. DMC is currently planning to install simple rain gauges to the communities vulnerable to sediment disasters based on the successful practices in the JICA Study. Local technical experts have already developed simple rain gauge by themselves for wider dissemination. DMC is going to prepare a number of these local-made rain gauges and distribute to the communities within the next year or two. It is recommended to further enhance this kind of activity.

(3) Encouraging More Active Involvement of Officers of Technical Organizations in CBDRM Activities

Involvement of technical organizations such as DOI and NBRO in the activities can also provide good opportunities for promoting risk communication, and build up channels to consult on possible risk conditions with and get proper advice from technical organizations. The communities that installed rain gauges in the Study have continuously communicated with NBRO officers about potential risks observed in their communities. Similarly, the involvement of technical organizations in the community-based hazard mapping activities brought pragmatic discussion and sometimes led to taking small-scale mitigation measures required in the areas. It is recommended to provide more of these kinds of activities involving technical organizations in order to open the avenues to have good communication on risks and proper knowledge dissemination.

For that purpose, it is recommended to establish an “Expert group for enhancing CBDRM” with the participation of representatives of technical organizations by the initiative of DMC. The activities of the group include development of useful educational materials for public awareness and conducting lecture courses for disaster reduction to the public. By establishing the group, the technical organizations will have the opportunity to appoint person(s) responsible to CBDRM and public awareness in their organizations as well as to enhance recognition of the importance of their involvement in CBDRM activities for reducing negative impact of disasters through conducting activities of the group.

(4) More Implementation of Community Evacuation Drill combined with Government-level Information Transfer Exercise

In the Study, the evacuation drills were conducted in combination with the government level information transfer exercise. In the discussion on considering early warning system in most of the pilot communities, the people were doubtful that early warning information would be delivered from the government based on their past experiences in disasters. The drills provided good opportunity to increase understanding of the community members that the government information system has been established and at the same time to enhance government officials realization of the need for the reliable information transfer system to reach to the communities. Preparation of this kind of the drills takes time; however, it is recommended to conduct more exercises of this kind of drill in consideration of its profound effectiveness.

(5) Promotion of Public Awareness through School Activities for Disaster Reduction

Raising awareness of the students has high possibility of easily expanding the knowledge on disaster reduction to a wide range of communities. Also, the approach to children can overcome resistance of adults stemming from past practices in case of disasters. From this viewpoint, it is highly evaluated that DMC is currently planning to support promotion of school safety program in the schools vulnerable to disasters. In the course of the activities, it is very important to pay special attention to enhance teacher awareness and capacities to promote disaster risk management in the schools in order to ensure its sustainability. For the purpose, it is recommended to include the course for the subject on disaster and disaster risk management in teacher training schools and provide teachers with regular training programs to update their knowledge on disasters and recent disaster risk management system in the country. Further, it is desirable DDMCU provide lectures on demand on disaster and disaster risk reduction to schools vulnerable to disasters with setting of annual numerical targets for conducting them in each district.

(6) Effective Utilization of Developed Educational Tool "Fliptation" for CBDRM

As reviewed in the Study, for further promoting common CBDRM activities with providing proper technical information, easily-understandable educational material for CBDRM in consideration of use under local conditions is required. For the purpose, the "Fliptation" (flip chart & presentation) materials for CBDRM with handbook was compiled based on the experiences and results of CBDRM activities in the Study conducted in cooperation with DMC, DOI, and NBRO. The developed tool provides the basic knowledge on CBDRM activities as well as the correct technical information of disasters in an easily comprehensible manner. It is expected that CBDRM activities will be propelled by effective use of the "Fliptation" materials for CBDRM. Further, it is requested to make periodical review and modification of the "Fliptation" materials for CBDRM by DMC in consultation of the relevant technical organizations based on the experience in the CBDRM activities.

(7) Formulation of Program to Make Effective Implementation of CBDRM Activities

Through the experiences of the CBDRM activities in 15 pilot communities, in general, the following factors drove the implementation: a) active involvement of community leaders, b) official endorsement of the program with the participation of government officers of DS offices, c) strong solidarity of community, and d) high risk in the areas and a greater awareness of disaster issue compare to the other problems in communities. It is recommended to consider those factors to initiate activities. For example, it can be considered to have leaders' training at the beginning of the activities, or to approach from children to conduct CBDRM activities in the areas the community people have low interest on disaster risk management even though they are located in high risk areas.

The table below shows the responsible and implementing agency, proposed implementation period, and necessity of assistance for the abovementioned recommendations.

Table IV-23 Recommendation for Promoting CBDRM

	Recommendation	Responsible Organization	Implementing Agency	Schedule	Necessity of Foreign Assistance
1a	Enhancing Capacities of Local Authorities and Local Bureaucracies for Sustainable CBDRM Activities: Regular Exercise	DMC	DMC, DDMCU, GA, DS, GN, Provincial/Urban and Municipal Council	A-B	Technical assistance on the program development
1b	Enhancing Capacities of Local Authorities and Local Bureaucracies for Sustainable CBDRM Activities: Appointment of officers in charge of disaster risk management	DMC	GA, DS, GN, Provincial/Urban and Municipal Council	C	Technical assistance on coordination with relevant agencies and formulation of necessary laws/regulations
2	Promotion of Activities which Needs Continuous Actions of Community Members for Ensuring Sustainability (Installation of River & Rainfall Gauges)	DMC	DMC in cooperation with DOI and NBRO	A	
3	Encouraging More Active Involvement of Officers of Technical Organizations in CBDRM Activities: Establishment of Expert Group	DMC	DOM, DOI, DOM, NBRO Other Technical Organizations	B	Technical assistance on establishment of expert group, and program development
4	More Implementation of Community Evacuation Drill combined with Government-level Information Transfer Exercise	DMC	DMC, DOM, DOI, NBRO Other technical Organizations DDMCU, GA, DS, GN, Provincial/Urban and Municipal Council	A-B	Technical assistance on effective information dissemination
5a	Promotion of Public Awareness through School Activities for Disaster Reduction: Training for Teachers	DMC	Ministry of Education in cooperation with DMC	B	Technical assistance on training program development
5b	Promotion of Public Awareness through School Activities for Disaster Reduction: Lectures on Demand	DOI	DMC, DDMCU in cooperation with DOI, DOM and NBRO	B	Technical assistance on program development
6	Effective Utilization of Developed Educational Tool “Fliptation” for CBDRM	DMC	DMC, DDMCU in cooperation with DOI and NBRO	A	

A: within one year, B: within 2 years, C: within 5 years

Source: JICA Study Team

Part V:
Capacity Development

PART V CAPACITY DEVELOPMENT

Chapter 1 GENERAL

For the plan formulated and activities carried out in this Study to be sustainable, development of the disaster management capacity is essential. Therefore, the capacity development (CD) activities are included in this Study as one distinct component.

To achieve effective CD during the course of the Study, the following steps have been taken:

1. Understand existing disaster management capacity
2. Set appropriate goals of the CD in this study based on the existing capacity
3. Plan CD activities
4. Implementation of CD activities
5. Evaluate and modify the CD plan

This Part summarizes the activities for capacity development that have been carried out in this Study.

Chapter 2 DISASTER MANAGEMENT CAPACITY AT THE BEGINNING OF THE STUDY

To understand existing disaster management capacity and identify CD needs, data and information about disaster management administration were collected. A series of interviews to the relevant organizations were also carried out.

2.1 Disaster Management Framework

Disaster Management Act, NCDM and DMC

Sri Lanka Disaster Management Act is the basis for the disaster management framework in Sri Lanka and establishment of National Committee on Disaster Management (NCDM) and Disaster Management Centre (DMC) is stipulated in the Act. The Ministry for Disaster Management and Human Rights (MDMHR) has been established in the end of the year 2005 and currently appointed as the leading organization of the disaster management in Sri Lanka even though the ministry is not stipulated in the Act.

In the Act, DMC has been assigned a coordination role of all DM related activities both at national and sub-national level. At the national level, DMC is directly involved with coordination of related organizations, while District Disaster Management Coordinating Unit (DDMCU) leads the coordination at sub-national level in consultation with DMC.

Three years have passed since the law was established, and the environment which surrounds disaster management and the Act has been changing. In response to this change, MDMHR started the activity for revision or amendment of the Act in November 2008.

National Disaster Management Plan, Emergency Response Plan and Local Level Plans

The Act also stipulated the formulation of a National Disaster Management Plan, however, the plan is still in preparation process even though the 4th draft of the plan was prepared in October 2007.

Necessity of the formulation of an emergency response plan is being recognized among the key organizations; however there is delay of the formulation of the National Disaster Management Plan, and it has not started yet.

The local revel plans for disaster management/preparedness/response is underway by the initiative of the DMC. DDMCU is the local responsible organization for the preparation of these plans.

Emergency Relief Organization

As the national level organization to assist the victims of disasters, Ministry of Resettlement and Disaster Relief Services was established in 2005. The ministry is in charge for supplying the goods and operation of relief shelters.

2.2 Organizations Concerned to Disaster Management

According to the Sri Lanka Disaster Management Act, Roadmap for Safer Sri Lanka and the Draft of the National Disaster Management Plan, various organizations are related to the disaster management, and the organizations listed below are examples of the concerning organizations to the disaster management in national.

- Disaster Management Center (DMC)
- Department of Meteorology (DOM)
- National Building Research Organization (NBRO)
- Geological Survey & Mines Bureau (GSMB)
- Mahaweli Authority of Sri Lanka
- Road Development Authority (RDA)
- National Water Supply and Drainage Board
- Department of Social Services
- Sri Lanka Police
- Department of Irrigation (DOI)
- Coast Conservation Department (CCD)
- National Aquatic Research & Dev. Agency (NARA)
- Sri Lanka Telecom (SLT)
- Central Environmental Authority (CEA)
- Ceylon Electricity Board (CEB)
- Marine Pollution & Prevention Authority
- National Science Foundation
- Sri Lanka Army/Navy/Air force

Among the organizations listed above, DMC, DOI, NBRO, and DOM are the national level organizations directly related to the Study.

In addition to the national level organizations, District Secretariat (GA), District Disaster Management Coordination Unit (DDMCU), Divisional Secretariat (DS) and Grama Niradari (GN) are organizations concerned at the sub-national level, and communities and media are society level concerned bodies.

2.2.1 DMC (Disaster Management Centre)

Immediately after the Sri Lanka Disaster Management Act was enacted, DMC was established in July 2005. At that time, DMC was placed under the presidential secretariat to be functional. In November 2005, Ministry of Disaster Management was established and the ministry was reformed to M/DM&HR in January 2006. After the establishment of separate ministry to handle disaster management, DMC was placed under this ministry.

DMC is the agency to promote the disaster management activities and was given the multiple functions of disaster management in mitigation, preparedness, response and recovery by gazette notification.

DMC currently has five operation units, three administrative units and district disaster management coordination units as shown in the following Figure.

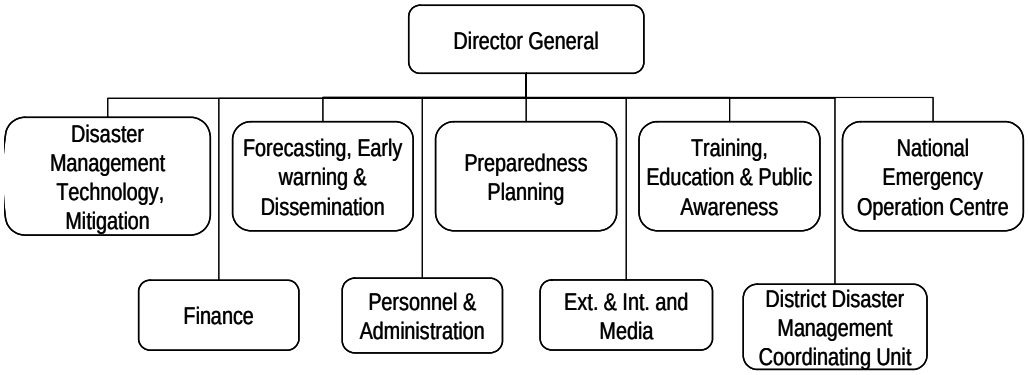


Figure V-1 Current Organization Structure of DMC

DMC had about 25 approved cadre positions in October 2005; however, some of the positions are still vacant although DMC is continuous in its effort to recruit qualified staff to the positions.

Although DMC has special attention from the government and donor agencies, especially from UNDP, DMC has not fully achieved its expected functioning due to insufficient staff and resources. However, DMC has gradually been improving its functions in terms of both physical and human resources since its establishment. It can be seen that initiation of the 24x7 emergency operation centre with communication equipment is one example of the remarkable progress of DMC.

In addition to the progress of legal rearrangement mentioned in the previous section, revised organizational structure of DMC is proposed in the 4th draft of the National Disaster Management Plan. According to the plan, DMC will have seven technical units under the Director General and Deputy Director General.

2.2.2 Department of Irrigation (DOI)

Department of Irrigation was established in 1900 and is currently placed under the Ministry of Irrigation and Water Management. River administration, including flood management, is the responsibility of the Department of Irrigation (DOI), except for a part of river stretches in urban areas and their suburbs. Since its establishment, DOI has accumulated abundant experience in drainage and flood management for over 100 years.

DOI currently has approximately 3,000 staff with an average annual budget of about Rs.1,000 million in recent years. However, due to the budget limitation for the flood management, no new flood management study/project is going to be implemented while some rehabilitation and maintenance works are completed.

Water Resources & Project Planning, Special Service and Training and Hydrology Division are related to the flood management. However, all these divisions are not specialized for flood management. Water Resources & Project Planning Division, for example, is dealing with not only flood matters but also water resources and irrigation matters, and the staff are not specialized in flood management. In case of the hydrology division which has very important role for flood monitoring and early warning, the professional and skilled staff is very limited to handle all hydrological information on a timely basis.

Although DOI has long experience in flood management, as mentioned above, flood management projects including development of flood management plan are not active in recent years. In such situation, the number of staff who has the sufficient knowledge and experience in flood management is decreasing.

Further, less interest in community-based flood management activity is another issue in DOI. DOI staff have relatively higher interest in the discussion in engineering/technical matters and they are willing to attend the meetings to discuss the technical matters and accompany the Study Team members in the field surveys. They however have less interest to attend the community-based workshops because DOI is a very technical organization. But since community-based flood management activity is important in flood management, DOI, as responsible agency for flood management, should play a key role in this activity by becoming resource persons on flood mechanisms, early warning systems, and warning criteria with sound technical background.

As a result of interviews and discussions, the following issues are identified regarding capacity for flood management in DOI:

- Development of knowledge on formulation of policies/guidelines for flood management in terms of both structural and non-structural measures, and provision of appropriate river basin plan
- Development of technology and capacity for issuing early warning to the governmental agencies and personnel concerned
- Enhancement of knowledge to create and update a computerized hydrological database system
- Preparation of technical guidelines and development of knowledge/capacity for hydrological monitoring and its transferring within DOI
- Preparation of technical guidelines and development of knowledge/capacity for sharing and disseminating of hydrological data with other agencies concerned
- Development of technology for encouraging awareness and participation in disaster mitigation activities (evacuation plan and drills, etc.)

2.2.3 NBRO (LSSD)

NBRO was established in 1984 and has six technical divisions and three administrative divisions under the Director General. In 2007, because of the institutional rearrangement of the government administration, NBRO was placed under MDMHR.

From 1988, NBRO is carrying out the studies related to landslide, and LSSD (Landslide Studies and Service Division) is presently in charge. Current major day-to-day activity of LSSD is landslide hazard mapping and there are several mandates allocated to LSSD. The hazard map preparation for landslide-prone area is ongoing in accordance with their long-term hazard map development program. However, the prepared hazard maps tend to remain within LSSD and are not being utilized much for other programs such as awareness raising program for community residents.

Besides the research activities in headquarters, LSSD also frequently carries out the site investigation after landslide disasters occur or based on the information from local governments and/or residents. After the site investigation which covers investigation of housing damage, slope crack, depression, etc., LSSD prepares a report that includes the recommendation for further damage mitigation to the district secretary. LSSD recommendations sometimes include the relocation of houses in landslide hazard areas if it is required, and assists them to relocate. This is one of most notable activities of LSSD because it highly contributes to landslide damage reduction. However, LSSD is not implementing structural measures for landslide prevention.

Total number of staff of LSSD is about 30 and it is obviously not enough considering the wide landslide prone area and large amount of inhabitants in the area. During the first phase of the Study, sediment disasters occurred in October 2006 and January 2007. NBRO dispatched teams to the sites to investigate the disaster situation. However, there were some difficulties to grasp the whole picture of the disaster phenomena due to the insufficient number of geologists and civil engineers, the lack of capacity to carry out the aerial investigation, and limitation of information reported from the district offices with visual observation. This shows that LSSD is facing resources constraints in terms of personnel, engineering and budget like other governmental organizations of Sri Lanka.

LSSD has also prepared education materials explaining the landslide mechanism, preventing measures and guidelines to prevent the landslide disaster. The materials are being distributed at schools, seminars, workshops and at other opportunities.

At present, LSSD focuses on the assessment of the hazardous area of landslide; however, the activities concerning the landslide forecasting and early warning will be increased because NBRO became a part of MDMHR and is given a responsibility to issue a disaster warning through DMC.

2.2.4 Department of Meteorology (DOM)

DOM has long experience in weather observation and weather forecasting from 1868, and has more than 300 staff at present.

Weather information especially rainfall information is very important for disaster management, especially for flood and landslide damage mitigation. DOM also has a role in the tsunami early warning since DOM is appointed as the agency which receives the tsunami warning from the Pacific Tsunami Warning Center and Japan Meteorological Agency together with GSMB.

In 2007, DOM was placed under the MDMHR and is expected to play a bigger role in disaster management, especially disaster forecasting and warning.

DOM has a number of staff and equipment for weather observation; however, it is not sufficient in terms of disaster management because DOM, at this moment, has no automated weather observation station and no realtime based rainfall amount is monitored. DOM is receiving a capital grant aid project from the Japanese Government to upgrade their observation capacity by providing Automated Weather Station with communication equipment and it is expected to contribute to providing better information for disaster management.

2.2.5 District Disaster Management Coordination Unit (DDMCU)

District Disaster Management Coordination Unit (DDMCU) is a district level disaster management organization under the DMC and it coordinates all disaster management activities in the district in cooperation with District Secretaries.

DDMCU, as a general rule, has one District Disaster Management Coordinator (DM Coordinator), one Assistant District Disaster Management Coordinator and several staff. Many of the DM Coordinators are seconded from the military and many of staff are also military related. Some of Assistant DM coordinators are volunteers from UN.

Although a series of training sessions have been held for district DM coordinators on disaster management, their backgrounds in general are not specialized in disaster management and their knowledge is rather

dominated by response activities. In the worst case, DM coordinator does not have proper knowledge of local hazards that may occur, which may end up misleading community people in case of emergency.

2.2.6 Divisional Secretariat and Grama Niradari

Divisional Secretariat (DS) and Grama Niradari (GN) are the local level government bodies closely related to the disaster management. Both Divisional Secretary and Grama Niradari are appointed by the central government.

In the DS office, in most cases, Social Service Officer (SSO) deals with a disaster management matters with consultation of the Divisional Secretary. However, they usually do not have enough capacity in disaster management because they have no specialized training in disaster management and there are fewer disaster management activities at divisional level.

Grama Niradai is the smallest administration unit in Sri Lanka. Although the GN has an important role in disaster management as the official way to disseminate the disaster information to the community, GN office has usually no staff and poor communication equipment such as telephone and fax to support GN's activity.

2.2.7 Community

Community is at the forefront of disaster management activities, especially preparedness and response. For community activities to be effective, proper knowledge on hazard, warning and emergency response are required. However, community people usually have less knowledge on them even when they are managing disaster based on their own experience.

Further, communities are usually not ready for disasters as demonstrated by the small number of information dissemination equipment, lack of search and rescue (SAR) equipment, and emergency supplies.

After the Indian Ocean Tsunami Disasters, the Sri Lankan Government has continuously emphasized community-based disaster management activities, and the effects on the activities have been seen especially in the tsunami affected communities. However, according to the flood survey, the people sometimes do not rely on the information issued by government but instead, make their own decisions which result in late evacuation because of insufficient flood information and knowledge on flooding mechanism.

2.3 Disaster Management Capacity at the Beginning of the Study

According to the analysis of capacity development programs for disaster management that are being conducted in Japan, the required capacity in disaster management is roughly classified into three different types as follows: 1) knowledge on disaster mechanism, 2) knowledge on disaster management (e.g. planning, coordination, response, etc.), and 3) ability to grasp and solve problems and decision making.

The organizations targeted in the Study have different roles in disaster management; therefore the capacities required are different by organization. Knowledge on disaster and disaster management planning is required for implementing agency of disaster countermeasures while capacity for response is required for local government and community, and coordination and decision making ability is required for the leading agency like DMC.

Therefore, the disaster management capacities of selected organizations at the beginning of the Study were examined based on the analysis done Section 2.2 with the following perspectives (Table V.1):

- Knowledge on disaster and disaster management
- Capacity for formulating plans
- Capacity for coordinating with related organizations
- Capacity for response
- Problem-solving and decision making capacity

The following Table shows the disaster management capacity of selected disaster management organizations at the beginning of the Study.

Table V.1 Disaster Management Capacity for Selected Organizations

	Knowledge on Disaster	Knowledge/Capacity on Disaster Management			Problem-solving and Decision Making
		Planning	Coordinating	Disaster Response	
DMC	General knowledge	Certain extent but receive external input to prepare National DM Plan	Gradually increasing but has not reached the expected level	Through DDMCU Fewer experience in large scale disaster	Fewer experience, Insufficient human resources
DOI	Enough technical knowledge	Certain extent but small amount of skilled personnel	Some experience in flood management	Some experience in flood management Site investigation during and after disasters	Fewer experience but limited requirement within their technical field
NBRO	Enough technical knowledge	Certain extent but small amount of skilled personnel	Some experience in landslide management	Site investigation after disasters	Fewer experience but limited requirement within their technical field
DOM	Enough technical knowledge	Certain extent but fewer skilled personnel	Some experience in landslide management	Issue weather watch but no real time	Fewer experience but limited requirement within their technical field
DDMCU	Insufficient level	No experience	Fewer experience	Fewer experience, Insufficient resources	Fewer experience, Insufficient human resources
Community	Insufficient level	No experience	Insufficient and spontaneous	Some experience, Insufficient resources	Insufficient but require very limited to solve local problem

Source: JICA Study Team

Chapter 3 CAPACITY DEVELOPMENT ACTIVITIES PLANNING

3.1 Planning Principle

The planning principles for the capacity development activities were set as follows:

- Capacity development (CD), in general, widely covers institutional strengthening and improvement of social systems as well as individual capacity enhancement. Since, national level institutional strengthening (e.g. organizational set up, assistance in formulating national disaster management plan, etc.) is ongoing in the UNDP's DRM Program, the CD activities in this Study mainly target the institutional strengthening of counterparts and their organizations and selected communities in Component 3.

- Capacity enhancement requires spontaneous learning process of knowledge, and therefore interactive CD activities will be taken to maintain motivation of the CD target bodies. On the other hand, since the aim of this project is to enhance the capacity in disaster management through the activities of Components 1 to 3, the CD activities will be done within their daily activities.
- As mentioned in the previous chapter, different capacities are required in different organizations. If it requires engineering knowledge, lectures in counterpart meetings may be effective. On the other hand, if someone requires rapid decision making in emergency operation, a workshop or drill may be much more effective than a lecture. To this end, CD activities will be planned with combination of On-the-Job Training (OJT) in day-to-day work, counterpart meetings on selected topics, drills on maps and drills at site with consideration of CD requirements. The drills on site for government officials will be conducted together with community-based disaster management activities with full utilization of equipment that will be installed in this Study.

3.2 Capacity Development Activities Planning

CD activities were planned based on the identified disaster management capacity and the planning principles mentioned in the previous section. There are three components in this study but they might be divided broadly into two from the CD perspective: 1) Assistance in establishment of end-to-end flood warning system and 2) Assistance in flood management planning. The goals for CD activities in this Study for the above are set as follows:

- At the end of the Study, an end-to-end early warning system established by the pilot project of this Study will be operating well. In other words, the organizations concerned have to have enough capacity to collect the flood related information, to analyze it for warning issue and to transfer warnings in an appropriate manner, and the communities have to have enough capacity to act properly based on the warning.
- At the end of the Study, a flood management plan and flood warning plan is to be prepared/revised based on the resources from Sri Lanka.

The following table shows the CD plan for selected organizations that shows the individual goals, outputs, proposed mode of activity, and indicators to assess the CD process.

Table V.2 Capacity Development Planning for Selected Organizations

	Individual Goals/Outputs	Mode of Activity	Indicators
DMC	Enhance capability as leading agency of disaster management Enhance capacity on Coordination, decision-making and information transfer	Day-to- day working with Study Team Counterpart meetings Drills Overseas training Trainers Training for DDMCU	No. of meetings chaired by DMC No. of workshops attended No. of DM activities that DMC leads
DOI	Enhance technical capabilities Develop capability to revise the plan by conducting engineering analysis Complete flood monitoring network and set up of flood warning criteria Develop capability to issue warning without delay Provide technical information on flood to community-based activity	Day-to- day working with Study Team Counterpart meetings Drills Overseas training	No. of staff who can handle application for analysis No. of staff who can operate flood monitoring system Time for early warning issuance
NBRO	Enhance technical capabilities Set warning criteria for landslide Establish early warning system for landslide Provide technical information on landslide to community-based activity Obtain capacity to predict disaster event	Day-to-day working with Study Team Counterpart meetings Drills Overseas training	No. of staff who can operate early warning system Time for early warning issuance Accumulation of data for prediction of disaster event
DOM	Enhance technical capabilities Develop capability to forecast hazardous weather based on past experience Develop ability to provide real-time based weather information to relevant organizations including media in an understandable manner	Day-to-day working with Study Team Counterpart meetings Drills Overseas training	No. of skilled staff for forecasting Frequency of information provision Time for information provision Preparation of Database for hazardous weather
DDMCU	Enhance DM capacity in total Develop proper knowledge on hazard which happens in their place Acquire proper knowledge on disaster management in mitigation, preparedness and response Timely transfer of proper disaster information in an understandable manner	Counterpart meetings Seminars Workshops Drills Overseas training Trainers Training for Sub-National Gov. Organization	No. of workshops attended No. of staff who understand local disaster situation Accuracy of information transferred No of staffs trained
Sub-National Level Gov. Organization	Enhance DM capacity in total Dvelop proper knowledge on hazard which happens in their place Acquire proper knowledge on disaster management in mitigation, preparedness and response Transfer disaster information properly	Seminars Workshops Drills Overseas training	No. of workshops attended No. of staff who understand local disaster situation Accuracy of information transferred
Community	Enhance DM capacity in total Acquire proper knowledge on disaster and their role in disaster management Ability to follow proper procedure in case of warning receive Get ready in case of emergency Formulate community-based disaster management organization Coordinate community-based DM activity by themselves	Seminars Workshops Drills	No. of people attending workshops No. of people who understand warning Necessary time for evacuation No. of activities organized by themselves
Media/ Society	Increasing involvement in disaster management Allocate and achieve certain roles in disaster management Transfer proper disaster information or forecast through the media in time Allocate space for synoptic weather chart on newspaper or broadcast synoptic weather chart regularly	Meetings Workshops Drills MOU preparation	No. of media groups that signed the MOU Frequency of broadcast Geographical coverage of media

Source: JICA Study Team

Chapter 4 CAPACITY DEVELOPMENT ACTIVITIES

4.1 Seminar and Workshop

The following Seminars and Workshops were carried out during the course of the Study as a part of capacity development activities.

Table V.3 Seminars and Workshops

Date	Title of Seminar/Workshop	Target	Contents and Discussions
2007			
Mar.8	1st Capacity Development Seminar Venue: SLFI Participants: 60 more	People concerning and/or working on disaster management	JICA Study Introduction of Disaster Management (Japan and Sri Lanka)
Oct. 16	Disaster Management Exercise (1)	DMC, DOM, NBRO, DOI, Police District DM Coordinator Officers in GA Office Officers in DS Office GNs	Information Transfer Exercise (Colombo, Gampaha, Ratnapura, Karutara, Galle, Matara)
Oct. 19	Joint Community Workshop Venue: Sarvodaya Hall Participants: 70 more	DMC,, NBRO,DOI District DM Coordinator Officers in DS Office GNs Community Members	Progress of Community Activities Exchanging and sharing information on community based disaster management activities among the target communities and government officers
2008			
Feb. 5	2nd Capacity Development Seminar Venue: Trans Asia Hotel Participants: 60 more	People concerning and/or working on disaster management	Progress of the JICA Study Discussion on flood management Planning Discussion on disaster management exercise implementation
Feb. 26	Disaster Management Exercise (2)	DMC, DOM, NBRO, DOI, Police District DM Coordinator Officers in GA Office Officers in DS Office GNs Community Members	Information Transfer Exercise (Colombo, Gampaha, Ratnapura) Community Evacuation Drill (Selected communities)
July 15 and 16	Training Program for CBDRM Venue: CEC Training Center Participants: around 70	Officers in DS Office GNs Community Members	Progress of Community-Based DRM activities of the JICA Study Lecture on technical aspects of the natural hazards Tools for community-based DRM activities
Oct. 16	Disaster Management Exercise (3)	DMC, DOM, NBRO, DOI, Police District DM Coordinator Officers in GA Office Officers in DS Office GNs Community Members	Information Transfer Exercise (Ratnapura, Karutara, Galle) Community Evacuation Drill (Selected communities)
Oct. 17	Mini-Seminar on Disaster Management Exercise Venue: Trans Asia Hotel Participants: 60 more	DMC District DM Coordinator Officers in GA Office Officers in DS Office GNs Community Members	Importance of Exercise – Japanese Experience JICA's Experience on Disaster Management Exercise Future Exercise Program in Sri Lanka
Dec. 5	CBDM Seminar Venue: SLFI Participants: 100 more	DMC District DM Coordinator Officers in GA Office Officers in DS Office GNs NGOs	Presentation of CBDM activities done in the Study Presentation of CBDM Materials Prepared by the Study Discussion for sustainable implementation of CBDM
2009			
Jan. 30	3rd Capacity Development Seminar	People concerning and/or working on disaster management	Results of the Study Discussion for sustainable implementation of disaster management activity

Source: JICA Study Team

Since details of the disaster management exercise and the seminars community-based disaster management are mentioned in the respective parts of this report, only the contents of the capacity development seminars are described below.

4.1.1 1st Capacity Development Seminar

The 1st Capacity Development Seminar was held on 8 March 2007 at the auditorium of the Sri Lanka Foundation with participants from more than 60 from relevant organizations. The seminar was the first in a series of three seminars in this Study, and was aimed at sharing and exchanging of knowledge and experience of disaster management, both in Sri Lanka and Japan.

The seminar had four technical sessions covering recent disaster management activities in both countries and the three technical components of the Study. The sessions were chaired by Sri Lankan counterpart personnel. Each session had two presentations, one each from Sri Lanka and Japan representatives, and then discussions followed.

4.1.2 2nd Capacity Development Seminar

The 2nd seminar for capacity development was held on February 5 2008 at Trans Asia Hotel with participants of about 50 from relevant organizations. The seminar had two sessions: 1) Presentation of progress of JICA Study and 2) Discussion of facing issues for sustainable disaster management activities. The second session was further divided into two sub-sessions: Group A: flood management and Group B: exercise planning.

Although the seminar was composed of two sessions, the main part of the seminar was Session 2. To start the session, two main issues for sub-group discussion were raised by counterpart members and it was followed by the presentation of Japanese experience to overcome the issues by the Study Team Member as inputs for discussion to participants. Discussions of two sub-sessions were done in parallel and both of them were led by Sri Lankan counterparts. Active discussion was made among the participants and the outcome of the discussion was presented and discussed among participants at the end of the seminar.

The following points are a summary of the outcomes.

Group A: Flood Management

Key issues

- Policy/Legal framework for resettlement and land acquisition
- Preparation of practical hazard maps
- Effective coordination with other agencies concerning to the flood management

Implementation schedule with milestone activities were prepared during the discussion and presented as outcomes of discussion, and this group concluded that coordination among stakeholders is important. DOI will continue to establish the coordination network of the stakeholders.

Group B: Disaster Management Exercise Planning:

Key issues

- Role allocation of concerning organizations
- Manual preparation
- Plan preparation
- Issues to be solved for implementation of the plan

Based on the common understanding of the issues presented above, the participants discussed the schedule for manual preparation, review of manual and DM exercise targeting year 2008 and 2009. DM exercises will be conducted in landslide, flood and tsunami areas. The manual will be reviewed every time after the DM exercise. Finally, this group concluded that issues to be solved for implementation are:

- Raise awareness
- Provide good equipments
- Allocate required funds
- Complete Intra-governmental network

4.1.3 3rd Capacity Development Seminar

The 3rd Capacity Development Seminar was held on January 29th, 2009. Discussions was made on the future direction of disaster management by incorporating the JICA Study results as well as presentation of the conclusion of the Study.

4.2 Counterpart Meetings

Counterpart Meetings are one of the main tools of the CD activity in this Study. In the meetings the Study Team Member explained the topics raised in the course of the Study and then discussion was made to enhance the knowledge on the Study as well as to enhance general knowledge on disaster management. The meetings were organized by the Study Team and participants invited varied depending on the topic discussed in the meeting.

The topics and items discussed in the meetings regarding Components 1 and 3 are summarized in Table V.4. As for Component 2: Early Warning and Evacuation System, a series of meetings were also conducted especially during the participatory planning process for the early warning and evacuation system. Details are described in the next section.

Table V.4 Counterpart Meetings

Date	Topic	Participated CP	Items Discussed
2006			
Oct. 27	Disaster Management Framework	DMC, DOI	Introduction of Japanese Disaster Management System Issues on further development of the Disaster Management System in Sri Lanka
Dec. 1	Component 3: Community Based Disaster Management	DMC, DOM, NBRO	CBDM experience in Ratnapura for Landslide disaster management CBDM activities by JICA Project
2007			
Jan. 30	Component 2: Early Warning and Evacuation System	DMC, DOI, SLRC(Media), DDMCU, Divisional Secretary	Flood in Kelani River Basin Existing evacuation system Pilot project by JICA
Feb. 13	Mitigation of Sediment Disasters	NBRO	Advanced landslide disaster mitigation measures (Introduction of Japanese measures to landslide)
Mar. 2	Component1: Flood Management	DMC, DOI	Hydrological analysis Review of existing plans Issues on flood management planning
Mar. 13	Progress Report	All CP Organizations	Contents of Progress Report

Date	Topic	Participated CP	Items Discussed
June 21	Component 3: Community-based Disaster Management	DMC	CBDM activities of the JICA Study How to promote community-based disaster management activity
July 13	Component1: Flood Management	DMC, DOI	Alternatives for structural measures and prospective non-structural measures
Oct. 10	Component1: Flood Management	DMC, DOI	Master Plan for flood management Selection of priority projects
Nov. 9	Component 3: Community-based Disaster Management	DMC, District DM Coordinators	Last mile of Early Warning Information Dissemination CBDM activities of the JICA Study
2008			
Jan. 17	Interim Report	DMC, DOM, NBRO, DOI	Contents of Interim Report
Jan. 24	Component1: Flood Management	DMC, DOI	Flood Management Master Plan for selected four river basins.
Mar. 5	Component 3: Community Based Disaster Management	DMC	Activity of next phase
Mar. 10	Progress Report	DMC, DOM, NBRO, DOI	Contents of Progress Report
Sep.25	Component 2: Early Warning and Evacuation System	DOI	Hydrological Information System launching
Nov.19	Component 2: Early Warning and Evacuation System	DMC, DOI, DOM	Hydrological Information System Operation and Maintenance

Source: JICA Study Team

4.3 Capacity Development Activity for Early Warning and Evacuation

4.3.1 Necessity of Capacity Development in Early Warning and Evacuation

There are two measures to mitigate damages of natural disasters. One is the structural measures which are the methods of controlling the external force by constructing the facilities, and the other one is the non-structural measures which create the safer living environment by improving the legal and social systems. In the case of Sri Lanka, due to the various reasons, early implementation of structural measures is difficult and therefore reducing the damage of disasters by implementing the non-structural measures is highly expected. Since an early warning system, one of the most popular non-structural measures, is recognized as very effective to reduce damage, the government of Sri Lanka puts priority for its implementation.

In the early warning and evacuation system, many organizations are involved from the issuance of warnings to evacuation. For the early warning system ro be effective, it is required that the organizations concerned shall take coordinated and appropriate actions based on a solid understanding of the early warning system, and therefore it is necessary to enhance the capacity in all levels. In addition, according to the current disaster management administrative framework, DMC should function as the focal point of the system.

4.3.2 Target and Method of the Capacity Development

In order for an early warning system to be functioning properly, the following activities have to be done properly: 1) information collection and analysis, 2) information dissemination, and 3) evacuation. However, at the beginning of the Study, regulations for the information flow, necessary activities, etc. did not exist in Sri Lanka. In view of the pilot project implementation including provision of monitoring equipment and community activities in this Study, the capacity on information monitoring and collection and evacuation activity have increased. In the planning process of the early warning system, capacity development activities for of governmental organizations especially information dissemination are considered to be crucial.

Since the proposed plan covers only flood disasters and the plan should eventually be integrated to cover other hazards such as tsunami, landslides, etc. in the future. The system should also be updated and modified in accordance with changing technical conditions as well as disaster management administrative changes by Sri Lankan side. Therefore, the organizations concerned should have enough capability to integrate, update and modify the plan (planning capability) to ensure sustainability of the early warning system as proposed in this Study.

On the other hand, to disseminate the information properly, capacities for decision making to issue a warning and transfer the message to the community are indispensable. Organizations concerned have to have operational capacities to disseminate the information as well as the planning capacity mentioned above.

To achieve the enhancement of the planning capacity together with the operational capacities in efficient way, the Study adopted a combined approach of "participatory planning process" and "exercise implementation" for the following reasons.

Reasons for participatory planning process

A participatory planning process with the organizations concerned is considered to be an effective way to determine the proper information flow and the method of transferring it as well as to develop the coordinating and planning capacity:

- As an early warning system will only properly function if the system conforms with the institutional framework.
- As a variety of organizations are concerned with the early warning, the system will not function if a single agency (e.g. DMC) drives the planning process.
- DMC needs to coordinate with other organizations when it issues an early warning, and therefore it should lead the planning process with the other concerned organizations.

Reasons for implementation of exercise

The implementation of the exercise was considered to have following advantages both for the early warring planning and the capacity enhancement of the organizations involved.

- The limits for the early warning system planning will arise only by discussion without a specific target (in this case, the target was exercise implementation). An image of the exercise implementation helps smooth the project and allows more detailed discussion during the planning process.
- Government officials can learn the actual procedures to issue and disseminate the early warning information.

- The effectiveness of the planned early warning system can be checked during the exercise implementation.

4.3.3 Capacity Development Activity in Participatory Planning Process

The participatory process taken in the early warning system planning consisted of two major meetings: namely a "joint meeting" which is the place for discussion of common aspects, and an "individual meeting" which is the place for detailed discussion with the DMC and the concerned organizations individually. The objectives of the joint meeting were to create consensus and establish a common direction of the early warning system planning among all the organizations concerned, while the individual meeting gave an opportunity to consider detailed procedures and action by the individual organization themselves. The DMC initiated the joint meetings with support of the Study Team and brought the concerned organizations into discussion for the early warning system planning. DOI, DOM, NBRO, Police, DDMCU, DS and GN were invited to this participatory planning process.

During the participatory planning process, attention was paid to the following points:

- Create an environment where active discussion could be made by Sri Lankan initiatives.
- Appoint DMC official as the focal point of the early warning system planning.
- Appoint officials in each organization to the early warning system planning and request them to participate in the meetings continuously.
- The Study Team only gave information and ideas based on Japanese experience when the participants were seeking the best alternative on the role of organizations, information flow, method of information transfer, etc., and did not give solutions to the problems.
- Set a target activity of the planning process in order to start discussion and to make detailed consideration of the problems.

For preparation of the exercise implementation as well as discussion of the early warning plan, the meetings shown in Table V.5 were carried out through the course of the Study. The exercises were conducted on October 16, 2007, February 26, 2008 and October 16, 2008.

Table V.5 Counterpart Meetings for Early Warning System Planning

Date	Topic	Participated CP	Items Discussed
Counterpart Meetings for 1st Information Transfer Exercise			
June 13	Information Transfer Exercise for Component 2: Early Warning and Evacuation System	DMC, DOI, DDMCU Divisional Secretary SLRC(Media),	・ Information Transfer Exercise Kick-off meeting
July 13		DMC	・ Early Warning System Planning ・ Information Transfer Exercise
Sep. 20		DMC, DOI, DOM, NBRO, Police, DDMCU, DS, Media	・ Outline of exercise ・ Role of organization, information flow and transfer methods ・ Actions to be taken by each organization
Sep.27			・ Role of organization, information flow and transfer methods ・ Actions to be taken by each organization
Oct.4			・ Actions to be taken by each organization ・ Documents for information dissemination ・ Staff assignment for exercise
Oct. 11			・ Confirmation on the actions to be taken at the exercise and documents for information dissemination ・ Confirmation of items previously discussed

Date	Topic	Participated CP	Items Discussed
Oct. 15			・ Final confirmation of schedule, staff assignment, etc. for the Information Transfer Exercise
Oct.16			・ Exercise ・ Evaluation Meeting of the Information Transfer Exercise
Counterpart Meetings for 2nd Information Transfer Exercise and Evacuation Drill			
Feb.1	Information Transfer Exercise for Component 2: Early Warning and Evacuation System and Evacuation Drill for Component 3: Community Based Disaster Management	DMC, DDMCU, DOM, NBRO, DOI, Police, Media, District Secretary, Divisional Secretary, GN, Community Leader	・ Review of last exercise ・ Outline of next exercise ・ Preparation Schedule
Feb. 7			・ Disaster Imagination Game (DIG)
Feb. 14			・ Discussion on the revised manual
Feb. 21			・ Distribution and explanation of revised manual ・ Confirmation of exercise procedure
Feb. 26			・ Exercise ・ Same day evaluation of the exercise
Mar. 10			・ Evaluation (After analyses) ・ Plan for next exercise
Counterpart Meetings for 3rd Information Transfer Exercise and Evacuation Drill			
Sep.18	Information Transfer Exercise for Component 2: Early Warning and Evacuation System and Evacuation Drill for Component 3: Community Based Disaster Management	DMC, DOI, DOM, NBRO, Police, DDMCU, DS, Media	Joint Meeting to explain the contents of the exercise and discuss necessary modification of the exercise manual
Sep. 22–30		DMC, DOI, NBRO, Police, DDMCU, DS, GN	District Level Meeting at each District to explain the contents of exercise and confirm the activity done by each organization.
Oct. 2		DMC, DOI, DOM, NBRO, Police, DDMCU, DS, GN, Community Leader	Rehearsal of Exercise at Ratnapura DDMCU to confirm the actual process of exercise
Oct. 3–14		DDMCU, DS, GN, Community Leader	Community Level Meeting at each community to discuss and confirm role of community level committee and other participants.
Oct. 9		DMC, DOI, DOM, NBRO, Police, DDMCU, DS, Media	Final Joint Meeting to discuss necessary modification and to confirm the contents of the exercise.
Oct.15		DMC, DDMCU	Final confirmation and discuss evaluation criteria for the exercise.
Oct.16		All exercise participants	Exercise
Oct.17			Exercise evaluation

Source: JICA Study Team

Active discussions took place in the joint meetings for the 1st exercise, especially regarding role allocation and the responsibility of each organization, information flow and method of information transfer. With the technical assistance based on the Japanese experience provide by the Study Team, the early warning plan which will be a basis of the multi-hazard warning plan was tentatively established, and manuals for the exercise were prepared as an outcome of discussion and as tools for identifying issues.

In the preparation meeting for the 2nd and 3rd exercise, discussions were made on the lessons learned from the previous exercise and necessary modifications of the manuals were made.

4.3.4 Capacity Development for Issuing and Disseminating Early Warning through Implementation of Information Transfer Exercise

Based on the tentatively proposed early warning plan (information flow and procedure) prepared through the participatory planning process, the exercises for information dissemination and evacuation were conducted three times during the Study period with participation of concerned organizations with the case scenarios of flood of 1989 in Kelani River, heavy rainfall in Ratnapura Area, etc.

Table V.6 Contents, Objective and Target Area of the Exercise

	Contents	Objective	Target Area
1	Information Transfer Exercise	To confirm the appropriateness of the information flow with decision making process for early warning and means of information transfer To enhance the information handling capacity and familiarize with equipment by doing actual activities	・ DMC, DOI, DOM ・ Police, Media ・ DDMCU (Colombo, Gampaha) ・ Selected DSs and GNs in Colombo and Gampaha
2	Information Transfer Exercise and Community Level Evacuation Drill	To confirm the appropriateness of the modified EWE system To confirm the community level evacuation procedure To enhance the information handling capacity and familiarize with equipment by doing actual activities	・ DMC, DOI, DOM, NBRO ・ Police, Media ・ DDMCU (Colombo Gampaha, Ratnapura) ・ Selected DS and GNs in Colombo, Gampaha and Ratnapura ・ Selected Communities in Colombo, Gampaha and Ratnapura
3	Information Transfer Exercise and Community Level Evacuation Drill		・ DMC, DOI, DOM, NBRO ・ Police, Media ・ DDMCU (Ratnapura, Kalutara, Galle) ・ Selected DS and GNs in Ratnapura, Kalutara and Galle ・ Selected Communities in Ratnapura, Kalutara and Galle

Source: JICA Study Team

Although this exercise was conducted for the first time in Sri Lanka and several issues were identified, generally, the information was transferred correctly and quickly because participants understood the information flow and their role in the early warning system from the discussion during the participatory planning process. As a consequence of the exercise, the appropriateness of information flow determined in the participatory process was confirmed.

Based on good practices and lessons learned from the 1st exercise, the 2nd and 3rd exercises were conducted. These exercises expanded the target area and hazards (not only flood warning but also landslide warning). Further the exercises covered the community level evacuation drill in selected communities.

4.3.5 Effects and Issues

The following are the effects identified as results of the participatory planning process and exercise.

- During the course of the discussions, all organizations have increased their awareness and understood their role and responsibility more on the early warning and evacuation system.
- DMC could lead the discussion as coordinating agency of early warning, and DMC was recognized as the focal point organization on the early warning and evacuation system.

- Exercises helped in the activities carried out to react to actual disaster events such as disaster related information dissemination to the community level through DMC.

These effects were proven during the actual events of heavy rainfall in October 2007 just after the 1st exercise and the flood events in the 1st half of 2008 which was occurred after the 2nd exercise.

In the flood event in October 2007, for example, heavy rainfall in the Ratnapura area and Kelani River basin was observed. During this heavy rainfall event, DOI and NBRO issued a flood and landslide warning, and it was transferred to the sub-national level government organizations (DS and G.N.) through DMC in line with methods agreed upon at the meeting for the exercise. Since there was no information dissemination rule through DMC before the Study, this change is considered to be triggered by the discussion in the planning process and exercise implementation.

In case of the event in 2008, flood warnings issued by DOI were disseminated to the local level organizations through DMC, although some warnings were issued after local floods had happened. In addition, DMC made calls to DOI and asked about the flood situation before the issuance of flood warning based on the rainfall situation and report from DDMCU. By observing the DMC's reactions on these actual events, the capacity of DMC was considered to have increased by experiencing the exercise and actual disasters.

On the other hand, through the participatory planning process and exercise implementation, the following were identified as issues to be solved.

Awareness on reading manuals:
Many of participants did not read the manual in depth and did not understand the detailed procedure of the exercise in advance. This suggests that less awareness from reading manual exists for achieving their role properly.

Standardization of warning format, check list, etc.:
Each organization used different technical terms, reporting format, etc., and this caused misunderstanding and problems when preparing document during the exercise.

Capacity enhancement of DDMCU:
Workload of the information dissemination activities was concentrated to DDMCU under the proposed system. For smooth dissemination of the information strengthening of DDMCU has been highlighted.

Responsible organization to issue evacuation instructions:
Responsible organizations (or persons) to issue evacuation instructions were not be able to be determined clearly during the preparation meeting for the 1st exercise, and so GA was tentatively set as the responsible person to issue it with consultation of DDMCU. During the series of discussions after the exercise, agreement was mostly reached that District Secretary is the responsible person to issue the evacuation instruction, and Colombo District Secretary actually issued the evacuation instruction during the disaster event of the year 2008 with consultation of the DM coordinator. However, more discussions are needed on this subject.

Discrepancy between actual situation and exercise:
The exercise was done with the assumption that the early warning comes before the disaster event. However, in case of the flood in 2008, it was confirmed that, in some areas, that the flood occurred earlier

than the flood warning of DOI, which was issued based on the current flood forecasting standards. To increase the reliability of the warning, the flood warning standard should be reconsidered.

Importance of Repeated Exercise:
Through repeated exercise, improved understanding of information dissemination procedure and skills to handle the information have been identified. Continuous implementation of the exercise is required for further capacity enhancement.

4.4 Overseas Training in Japan

Overseas training in Japan is an opportunity to gain knowledge of the Japanese administration for disaster management, to see the actual measures for preventing damages and experience disaster management at site, and to share the experience; it is the one of the most effective way for capacity development. During the Study period, seven (7) counterpart members (4 in 2007 and 3 in 2008, see Table V.7) were dispatched and took part in the training program shown in Table V.8.

The training in Japan had the following objectives:

- To learn the Japanese disaster management administration system by visiting selected concerned organizations
- To learn the effectiveness of structural measures to mitigate damages of natural disasters by field trip.
- To learn the importance of drills and exercises for disaster risk management by observing actual role-playing style exercise and on-site comprehensive disaster management drill.
- To learn one of the ways for disaster education by visiting the memorial, educational and enlightenment facilities on disaster risk management

Table V.7 Participants to the Counterpart Training Program

	2007	2008
Participants to the Counterpart Training	Major General Gamini Hettiarachchi (DMC) Mrs. Lalani Imbulana (DMC) Mrs. J. Amarakoon (DOI) Mr. R.M.S.Bandara (NBRO)	Mr. U.W.L. Chandradasa (DMC) Mr. Senarathne (DOI) Mrs. Kumari (NBRO)

Source: JICA Study Team

Table V.8 Counterpart Training Program in Japan

Date	Location	Contents of Training
2007		
August 27th(Mon)	JICA	Orientation
	Honjo Bosai-Kan	Museum of Disaster Risk Management To learn the methods for education and enlightenment of the people
28th (Tue)	Cabinet Office	To learn how to formulate the policy of DRM and implement it with coordination of other organizations.
	Japan Meteorological Agency (JMA)	To lean the meteorological observation and the Japanese systems for forecasting, issuing advisory and warning for natural disasters.
29th(Wed)	Public Works and Research Institute (PWRI)	To lean the advanced technology of structural measures and necessity of research for disaster damage mitigation, and Japanese contributions to international communities In the ICHAM (International Center for Water Hazard and Risk Management) of PWRI
30th (Thu)	Nagano Prefecture	To see the actual countermeasures for sediment disasters in the field and to learn the importance of structural measures and its applicability

Date	Location	Contents of Training
31st (Fri)	Foundation of River Basin Integrated Communications	To learn the importance of the disaster information sharing among the concerned organizations by seeing the ideal situation of real time river water level monitoring and information sharing.
	Kanto Regional Office , MLIT	To learn the effectiveness of exercises by observing the scenario based flood management role play exercise in the Office.
September 1st (Sat)	Saitama City	To lean the effectiveness of exercises by observing “Tokyo Metropolitan Area Comprehensive DRM Drill” that is the large scale on site drill conducted collaboratively by local governments every year on Disaster Prevention Day (Sep.1st).
2nd (Sun)	Reporting	
3rd (Mon)	Yamato-gawa River Management Office, MLIT	To see the actual countermeasures both structural and non-structural measures for flood and sediment disasters in the field and to learn its applicability
	Asian Disaster Reduction Center (ADRC)	To lean the activities and the international contributions of ADRC by consolidating the Japanese knowledge for DRM
4th (Tue)	Kobe City	To lean the disaster risk management education and community-based activities conducted in Kobe city that has been prepared based on the experience of the Great Hanshin-Awaji Earthquake in 1995.
5th (Wed)	Wakayama Prefecture	To lean methods for education and enlightenment of the people for Tsunami and DRM by visiting “Inamura no Hi no Yakata museum”
6th (Thu)	Maiko High School (Hyogo)	To learn the DRM education and its curriculum in Maiko High school and volunteer activities for DRM by the school students
7th (Fri)	Evaluation (JICA)	
2008		
August 25th(Mon)	JICA	Orientation
	Honjo Bosai-Kan	Museum of Disaster Risk Management To learn the methods for education and enlightenment of the people
26th (Tue)	Cabinet Office	To learn how to formulate the policy of DRM and implement it with coordination of other organizations.
	Japan Meteorological Agency (JMA)	To lean the meteorological observation and the Japanese systems for forecasting, issuing advisory and warning for natural disasters.
27th(Wed)	Toyooka, Hyogo Prefecture	To see the actual countermeasures both structural and non-structural measures for flood disasters done by local government in the field
28th (Thu)	Kobe City	To lean the disaster risk management education conducted in Kobe city that has been prepared based on the experience of the Great Hanshin-Awaji Earthquake in 1995.
	Community FM Radio Station, Kobe,	To lean the role of media especially “Community Radio” by visiting community FM radio staion in Kobe
29th (Fri)	Wakayama Prefecture and Hirokawa Town	To lean methods for education and enlightenment of the people for Tsunami and DRM by visiting “Inamura no Hi no Yakata museum”
30th (Sat)	Hyogo Prefecture, (Nishinomiya City)	To lean the effectiveness of exercises by observing “Hyogo Prefecture Disaster Management Drill” that is the large scale on site drill conducted annually by local governments every year
31st (Sun)		Reporting
September 1st (Mon)	Hito to Bousai Mirai Centre, Kobe	To lean the importance for sharing the experience of disaster and passing it down to next generation by visiting the Hito to Bousai Mirai Centre that was established to memorize the Great Hanshin-Awaji Earthquake in 1995
2nd (Tue)	MLIT Kanto Regional Office, MLIT	To learn the effectiveness of exercises by observing the scenario based earthquake emergency response role play exercise in the Office.
	Foundation of River Basin Integrated Communications	To learn the importance of the disaster information sharing among the concerned organizations by seeing the ideal situation of real time river water level monitoring and information sharing.

Date	Location	Contents of Training
3rd (Wed)	Nagano Prefecture	To see the actual countermeasures for sediment disasters in the field and to learn the importance of structural measures and its applicability
4th (Thu)	Tone River Works Office, MLIT and Tokyo Met. Gov.	To lean the Japanese efforts to mitigate the urban flood damages by visiting flood control facilities in Tokyo Area
5th (Fri)	JICA Tokyo	Lecture on the method of project evaluation Evaluation of Training Program.

Source: JICA Study Team

The Study Team also introduced the JICA Training Program related to the disaster management sector to the counterpart members, and the some of counterparts took training courses in "River and Dam Engineering", "Hazard Mapping", "Community Based Disaster Management", etc.

4.5 Other Capacity Development Activities

In addition to the day-to-day activities, counterpart meetings and seminars/workshops, the Study Team members were also invited as resource persons to the following activities.

Regional Workshop on Community-based Disaster Management

This workshop was held on July 30-31, 2007 and was organized by DMC in collaboration with UNDP, All India Disaster Mitigation Institute and Practical Action. A member of the Study Team in charge of community-based disaster management (CBDM) was invited as a resource person and presented the CBDM activity in this Study for sharing the information with other countries and organizations.

Workshops for preparing the local level disaster preparedness and response plan

The workshops were aimed at sharing the general idea for preparation of local level disaster preparedness and response plan. A member of the Study Team attended one workshop on Kelani River Basin, and gave a presentation to the officials in charge of preparation of plan to share and enhance the knowledge of floods of Kelani River, which are the most serious and frequent natural disasters in the area.

Chapter 5 EVALUATION OF THE CAPACITY DEVELOPMENT

5.1 Overall Evaluation

In Chapter 3, from the CD perspective, the contents of the study was broadly divided as follows: 1) Assistance in establishment of end-to-end flood warning system and 2) Assistance in flood management planning, and respective objectives were set for each objective. Overall evaluation will be done by considering the achievement of these objectives.

5.1.1 Evaluation on CD for the Assistance in Establishment of Flood Warning Systemxxx

The set objective for CD on the establishment of end-to-end flood warning system is:

- At the end of the Study, an end-to-end early warning system established by the pilot project of this Study will be operating well. In other words, the organizations concerned have to have enough capacity to collect the flood related information, to analyze it for warning issue and to transfer warnings in an appropriate manner, and the communities have to have enough capacity to act properly based on the warning.

The flood early warning system established in the Pilot Project of this Study is currently functioning well as a whole.

Flood Related Information Collection

Flood related information is being collected continuously on realtime basis through the maintenance of the equipment and application software is being made by the Study Team. The collected information is seen at the headquarters of DOI and organizations connected to the Intra-Government Network.

Information Analysis for Warning Issue

Criteria for issuing the flood warning was discussed several times with DOI; however the discussions have not concluded yet. The same analysis method for flood warning is still being utilized, and the method cannot analyze the flood condition for issuing the warning at local level although it can grasp the flood conditions on a broader perspective. Thus, further discussion on the flood analysis for warning and enhancement of analyzing capability is required.

On the other hand, the capability of information analysis for evacuation instruction has been enhanced. In the target district of the Pilot Project, DDMCU and GA discussed and decided on a method for issuing the evacuation instruction. These behaviors were not observed before the Pilot Project implementation, and thus they show the results of the CD activities done in the Study.

Transfer warning in appropriate manner

The capacity of transferring the warning has been notably enhanced. Advisories and warnings issued by the technical organizations are now being disseminated to the local level government bodies as well as police and media through DMC, whereas this information was passed directly from the technical organizations before the Pilot Project implementation. Further, even when the target of the advisories and warnings were outside the Pilot Project area, the information was transferred in accordance with the method defined the Pilot Project; this shows the effects of the Pilot Project.

Skills for information handling have also been enhanced through the exercises. The Intra-Governmental Network is being utilized in the Pilot Project Areas, and the exercise manual is referred to confirm the information dissemination procedure for the other areas than the Pilot Project Areas.

However, the required time for the information dissemination to the local level government organizations still widely varies, and further improvements are required for accurate and prompt information dissemination.

Communities' Capacity for Proper Action based on the Warning

As a result of the community activity in this Study, community people agreed to evacuate to pre-designated evacuation places based on the warning and instruction of GN or community leaders, and the procedure for the evacuation has been confirmed by the exercise. The capacities for communities to react to event have been enhanced because some example of actual evacuation activity was observed during the flood events that occurred during the Study period.

5.1.2 Evaluation on CD for Flood Management and Early Warning System Planning

The set objective for the CD on the Flood Management and Early Warning System Planning is:

- At the end of the Study, a flood management plan and flood warning plan is to be prepared/revised based on the resources from Sri Lanka.

As for the CD for flood management planning, understandings for setting the planning principles, target flood scale and protection areas and alternatives have been deepened through the counterpart meetings. However, the capacity enhancement of simulation techniques for determination of the scale of facilities has not been achieved due to the small amount of time allocated for the operation of the simulation software.

Regarding the planning capacity for the early warning system, it is considered that the necessary capacity has already been acquired because the coordinating mechanism that DMC leads the discussion has been established, and the organizations concerned with the early warning system understood their role and responsibility.

5.2 Evaluation of CD on Individual Organizations

In this section, evaluations of CD on individual organizations are made. Table V-9 shows the results of the evaluation based on the CD plan and evaluation indicators that are shown in Table V-2.

Table V.9 Results of the evaluation based on the CD plan and evaluation indicators

	Individual Goals/Outputs	Indicators	Evaluation	Further Requirements on CD
DMC	・ Enhance capability as leading agency ・ Enhance capacity on Coordination, decision-making and information distribution	・ No. of meetings chaired by DMC ・ No. of workshops attended ・ No. of DM activities that DMC leads	As far as the EWE system planning and CBDM activities in this Study, DMC lead the meeting (more than 20 meetings for the EWE planning) and activities, and has been recognized as leading organization of DM. Implemented DM exercise 3 times. DMC counterparts attended all seminars and workshops including community activities. Dissemination capacity of disaster information has been increased however decision making and appropriateness on information dissemination still needs to be improved.	・ Repeated exercise ・ Further discussion on early warning ・ Prepare basic information for precise early warning
DOI	・ Enhance technical capabilities ・ Obtain capability to revise the plan by conducting engineering analysis ・ Complete flood monitoring network and set up of flood warning criteria ・ Obtain capability to issue warning without delay ・ Provide technical information on flood to community-based activity	・ No. of staff who can handle application for analysis ・ No. of staff who can operate flood monitoring system ・ Time for early warning issuance	Most of the staffs of the Hydrology division become familiar to the hydrological information system. Increment of staffs that can operate the application for simulation is limited. Warning criteria and time for early warning issue is not sufficiently improved.	・ Expanding early warning system to other river basins ・ Continuous monitoring and analysis on flood data ・ Further discussion on the flood early warning criteria with other organizations ・ Training on staff to acquire proper knowledge for early warning ・ Training on the hydrological information system and simulation software
NBRO	・ Enhance technical capabilities ・ Set warning criteria for landslide ・ Establish early warning system for landslide	・ No. of staff who can operate early warning system ・ Time for early warning issuance	The warning criteria have not decided in the Study and the early warning system for landslides has not completed yet, but the community level warning system has been progressed. Warning can be issued relatively in time and frequency of warning is increased.	・ Increase capacity on monitoring and analysis on landslide data ・ Continue hazard/risk assessment ・ Training on staff to acquire proper knowledge for early warning
DOM	・ Enhance technical capabilities ・ Obtain capability to forecast hazardous weather based on past experience ・ Obtain ability to provide real time based weather information to relevant organization including media in understandable manner	・ No. of skilled staff for forecasting ・ Frequency of information provision ・ Time for information provision	Realtime basis weather observation will be completed by the end of Feb. 2009. Capacity enhancement for forecasting weather based on the past experience is still not enough	・ Continuous monitoring and analysis on landslide data for enhancing a capability to issue landslide warning ・ Continue hazard/risk assessment ・ Training on staff to acquire proper knowledge for early warning

	Individual Goals/Outputs	Indicators	Evaluation	Further Requirements on CD
DDMCU	・ Enhance DM capacity in total ・ Obtain proper knowledge on hazard which happens in their place ・ Obtain proper knowledge on disaster management in mitigation, preparedness and response ・ Transfer proper disaster information in time with understandable manner	・ No. of workshops attended ・ No. of staffs who understand local disaster situation ・ Accuracy of information transferred	Capacity of DDMCU, especially target areas for the Pilot Project has been enhanced in general. Increased awareness on community- based activities and an early warning system can be seen from their attitude. However, in view of appropriateness, information dissemination capacity is still not insufficient level.	・ Continue and expand the activities that have been done in the Study ・ Training to DM coordinators and his staffs to acquire proper knowledge on DM ・ Expand the Intra-Gov. Network to other DDMCU offices
Sub-National Level Gov. Organization	・ Enhance DM capacity in total ・ Develop proper knowledge on hazard which happens in their place ・ Acquire proper knowledge on disaster management in mitigation, preparedness and response ・ Transfer disaster information properly	・ No. of workshops attended ・ No. of staff who understand local disaster situation ・ Accuracy of information transferred	Capacity of officers who participated workshops/seminars and exercises considered to be remarkably enhanced, and this shows they have sufficient capacity to deal with a part of DM activity especially in the early warning and CBDM. However, due to small number of target organizations, capacity in general not so much enhanced in the Study.	・ Continue and expand the activities that have been done in the Study ・ Training to sub-national government officers to acquire proper knowledge on DM
Community	・ Enhance DM capacity in total ・ Obtain proper knowledge of disaster and their role in disaster management ・ Ability to follow proper procedure in case of warning receive ・ Get ready in case of emergency ・ Formulate community-based disaster management organization ・ Coordinate community-based DM activity by themselves	・ No. of people attending workshops ・ No. of people who understand warning ・ Necessary time for evacuation ・ No. of activities organized by themselves	Knowledge and ability to cope with disaster in target communities are considered to be increased. Most of the people continuously participated to the workshop. Two landslide prone communities and two flood prone communities are started disaster mitigation activities by themselves. However, due to small number of target communities, capacity in general not so much enhanced in the Study.	・ Continue and expand the activities that have been done in the Study ・ Training to sub-national government officers to acquire proper knowledge on DM
Media/ Society	・ Increasing in involvement in disaster management ・ Allocate and achieve certain role in disaster management ・ Transfer proper disaster information or forecast through their media in time ・ Allocate space for synoptic weather chart on newspaper or broadcast synoptic weather chart regularly	・ No. of media groups that signed the MOU ・ Frequency of broadcast ・ Geographical coverage of media	Media people who attended the planning process and exercise of the Early Warning have got increased awareness on it, and appointed the focal point for disaster information dissemination. They have enough capacity to disseminate the information, if they have information in time, and it proved in case of the tsunami warning on Sep. 12, 2007. MOU with media could not be prepared in the Study.	・ Continue discussion on role of media/society in disaster management and how they can contribute

Source: JICA Study Team

Chapter 6 RECOMMENDATIONS

Based on the results and lessons learned from the capacity development activities that have taken place in this Study, the Study makes following recommendations for further enhancement of disaster management capacity.

- Recruiting of Talented Personnel and Human Resources Development in DMC and DDMCU

Recruiting a Talented Personnel

Although DMC is gradually improving its operational structure, they still face the shortage of skilled staff. The majority of the staff are hired on contract basis and their contract period is mostly two years. This causes instability of staffing in DMC. It is also considered that the short term contract is hindering the long-term development of human resources.

DDMCU is the key organization for the disaster management activities at the local level; however, many of the DM coordinators come to DDMCU from the military and their service periods are relatively short. For emergency response or disaster relief, their abilities might have advantages but for implementing the activities that meets the local needs, the persons who can stay in their service area for a longer period is required.

Therefore, reconsideration of the mode of recruiting/employing is recommended. In addition, to overcome the difficulty of recruiting qualified personnel, it is recommended to accommodate temporary transfer of qualified staff to DMC from other government sources for it to become more functional.

Human Resources Development

There are few people who have a background in disaster management. Thus, DMC should establish its own human resources development program, to train the personnel it needs to meet the requirements of the DMC activities.

Examples of the human resources development program will include: 1) training for new employee (basic course), 2) training for mid-level employee (basic and advanced program), 3) training for the DM coordinators, etc. The basic course will hold lectureson disaster mechanisms, disaster management theory and disaster management administration, while the advanced training course will provide enhanced knowledge on disaster management activity, decision making and communication ability.

In addition, cooperation with universities is also recommended for developing younger human resources. For receiving internship students in DMC to acquire talented personnel, lectures as well as recruit activity in the universities might have value.

- Capacity Enhancement of Local Level Government Organizations

Natural disasters are usually local events and local government organizations have to deal with these local disasters. However, in many cases, the capacities for managing disasters in local government organizations are very weak. These organizations have to be functional for effective disaster management activities, so the active implementation of CD activity targeting local government organizations is strongly recommended.

Through the exercises conducted in the Study, officials of local level government organizations were shown to have the capability to accomplish tasks if their tasks are clearly specified. Therefore for

enhancement of disaster management capacity in the local government level, role definitions for officials regarding disaster management and the capacity enhancement of individual officials are required. To define the roles of the officials, discussions among ministries in central level is required since the officials of the local governments (e.g. DS, SSO, GN) are dispatched by the central government and report to it. In addition, development of the training programs and its implementation for such officials are required.

- Preparation and Consolidation of the Information related to Disaster Management Activities and its Sharing

For formulation of the flood management plan, establishment of the early warning system and setting up the warning criteria for the target area in a proper way, it is necessary to prepare and consolidate the basic information such as topographic map, weather and hydrological data, hazard map, etc.

In case of Sri Lanka, meteo-hydrological information is accumulated in a relatively good manner, although it is recorded on paper for longer observation periods, while topographic information is not sufficient for the activities. Hazard maps have been prepared by various organizations; however, these maps were prepared for different purposes in different standards and scales, and thus they cannot be utilized in unified way. Although disaster information has been collected, detailed analysis, such as cause of disasters, cause of expanding impacts and countermeasures, etc. have not been conducted in most cases.

For implementation of the activities in an effective way, this basic information should be prepared based on a standardized format.

In concrete terms, the following are priority actions for preparation and consolidation of such information: a) preparation of base map and sharing (by DMC), b) construction of database for meteo-hydrological information (by DOM and DOI), c) periodic observation of river discharge and revision of rating curves (DOI), d) preparation of hazard maps and sharing (by DMC, DOI, NBRO), and e) collection and analysis of disaster related information and sharing & publishing the results (by DMC in collaboration with related organizations).

- Focus on Disaster Forecast and Adaptation of Climate Change

To mitigate the damage of natural disasters, it is necessary to forecast the disastrous events and warn the people in advance. The capacity for monitoring of meteo-hydrological information has considerably been enhanced through the Pilot Project of this Study. Also, Japan's grant aid project has provided AWS equipment to DOM although it is still not sufficient for forecasting very local events such as landslides.

In addition to the further development of the realtime-based monitoring capacity, the implementation of activities for enhancing the capacity for forecasting and issuing the warning are recommended.

Specifically, the capacities that needs to be enhanced are: short- and medium-range rainfall forecasting in DOM, flood water level variation forecasting in DOI and possibility of landslide occurrence in NBRO. To carry out the CD activities on these aspects, establishment of weather database and categorization of weather patterns that caused disasters, analysis on the correlation of water level gauging stations or rainfall stations, and analysis on the relationship between rainfall amount and landslide events are necessary.

On the other hand, the "Climate Change" may have a possibility to aggravate damages of natural disasters. Therefore, it is necessary and important to evaluate the impact of the climate change on disasters that may happen in Sri Lanka, and to consider how to adapt on the climate change to mitigate the damages.

- Implementation of Continuous and Repeated Disaster Management Activity

It is observed that understanding of action that should taken by the staff and operational skill using equipment have been enhanced by the repeated exercises in this Study. This confirms the importance of the repeated exercise. It is obviously important to expand similar exercises to other disaster prone locations, and at the same time, repeated exercises are also necessary for the organizations targeted in the Study.

The community-based disaster management (CBDM) activity has just taken off after the two years continuous and repeated activity during the Study. For further enhancement of the CBDM capacity and getting the commitment from the community for the CBDM, continuous activities in these particular communities are necessary. Therefore, it is recommended that at least one activity per year should be undertaken in these communities after completion of the Study as well as the expansion of the CBDM activity to other areas.

It is remarkable in terms of community effort of disaster management that some communities have started and are continuing monitoring rainfall and river water level. Communities should continue their efforts and technical organizations such as NBRO and DOI should analyze them and utilize them for the disaster management activities. Particularly, the rain gauge is very simple and its use can be expanded by Sri Lankan efforts as a part of the implementation of the non-structural measures for disaster management.

- Stronger Cooperation with Concerned Organizations

Early Warning

The Study recommends establishing a place for discussions for promoting stronger cooperation for issuing the early warning. The discussions should include the criteria and ways for information disclosure, and targets to create stronger cooperation especially between DMC and DOI for flood warning and DMC and NBRO for landslide warning.

All organizations in the discussion should go back to discussion on which kind of information should be disclosed and shared, and how the organizations share the information to reduce the damage of disaster. By sharing realtime information, for example, the technical organizations can concentrate on forecasting activity and local government organizations can be prepared in advance for response activities. Further discussions, including the discussions on disadvantages of keeping information within the organizations, are required to establish the most ideal way for the early warning and creation of stronger cooperation.

As mentioned in the recommendation of Part III, a memorandum that is agreed by the related organizations should be prepared based on the results of discussion.

Building Better Disaster Management Framework

The administrative framework that enables sharing and coordinating all disaster related information and measures among concerning organizations should be established. In this particular case, the concerned

organizations includes not only the organizations directly involved in the disaster management activity but also the organizations for urban planning (e.g. UDA, NPPD, Urban Council), and other sectors like the Ministry of Education.

In particular, for the first stage of building such an administrative framework, incorporating the disaster management viewpoints into development activities will be promoted by establishing a GIS-based database for hazard maps and disaster related information that is open to urban planning organizations and/or infrastructure development organizations.

For building better disaster management it is recommended to build strong cooperation with schools. The school are good and important forums to educate children about disasters and disaster management. However, the education sector of the government and teachers interest or awareness of disaster management is not high enough, and also their role in disaster management has not been clearly allocated. Hence, schools have not fully functioned in the disaster management activities as expected. With close cooperation of the Ministry of Education, activities for allocation of roles for the schools and teachers, and enhancing school education programs should be carried out.

Promoting such disaster management framework, DMC should establish two separate working groups to discuss the coordinated information sharing and role of schools and teachers under the NDMCC (National Disaster Management Coordinating Committee), and prepare the agreement on it within one year period for starting concrete actions.

- Establishment of Flood Management Division

The institutional arrangement for flood management in Sri Lanka is relatively weak because there is no department exclusively handling the flood issues in DOI which has the responsibility of flood management as typical example. To strengthen its flood management capacity, establishment of a Flood Management Division is recommended. There are some organizational options for flood management division such as independent organization, under DOI or MDMHR. With view of the technical capability, experience and accumulated information, DOI is the most suitable organization to house such department and thus the flood management division established in DOI is recommended.

The Flood Management Division should have total responsibility on flood management from planning, design and implementation, to operation and maintenance. Also, the division should have the responsibility for flood early warning including the determination of warning criteria. The flood management division should have the sub-divisions of planning, design and implementation, and hydrological monitoring and early warning.

The following table shows the responsible and implementing agency, priority and necessity of assistance for the abovementioned recommendations.

Table V.10 Recommendations

	Recommendation	Responsible Organization	Implementing Agency	Schedule	Necessity of Foreign Assistance
1	Recruiting of Talented Personnel and Human Resources Development in DMC and DDMCU	DMC	DMC, DDMCU	A~B	Technical assistance on the development of training program

	Recommendation	Responsible Organization	Implementing Agency	Schedule	Necessity of Foreign Assistance
2	Capacity Enhancement of Local Level Government Organizations	DMC	DDMCU, GA, DS, GN Provincial/Urban and Municipal Council Police	A	
3	Preparation and Consolidation of the Information related to Disaster Management Activities and its Sharing	DMC	DOM, DOI, NBRO Other technical Organizations Mn. of Environment Mn. of Education UDA, RDA, SLRDC Port Authority Survey Department, etc.	B	Technical assistance on standardization and ordering of required information
4	Focus on Disaster Forecast and Adaptation of Climate Change	DMC	DOM, DOI, NBRO Other technical Organizations	A~B	Technical assistance on capacity development on disaster forecast and climate change
5	Implementation of Continuous and Repeated Disaster Management Activity	DMC	DOM, DOI, NBRO DDMCU, GA, DS, GN Police, Community	A continuous	
6	Stronger Cooperation with Concerned Organizations	DMC	DOM, DOI, NBRO Other technical Organizations Mn. of Environment Mn. of Education Survey Department UDA, RDA, SLRDC Port Authority Police, etc.	A	
7	Establishment of Flood Management Division	DOI	DMC	C	Technical assistance on institutional arrangement

A: within one year, B: within 2 years, C: within 5 years
Source: JICA Study Team

Part VI:
Conclusion and Recommendations

PART VI CONCLUSIONS AND RECOMMENDATIONS

CAPTER 1 CONCLUSION

In the wake of the recent large-scale disasters especially the Tsunami disaster in December 2004, the disaster management system in Sri Lanka has changed meaningfully. While four years have passed since the devastating tsunami disaster and the memories of this catastrophe are fading with time, the Government of Sri Lanka is strengthening disaster management administration, particularly the strengthening of DMC. The Study also has greatly contributed for the development of the capacity of disaster management in Sri Lanka.

The outcomes of the Study are as follows:

The flood management plans for four major river basins of Kelani, Kalu, Gin and Nilwara which are located in the wet zone of the South-Western part of Sri Lanka were formulated, with a detailed action plan for Kalu River which was selected as the priority river basin for urgent implementation.

Regarding the early warning and evaluation (EWE) system planning, the overall plan for the EWE is presented in this report. During the Study period, the Hydrological Information System with meteo-hydro monitoring and communication equipment were installed in the Kelani and Kalu rivers, and the Intra-Governmental Network was also established for information sharing as pilot project. In the planning process of the EWE system, the participatory planning process and the exercise implementation scheme was introduced for enhancing the planning capacity of concerned organizations, verifying the appropriateness of plan, and familiarizing people with the system. Disaster management exercises were conducted three times during the Study.

As part of the community level disaster management activities, the Study Team selected 15 disaster prone communities and conducted two and a half years continuous community-based disaster management (CBDM) activities including five workshop sessions in each community. Through the CBDM activities, community people produced a hazard map for their village, formed disaster management committees, and conducted evacuation exercises and other small-scale disaster management activities. Based on good practice and lessons learned through the CBDM activities, a handbook and educational materials called “Fliptation” (a combination word of flip chart and presentation) for further activities that will be carried out by the disaster management concerning organizations were prepared by the Study Team.

In addition to the above mentioned visible output, through the day-to-day work with Sri Lankan organizations in the planning process of the flood management plan and the EWE, counterpart meetings, seminars, etc., the capacities for performing their task has been remarkably enhanced.

CAPTER 2 RECOMMENDATIONS

The outcomes presented in the previous section were obtained through the Study. Continuous activities in the disaster management sector need to be carried out by incorporating these outcomes to the activities done by the Sri Lankan side to date.

For further promotion of the disaster management in Sri Lanka, the Study makes the following recommendations:

- Authorizing the plans presented in this Report and their early implementation
  (Responsible Organization: DMC, As early as possible)

First of all, immediate authorization of the plans proposed in the Study as national or government plans is strongly recommended since their benefits for local communities are large. It is also recommended that the organizations concerned take necessary actions such as budget allocation etc. for the implementation and implement the measures including structural measures in accordance with the proposed implementation plan.

Additionally, it is recommended that future disaster management activities, especially the activities that require foreign capital and technical assistance, should be implemented as a package consisting of structure measures, CBDM, early warning and evacuation and others.

- Establishment of DMC's core areas and implementing focused activities in them
  (Responsible Organization: DMC)

About four years has passed from the establishment of Disaster Management Centre (DMC), the environment surrounding the DMC is changing. As mentioned in the previous sections, the DMC's function is gradually being enhanced' however, their abilities are still limited to some extent. Therefore, DMC should establish core activity areas and focus their activity in them.

As the guiding and coordinating body, DMC should establish a disaster management platform for Sri Lanka especially focused on: 1) institutional framework, 2) coordination on the disaster management activities such as preparation of hazard maps, early warning system, disaster management exercise and implementation of structural measures, 3) community based disaster management, and 4) guiding of research and human resources development.

- Preparation, consolidation and sharing of the information related to the disaster management
  (Responsible Organization: DMC, Within 1 to 2 years)

It is a basic requirement to prepare, consolidate and share basic information related to disaster management (such as topographical maps, meteo-hydrological information, land use, etc., hazard maps, disaster records, disaster management plans and measures) and other required information for appropriate implementation and creating cooperation with concerned organizations for disaster management. The DMC should promote such activities.

Construction of a database for basic information and publishing an annual book on disaster management (a white paper for disaster management) are examples of promotional activities. By publishing a general policy on disaster management, record of disasters that happened in the previous year, the measures taken to mitigate disasters, etc. in the white paper for disaster management, many kinds of information will be consolidated and can be shared.

- Implementation of the structural measures
  (Responsible Organization, DOI, NBRO and other technical organizations, As early as possible depending on the allocated budget)

It is obviously important to implement the early warning and community-based disaster management for reducing damage; however these activities cannot prevent hazardous events. To create a safer living environment, external forces that cause the disasters should be addressed by the structural measures. Therefore, promotion of implementation of the structural measures is also recommended.

In addition to the flood disaster that this report has already proposed structural measures for, it is strongly recommended that a plan for the structural measures for sediment disasters that cause many human casualties should be prepared, based on the geological investigation, monitoring and assessment of the risks at site, and implemented.

- Definition and designation of the disaster areas, conservation areas and public water body in written format
  (DMC with collaboration of other related organizations, Within 2 years)

It is recommended to have a clear definition and designation of the disaster areas, conservation areas and public water body in written format. It is also recommended to prohibit and/or control the development activities in the area that are disaster prone. Such activities lead to appropriate land use from the disaster management viewpoint and are important as nonstructural measures. The required process includes identification of the disaster areas and public water bodies based on the existing land use and natural conditions, setting the boundaries for the areas, and publishing this material for the public.

- Incorporating disaster management into development and enforcement of Disaster Impact Assessment (DIA)
  (DMC with collaboration of other related organizations, Within 2 years)

Ensuring guidance or instruction to incorporate disaster management viewpoints into the development activities is recommended. It is also recommended to introduce the Disaster Impact Assessment (DIA) into all developments. Currently, Environmental Impact Assessment (EIA) is enforced to the development activity and it is practical that DIA be conducted together with EIA, especially for large-scale development.

- Promotion of cooperation among concerned organizations
  (Responsible Organization: DMC, As early as possible)

Many organizations are involved in the disaster management. For effective implementation of the proposed measures and recommendations presented in this report, close cooperation among the organizations concerned is indispensable. For early realization of a safer society, building a good relationship among the organizations concerned, cooperation among them, and promoting implementation of disaster reduction measures are desirable.