H. Non-Structural Measures

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H. NON-STRUCTURAL MEASURES

1 GENERAL

In this supporting report, detailed results of the study on non-structural measures are described. Firstly, basic concept of non-structural measures applied in the Study is shown in Chapter 2. Chapter 3 explains study methodology and output of the Study. Among many non-structural measures, preliminary studies on flood warning system and baseline activities for watershed management have been conducted in the Study. Those results are summarized in Chapters 4 and 5, respectively. Finally, recommendation on other measures for model river basins is summarized in Chapter 6.

2 BASIC CONCEPT OF NON-STRUCTURAL MEASURES

2.1 Process of Natural Disaster

Both structural measures and non-structural measures are important to reduce damage in natural disaster. Figure H.2.1 shows a typical process of natural disaster. An extreme event such as heavy rainfall causes a hazard like flooding. The hazard does not always make damages. For example, if there are no people living in flooding areas and no properties there, damages seldom occur. How the hazard makes the damages under the given condition of hazard is strongly related to social vulnerability including the following factors:

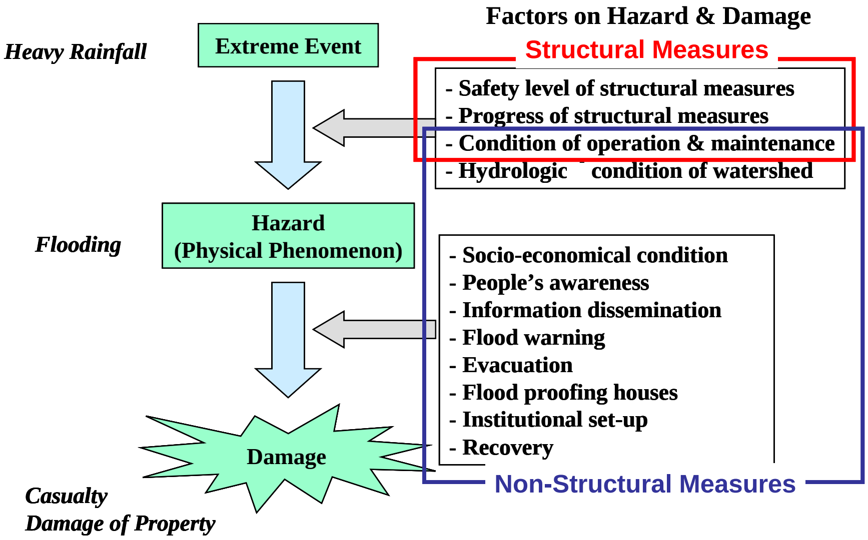
(a) Socio-economical condition,
(b) People's awareness,
(c) Information dissemination,
(d) Flood warning,
(e) Evacuation,
(f) Flood proofing houses,
(g) Institutional set-up, and
(h) Recovery.

By enhancing disaster management, which is one of non-structural measures, the social vulnerability against hazard can be reduced.

On the other hand, how severe hazard occurs under the given condition of extreme event is related to the condition of structural measures. If there is enough working structural measures for certain safety level, there will be no hazard under the extreme event which is less than the safety level set.

Condition of operation and maintenance (O&M) is also important for reducing hazard. For example, a channel is full of garbage and/or sediment, it does not work and can not prevent flooding. Under this condition, to promote more ensured O&M, non-structural measures such as enhancement of community-based activities for supporting O&M is sometimes necessary.

Hydrologic condition of watershed is also one of control factors for hazard. When one makes a plan for structural measures, one has to assume the hydrologic condition of watershed to estimate runoff volume and pattern for the planned safety level. Therefore, if the hydrologic condition alters drastically, the safety level of structural measures may change. Non-structural measures to keep the assumed hydrologic condition of watershed or to make even better hydrologic condition are necessary to ensure the effect of structural measures.



Source: JICA Study Team

Figure H.2.1 Process of Natural Disaster

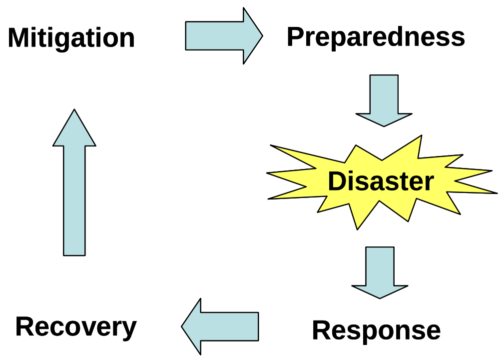
The purpose of non-structural measures can be categorized as shown in the following table:

Table H.2.1 Purpose of Non-Structural Measures

Purpose		Examples for Flood-Related Disaster
1	To ensure the effect of structural measures to mitigate hazard condition	• To prevent more severe runoff condition than a planned condition due to unregulated land use • To prevent severe sediment load condition as much as possible so that maintenance of structure is easier • To prevent severe clogging of channel by sediment and garbage
2	To reduce vulnerability against flood-related hazard	• Enhancement of preparedness • Enhancement of response & recovery activities

2.2 Menu of Non-Structural Measures

In the present Study, the well-known cycle of disaster management is referred as shown in Figure H.2.2. The cycle of disaster management consists of mitigation, preparedness, response and recovery.



Source: JICA Study Team

The Concept of Disaster Cycle was proposed by FEMA (FEMA: Federal Emergency Management Agency)

Figure H.2.2 Cycle of Disaster Management

For each stage of disaster management, several non-structural measures can be applied as shown in the following table:

Table H.2.2 Menu of Non-Structural Measures for Each Stage of Disaster Cycle

Source: JICA Study Team

To ensure the effect of structural measures to mitigate hazard condition	
Mitigation	• Land use regulation • Afforestration & Reforestation • O&M supported by local residents including preventive activity against encroachment
To reduce vulnerability against flood-related hazard	
Mitigation	• Flood proofing structures
Preparedness	• Emergency, evacuation and post-flood plan • Hazard map • IEC • Monitoring / Flood forecasting and warning
Response	• Information dissemination • Flood fighting • Evacuation • Reporting of disaster condition • Rescue activity • Supporting from neighboring LGUs
Recovery	• Post-flood damage assessment • Rehabilitation • Insurance

3 STUDY METHODOLOGY

3.1 Selected Model River Basins

Among the selected river basins by the Second Screening in the present Study, 6 model river basins have been selected for model study for formulating a flood mitigation plan. The selection has been made in order to include different flood disaster patterns and different regions. The purpose of the study for the model river basin is to show typical example for formulating a flood mitigation plan for flood disaster with different patterns and regions. List of the selected 6 model river basins are shown below.

Table H. 3.1 List of Selected 6 Model River Basins

Group	Name of River Basin	Region	Catchment Area (km^2)	Ranking
F+O+B, F+B Type	Ilog-Hilabangan	VI and VII (Visayas)	2,162	30
O+B Type	Dungcaan	VIII (Visayas)	176	47
F+O, O, F Type	Meycauayan	III and NCR (Luzon)	201	7
F+O+B+I, F+I Type	Kinanliman	IV-A (Luzon)	10	25
F+O+I, F+I+B, F+I Type	Tuganay	XI (Mindanao)	747	32
F+O+B+I+L Type	Dinanggasan	X (Mindanao)	29	16

** F: Flash Flood, O: Overflow, B: Bank Erosion, I: Inland Flooding, L: Lahar and/or Debris Flow*
Source: JICA Study Team

Based on the results of the First Screening for the selected 6 model river basins and questionnaires provided to the model river basins during the Second Screening, the characteristics of the model river basins with regard to flood disaster are summarized as shown in Table H.3.2. Considering these characteristics, the study has been conducted.

Table H.3.2 Characteristics of the Selected 6 Model River Basins

River Basin	Region	Related Province	Related Minucipality & City	Watershed Area (km2)	Urban or Rural	Time scale of flood wave	Type of Flood (main)	Damage	Largest Damage in Recent Years		Existing Non-Structural Measures	Existing Study		Remarks
Ilog-Hilabangan	VI VII	1) Negros Occidental 2) Negros Oriental	1-1) Kabankalan 1-2) Himamaylan 1-3) Ilog 1-4) Cauayan 1-5) Candoni 2-1) Bayawan 2-2) Mabinay 2-3) Tanjay 2-4) Bais 2-5) Manjuyod 2-6) Bindoy 2-7) Ayungon 2-8) Tayasan 2-9) Jimalalud	2,162	Basically rural, city exists	a day	Overflow	Property damage	1990	Flood area:22,400ha Flood duration:5days Dead:11, Injured: 36 Affcted people:78,380 Affected houses:908	Flood Warning Preparedness Plan	JICA M/P 1989	1/25	Model case for a large river basin with wide agricultural area and a few cities.
Dungcaan	VIII	Leyte	1) Baybay 2) Inopacan	176	Basically rural, city exists	Several hours	Over flow	Casulaity (Only injured)	1972	Flood area:10ha Affcted people:10,000 Affected houses:250	No	N/A		Model case for small river with agricultural area and a city.
Meycauayan	III NCR	1) Metro Manila 2) Bulakan	1-1) Valenzuela 1-2) Calookan (North) 1-3) Quezon 2-1) Meycauayan 2-2) Obando 2-3) Marilao 2-4) Santa Maria 2-5) San Jose Del Monte	201	Highly urbanized area	Several hours	Over flow, high tide	Property damage	2002	Flood duration:5days Dead: 1 Affcted people:19,800 Affected houses:300+6300(partially)	Information Campaign	2001:F/S Valenzuela-Obando-Meycauayan (VOM) area drainage system improvement project	1/30 (drainage: 1/10)	Model case for a river basin with rapidly urbanizing raea Study for VOM area has been completed wuth F/S level. In this study, the F/S for VOM will be reviewed and its result is utilized.
Kinanliman	IV-A	Quezon	Real	10	Rural	Less than a hour	Flash flood with debris	Casuality	2004		Flood Warning F lood Fighting Hazard Maps Preparedness Plan	FCSEC Study (DD for urgent improvement) 2006	1/25	Model case for a basin in rural area with potential risk for flash flood with debris. FCSEC has already conducted a study.
Tuganay	XI	1) Davao del Norte 2) Davao	1-1) Carmen 1-2) Dujali 1-3) Santo Tomas 1-4) Panabo 1-5) Talaingod 2-1) Davao	747	Basically rural, city exists	Several hours to a day	Overflow	Property damage	2004	Flood area: 15km2 Flood duration: 5days	Flood Warning Hazard map Preparedness plan Watreshed management	Preliminary Design of Liboganon River Dike Extension, 1998 (for Linoganon River basin)	1/25	Model case for a middle size river basin with wide agricultural area. Next basin is Tugum-Lobiganon river basin, one of major river baisns.
Dinaggasan	X	Camiguin	1) Catarman	29	Rural Povety Index high	Less than a hour	Debris and/or Lahar	Casuality Property damage	2001	Dead: 166 Injured: 146 Disappearance: 84	Hazard Maps Preparedness Plan	Structural：JICA Study 2003 Non-structural：JICA Study 2004		Model case for a basin in rural area with potential risk for debris and Lahar. In the Camigin island, JICA studies have been conduted

3.2 Study Items and Procedures

The Study started at the middle of September, 2007 and ended at the end of November, 2007. The procedure of the study is shown in Figure H.3.1

First of all, basic idea on non-structural measures were shown to and discussed with C/P engineers. The idea was basically agreed and some parts were modified based on the discussion.

Although the time available for the Study was quite limited, the field study was inevitable study item. Without directly seeing and feeling actual situation of the field and without directly meeting and discussing with the people related, nothing realistic could have been produced. The initial idea for the items of field study was firstly prepared by the Study Team, referring to the results of 1st Stakeholder Meeting held at the end of July, 2007. It was then modified through discussions with C/P engineers in DPWH. The items of the field survey are, as follows:

(a) Interview from personnel related to non-structural measures in the basin
- LGUs, DPWH, DENR, DCC, NIA, PAGASA, etc.

(b) Ocular inspection of site with interview

(c) Workshop
- Self-evaluation of existing non-structural measures

Representative of C/P engineers in DPWH and two or three Study Team members (one is in charge of non-structural measures and others are in charge of structural measures) visited to all of the model river basins for the filed study. The field study was conducted with great support from DEO of DPWH, LGUs and other related agencies. Totally 6 weeks (1 week for 1 river basin) were used for the field study. After the filed study, the results were compiled, and the issues and recommendations were summarized based on them.

Through the field survey, among the several menus for non-structural measures for the purpose 1 (*To ensure the effect of structural measures to mitigate hazard condition*), it is considered that watershed management is one of key and common measures among all model river basins. In the present study, further preliminary study for potential soil loss as well as checking of condition of watershed management activities using available information has been conducted.

Based on the preliminary study, in the present study, it is recommended that at least minimum necessary activities related to flood mitigation be implemented as baseline activities on watershed management. The cost for the recommended activities is also roughly estimated.

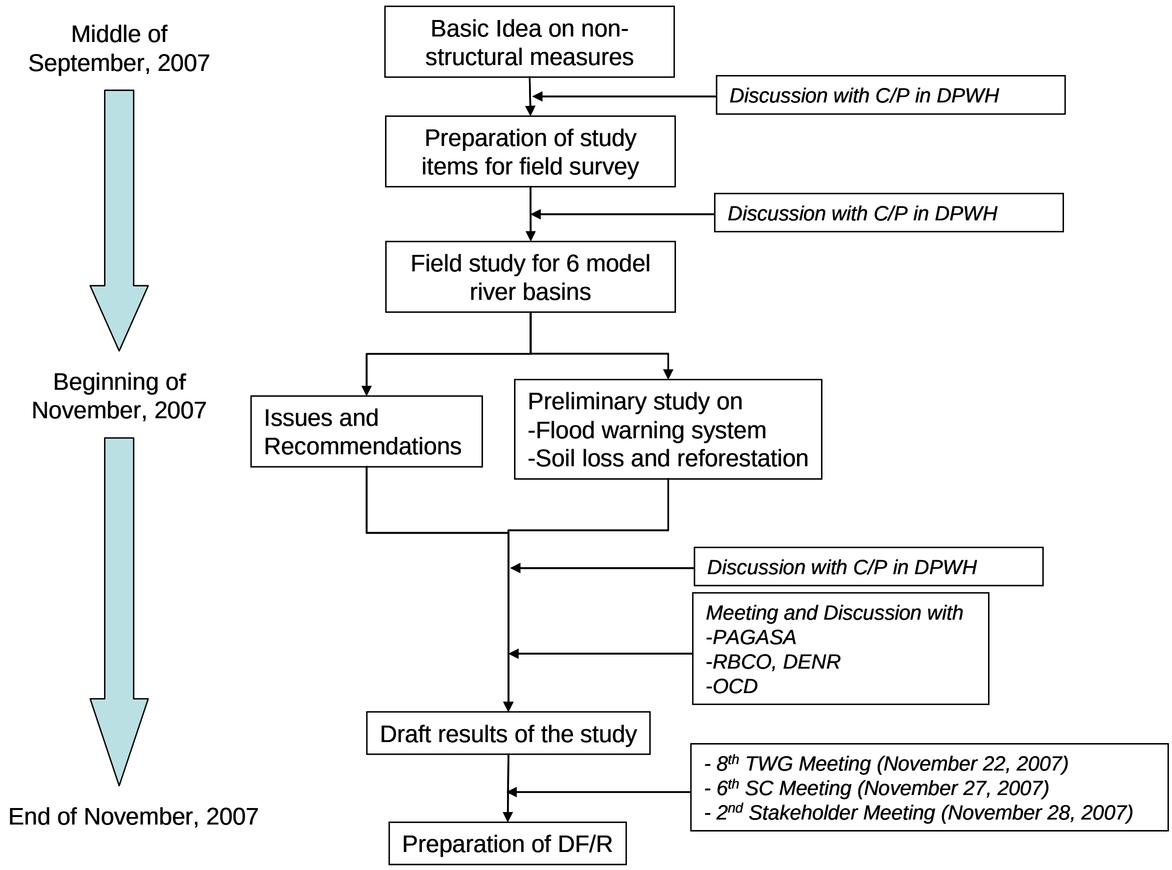
Among the several menus for non-structural measures for the purpose 2 (*To reduce vulnerability against flood-related hazard)*, it is considered that flood warning system and related matters are one of key and common measures among all model river basins. Therefore, further preliminary study for possible benefit by flood warring system has been conducted. Based on the study, recommended flood warning system for each river basin is shown together with rough cost estimation.

There are some recommendations for each river basin considering its specific characteristics based on the filed survey. They are summarized as recommendations for other measures.

Because non-structural measures are related not only to DPWH but also to other agencies, the basic ideas and findings based on the study were shown to and discussed with the representative of the other agencies, especially for the following agencies:

(a) PAGASA for flood warning system
(b) River Basin Control Office (RBCO), DENR for watershed management
(c) OCD for disaster management

The results of the discussion were reflected to the recommendation made by the study. The draft results of the study were presented in 8th Technical Working Group meeting, 6th Steering Committee Meeting and 2nd Stakeholder Meeting at the end of November, 2007. The contents of the draft results were basically accepted by them.



Source: JICA Study Team

Figure H.3.1 Study Items and Procedures

3.3 Outputs of the Study

Based on the study items and procedures shown in the above, the following outputs have been prepared in the study:

(a) Output 1: Results of Field Study
- Record of interview
- Photos of site condition with coordinate (location) and explanation
- Results of workshop

(b) Output 2: Recommendation on Flood Warning System and Related Matters
(c) Output 3: Recommendation on Baseline Activities on Watershed Management
(d) Output 4: Recommendation on Other Measures

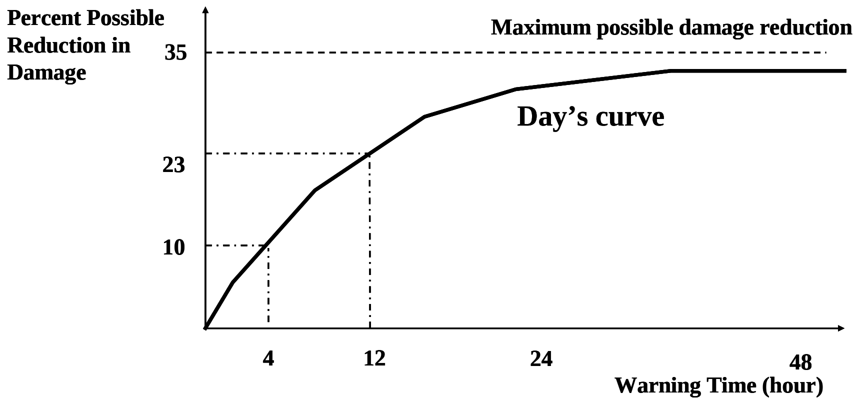
The output 1 has been summarized as a digital version and it has been delivered to DPWH. The outputs 2, 3 and 4 are described in the later sections. It should be reminded that the study is preliminary level because of limited time frame and resources. Only three months for all of 6 model river basins were given to the study. Therefore, the study concentrated to discuss general direction of flood mitigation using currently available information. Further detailed study toward implementation of flood mitigation measures is recommended at the next stage such as feasibility study.

4 RECOMMENDATION ON FLOOD WARNING SYSTEM

4.1 Basic Idea on Possible Benefit of Flood Warning System

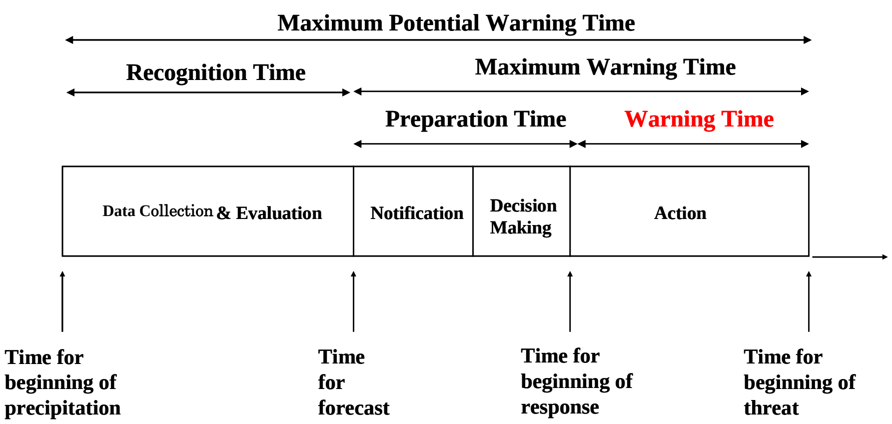
If people can know threat of flood before the actual threat starts, people can prepare and act to mitigate flood damage. For example, movable asset can be moved to safety place. This is important benefit provided by flood warning system (FWS).

There are several studies on how to estimate the reduction of damage by flood warning system. How much damage is reduced is depending on mainly warning time, which is determined as the time for action for mitigation. The percent possible reduction in damage as a function of warning time can be expressed by Day's curve developed in United States, as shown in Figure H.4.1. To apply the curve, it may be better to consider local socio-economical condition.



Source: HEC-HMS Application Guide, modified by JICA Study Team

Figure H.4.1 Schematic Draw of Day's Curve



Source: Carsell et al (2004), ASCE, modified by JICA Study Team

Figure H.4.2 Warning Time

The maximum potential warning time is determined as the time for beginning of threat minus the time for beginning of precipitation as shown in Figures H.4.2. It is strongly related to hydrological property of watershed. The warning time is the maximum potential warning time less (1) recognition time, (2) the time for notification, and (3) the time for decision making.

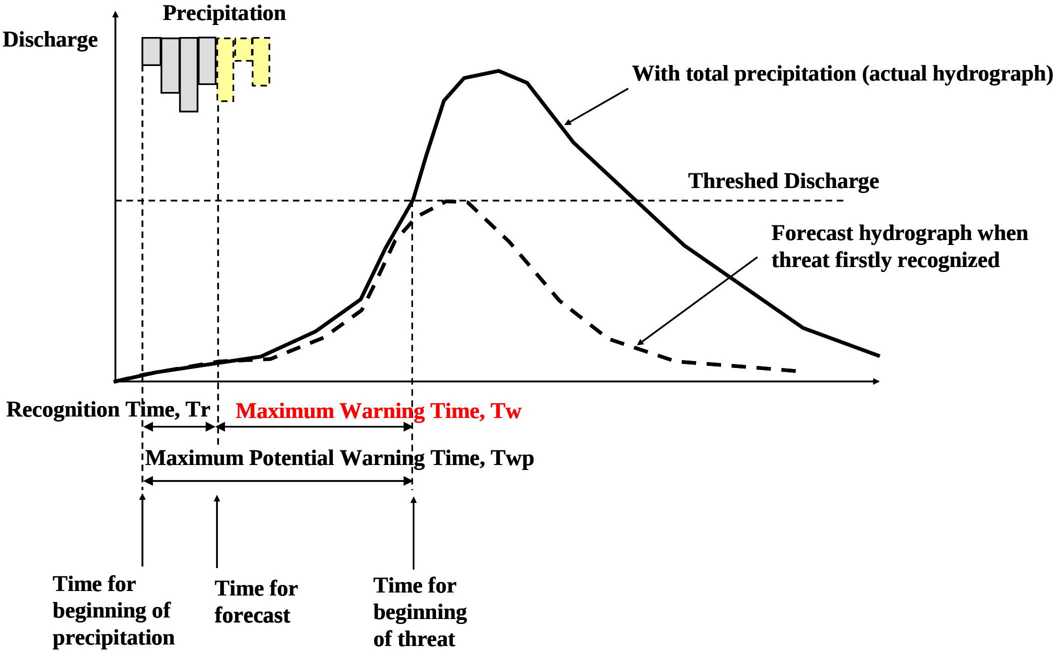
4.2 Procedure for Estimating Warning Time

The expected warning time can be calculated considering several extreme events with different return period as follows:

$$E[T_w] = \int T_w(p)dp$$

where $E[T_w]$ = the expected value of warning time, p = annual exceedance probability (AEP) of the event considered; and $T_w(p)$ = the warning time for an event with specified AEP.

Figure H.4.3 shows how the warning time will be computed for each event. The solid line in the figure expresses actual hydrograph. This will occur when the entire rainfall event has occurred. The time that passes between the onset of the rainfall and the exceedance of the threshold is the maximum potential warning time, *T.*



Source: HEC-HMS Application Guide, modified by JICA Study Team

Figure H.4.3 Warning Time Components

The recognition time, T_r in the figure is determined as the time that passes before the threshold exceedance can be detected. Without the FWS, T_r will approach T_{wp}, and little or no time will remain for notification and action. The maximum warning time, T_w, is then the difference between T_{wp} and T_r.

Using rainfall-runoff analysis, recognition time, T_r, can be estimated for extreme events with different return period. By changing the precipitation duration, rainfall-runoff analysis is conducted. Then, if precipitation duration is long enough to produce the threshed discharge, its duration indicates the recognition time. The extreme event which is smaller than certain return period would not provide the discharge that exceeds the threshed value. Such events are not used for calculating the expected value of the warning time. In other words, conditional probability is used for computation of the expected warning time.

4.3 Efficiency of Flood Warning System

How flood warning system works is depending on its efficiency. The actual benefit could be computed by the following manner:

(Actual Benefit) = (Possible Reduction of Damage) x (Efficiency)

The efficiency is mainly determined by social factors. Carsell et al (2004), ASCE, shows one of methods to estimate the efficiency of flood warning system, as follows:

(Efficiency) = F_1 x F_2 x F_3

where F_1 = Fraction of the public that receives a warning, F_2 = Fraction of the public that is willing to respond, and F_3 = Fraction of the public that knows how to respond effectively and its capable of responding (or has someone to help them). It is set that the maximum efficiency is 0.8 in this case. The efficiency can be increased by enhancing disaster management.

4.4 Evaluation of Possible Benefit of Flood Warning System for Model River Basins

In the present study, possible benefit of flood warning system for the model river basins are estimated under the following assumptions:

(a) Damage to be considered for benefit of flood warning system
- Tangible: Movable asset in built-up area is considered.
- Intangible: Not considered (Causality is not taken into account)

(b) Annual average damage
- The damage for the event with certain safety level is converted to annual average damage with excess flood using the coefficient estimated from several previous study reports in the Philippines.
- Future damage value used in the Second Screening of this study is applied.

(c) Damage reduction rate by flood warning
- Day's curve is applied.

(d) Hydrograph
- SCS unit hydrograph with uniform precipitation is assumed.

(e) Efficiency of flood warning system
- The most efficient condition is assumed to evaluate potential benefit of flood warning system. (Efficiency) = 0.8 is assumed.

(f) Time for preparation
- For large and inter-regional river basin: 120 min
- For medium and inter-regional or inter-provincial river basin: 60min
- For small river basin: 30min

(g) Threshed discharge

- For the case with proposed structural measures
  - Discharge with the return period under the safety level of proposed structural measures
- For the case without proposed structural measures
  - Existing flow capacity if it is more than the discharge with 5-year return period
  - Discharge with 5-year return period, if existing flow capacity is less than discharge with 5-year return period

It should be remained that intangible damage such as causality is not taken into account in the analysis.

The results of analysis are summarized in Tables H.4.1 and H.4.2, which show the results for the case without proposed structural measures and the results for the case with proposed structural measures, respectively. Calculation sheets are shown in Annex H.1.

Table H. 4.1 Possible Benefit by Flood Warning System in Case without Proposed Structural Measures

	Area (km^2)	Time of Concen-tration (min)	Return period of Threshed Discharge	Expected Maximum Warning Time (min)	Time for Prepa-ration (min)	Maximum Warning Time (min)	Annual Ave. Damage Reduction by FWS (mil. Pesos)	Benefit Index (mil. Pesos)
Ilog-Hilabangan	2,162	939	1/8	259	120	139	14.34	48.75
Dungcaan	176	264	1/5	69	30	39	0.30	1.01
Meycauayan	201	362	1/5	99	60	39	7.38	25.09
Kinanliman	10	48	1/5	10	30	N/A	N/A	N/A
Tuganay	747	492	1/5	143	60	83	7.17	24.39
Dinanggasan	29	72	1/5	17	30	N/A	N/A	N/A

Source: JICA Study Team

Table H.4.2 Possible Benefit by Flood Warning System in Case with Proposed Structural Measures

	Area (km^2)	Time of Concen-tration (min)	Return period of Threshed Discharge	Expected Maximum Warning Time (min)	Time for Prepa-ration (min)	Maximum Warning Time (min)	Annual Ave. Damage Reduction by FWS (mil. Pesos)	Benefit Index (mil. Pesos)	Cate-gory
Ilog-Hilabangan	2,162	939	1/25	248	120	128	4.82	16.39	*B*
Dungcaan	176	264	1/20	67	30	37	0.09	0.32	*C*
Meycauayan	201	362	1/30	89	60	29	1.29	4.37	*B*
Kinanliman	10	48	1/25	10	30	N/A	N/A	N/A	*C*
Tuganay	747	492	1/25	125	60	65	1.64	5.56	*B*
Dinanggasan	29	72	1/20	17	30	N/A	N/A	N/A	*C*

Source: JICA Study Team

The river basins can be categorized into the following three categories based on the evaluation:

Table H.4.3 Category for Flood Warning System

Category	Expected Benefit	Recommended Warning System
A	• Tangible damage **can** be reduced by flood warning system and its **benefit is very large.**	• **Sophisticated System such as Telemetry System**, which is usually costly, is recommended.
B	• Tangible damage **can** be reduced by flood warning system.	• **Community Based Flood Early Warning System (CBFEWS),** which PAGASA is now introducing, is recommended.
C	• Reduction of tangible damage would be **minimal** by flood warning system, because of no or little warning time. • B/C < 1 is expected. However, the warning system should be prepared as “**Civil Minimum**”.	• **Community Based Flood Early Warning System (CBFEWS),** which PAGASA is now introducing, is recommended. However, disaster management should consider more on “response” including information dissemination and evacuation than “forecast” in order to reduce causality. • Direct monitoring of water level may be more useful for decision making.

Source: JICA Study Team

4.5 Recommended Flood Warning System for Model River Basins

Based on the evaluation shown in the previous section, recommended flood warning system for each model river basin is summarized in Table H.4.4.

Table 4.4 Recommended Flood Warning System for Model River Basins

River Basin	Recommended System	Remarks
Ilog-Hilabangan	CBFEWS	➢ It is expected that there is a difficulty of inter-Regional communication between Region 6 and 7. Slight modification is necessary. For example, as a first step, for the warning system for Kabankalan and Ilog area, the system without using the information in Region 7 could be tentatively set. Instead of measurement of precipitation in region 7, direct measurement of river discharge at boundary of region 6 and 7 can be utilized, although warning time may be reduced. ➢ Considering that the Ilog-Hilabangan River Basin is one of major river basins, more sophisticated system might be introduced in future. However, it is recommended to start simpler and less costly system with establishing good communication in the basin.
Dungcaan	CBFEWS	➢ PAGASA is now introducing CBFEWS in Southern Leyte. Almost same scheme can be applied into the Dungcaan River Basin. Because time of concentration of flood wave is small, it is very difficult to get benefit by reduction of tangible damage by introducing the flood warning system. Disaster management should consider more on "response" including information dissemination and evacuation than "forecast" in order to reduce causality when the flood warning system is introduced ➢ Park stations, which are proposed as one of other measures, can be utilized also for the monitoring station for the flood warning system.
Meycauayan	CBFEWS	➢ It is expected that there is a difficulty of inter-Regional communication between Region 3 and NCR. However, the Meycauayan River Basin is rather compact. Close communication between the municipalities in Region 3 and those in NCR is not impossible. It should be enhanced more through cooperative activities recommended as one of other measures.
Kinanliman	CBFEWS	➢ Almost same scheme as the PAGASAs system can be applied into the Kinanliman River Basin. Because time of concentration of flood wave is small, it is very difficult to get benefit by reduction of tangible damage by introducing the flood warning system. Disaster management should consider more on "response" including information dissemination and evacuation than "forecast" in order to reduce causality when the flood warning system is introduced.
Tuganay	CBFEWS	➢ Basically same scheme as PAGASAs system can be applied. ➢ However, special treatment of mountain area belonging to another province (Davao) should be considered when the warning system is established.
Dinanggasan	CBFEWS	➢ Almost same scheme as the PAGASAs system can be applied into the Dinanggasan River Basin. Because time of concentration of flood wave is small, it is very difficult to get benefit by reduction of tangible damage by introducing the flood warning system. Disaster management should consider more on "response" including information dissemination and evacuation than "forecast" in order to reduce causality when the flood warning system is introduced. ➢ PHIVOLCS's role is important for supporting the flood warning system.

4.6 Rough Cost Estimation

Cost for flood warning system is roughly estimated based on the following:

(a) Community Based Flood Early Warning System (Initial Setting)

- 1.5 million pesos / province
  - ➢ For large river basin, increasing factor is considered.
- 0.3 million pesos / small river basin

(b) Operation & maintenance cost

- Refinement of warning system including checking of equipment (Once 3 years)
  - ➢ 20% of the cost for initial setting
- Cost for voluntary stuff for monitoring
  - ➢ 800 pesos/ month/man

There is an option to utilize advanced SMS communication system in community-based system. However, it is still experimental and further study is required at the next stage such as F/S. It may cost about 300,000 pesos per gauge.

The following table shows the roughly estimated cost for each river basin.

Table H.4.5 Roughly Estimated Cost of Flood Warning System for Each River Basin (Total in 26 Years)

River Basin	Cost for Initial Setting (mil. Pesos)	Total Cost for O&M for 26 years (mil. Pesos)	Total Cost for 26 years (mil. Pesos)
Ilog-Hilabangan	6.0	12.1	18.1
Dungcaan	0.3	1.2	1.5
Meycauayan	3.0	6.0	9.0
Kinanliman	0.3	1.2	1.5
Tuganay	1.5	3.6	5.1
Dinanggasan	0.3	1.2	1.5

Table H.4.6 Cost Breakdown for Flood Warning System

	Unit Cost for Initial Setting	Number of Basin or Province	Incresing Factor considering modification	Cost for initial setting	Percent of cost for revision	Cost for revison per revison	Number of revison for 26 years	Cost for revison for 26 years
Ilog-Hilabangan	1.5 million pesos /province	2	2	6 million pesos	20	1.2 million pesos/rev	8	9.6 million pesos
Dungcaan	0.3 million peso/ basin	1	1	0.3 million pesos	20	0.06 million pesos/rev	8	0.48 million pesos
Meycauayan	1.5 million pesos /province	2	1	3 million pesos	20	0.6 million pesos/rev	8	4.8 million pesos
Kinanliman	0.3 million peso/ basin	1	1	0.3 million pesos	20	0.06 million pesos/rev	8	0.48 million pesos
Tuganay	1.5 million pesos /province	1	1	1.5 million pesos	20	0.3 million pesos/rev	8	2.4 million pesos
Dinanggasan	0.3 million peso/ basin	1	1	0.3 million pesos	20	0.06 million pesos/rev	8	0.48 million pesos

	Unit Cost for Observoir	Number of observoir	Total months for 26 years	Cost for Observoir	Total Cost for O&M for 26 years	Total Cost for 26 years
Ilog-Hilabangan	800 pesos/month/man	10	312	2.496 mil pesos	12.096 mil pesos	18.096 mil pesos
Dungcaan	800 pesos/month/man	3	312	0.749 mil pesos	1.2288 mil pesos	1.5288 mil pesos
Meycauayan	800 pesos/month/man	5	312	1.248 mil pesos	6.048 mil pesos	9.048 mil pesos
Kinanliman	800 pesos/month/man	3	312	0.749 mil pesos	1.2288 mil pesos	1.5288 mil pesos
Tuganay	800 pesos/month/man	5	312	1.248 mil pesos	3.648 mil pesos	5.148 mil pesos
Dinanggasan	800 pesos/month/man	3	312	0.749 mil pesos	1.2288 mil pesos	1.5288 mil pesos

5 RECOMMENDATION ON BASELINE ACTIVITIES ON WATERSHED MANAGEMENT

5.1 Overview of Existing Condition of Watershed Management in Model River Basins

Table H.5.1 summarizes the existing condition of watershed management in the model river basins. Usually, watershed characterization is necessary to prepare watershed management plan. Among 6 model river basins, only the Dinanggasan River Basin has an existing complete watershed management plan. In the Tuganay River Basins, watershed management plan is under developing, but is going to be finalized soon.

The Ilog-Hilabangan River Basin and the Meycauayan River Basin are shared by different two regions. Inter-regional management is necessary for those basins.

Table H.5.1 Existing Condition of Watershed Management in the Model River Basins

	Watershed Characterization	Watershed Management Plan	Remarks	Institutional Issues
Ilog-Hilabangan	△	△	• Watershed Characterization in the Hilabangan River Basin is on-going. • River Basin Council is established in the Hilabangan River Basin.	Inter-Regional Management
Dungcaan	×	×		
Meycauayan	×	×	• Almost all of land is already Alienable & Disposable Land.	Inter-Regional Management
Kinanliman	×	×	• Watershed Management Plan for the Agos River Basin can be referred. • River Basin Council for the region including the Agos River Basin has been established.	
Tuganay	○	○	• Watershed Management Plan for the part of Davao Del Norte is going to be finalized soon.	Inter-Provincial Management
Dinanggasan	◎	◎	• Watershed Management Plan already exits.	

Note: □: Existing, ○: Prepared Soon, □: Under Preparation Partially, × : Not Existing

Source: JICA Study Team

5.2 Rough Estimation of Potential Soil Loss in Model River Basins

Table H.5.2 demonstrates average soil loss rate with different land use type in the Philippines by FAO report 1998). Average rate of soil loss for all land use type is about 80 (tons/ha/year), according to FAO report (1998).

Table H.5.2 Average Soil Loss in the Philippines

Land Use Type	Average Soils Loss (tons/ha/year)
Wood	3.0
Agriculture	61.8
Grass	173.7

Source: FAO (1998)

Using NAMRIA's landuse data, potential soil loss rate for each model river basin is estimated as shown in Table H.5.3. It is expected that the Ilog-Hilabangan River Basin provides much higher soil loss. Tuganay and Dinanggasan may produce higher soil loss than the national average.

Table H.5.3 Estimated Potential Soil Loss for Model River Basins

Source: JICA Study Team

	Total Area (km^2)	Urban (%)	Wood (%)	Agriculture (%)	Grass (%)	Total Erosion Volume (tons/ha/yr)	Total Erosion Depth (mm/y)
Ilog-Hilabangan	2,162	0.19	4.03	20.68	73.72	140.96	10.84
Dungcaan	176	0.50	30.51	54.78	14.04	59.16	4.55
Meycauayan	201	47.94	0.17	19.06	12.20	32.97	2.54
Kinanliman	10	1.29	86.15	0.00	12.56	24.41	1.88
Tuganay	747	0.94	6.28	53.29	38.76	100.45	7.73
Dinanggasan	29	0.42	16.44	56.66	26.47	81.50	6.27

5.3 Conservative Estimation of Reforestation, Restoration and Rehabilitation Rate in the Philippines

Based on the statistical year book for forest in the Philippines, average total area of reforestation in the last 5 years is about 22,000 ha/year. Among those areas, 57% is provided by Governmental Sector and 43% is by Non-Governmental Sector.

By assuming same rate of reforestation, total reforestation area for 26 years would be about: 22,000 ha/year x 26 years = 572,000 ha. This is equivalent to 5.7% of Land without Forest Cover.

Unit cost of reforestation is 24,500 pesos/ha. Therefore, total cost for 26 years for the entire country is estimated at 14,014 million pesos. The present study recommends keeping at least same rate of reforestation from the viewpoint of flood mitigation.

As a reference, average area for restoration or rehabilitation of degraded forestland from 2006-2010 is estimated at about 3,000 ha/year based on the invested amount for them.

Assuming same rate of restoration or rehabilitation of degraded forestland area, the total area would be 3,000 ha/year x 26 years = 78,000 ha. This is equivalent to 0.39% of Land with Forest Cover.

Unit cost of restoration or rehabilitation degraded forestland is 52 million pesos/3,000 ha = 17,333 pesos/ha. Therefore, total cost for 26 years for the entire country is estimated at 1,352 million pesos.

5.4 Recommendation on Baseline Activities on Watershed Management in Model River Basins

Watershed management includes many aspects than flood mitigation. In the present study, it is recommended that at least minimum necessary activities related to flood mitigation be implemented as baseline activities on watershed management. The recommendation is summarized in Table H.5.4.

It is recommended as a first step to prepare watershed characterization and watershed management plan for each model river basin. Critical area should be identified and monitored. Reforestation should be continued with at least same rate as current national average. To enhance more communication within a basin, it is recommended to prepare budget to support activities of river basin council.

Table H.5.4 Recommendation on Baseline Activities of Watershed Management in the Flood Mitigation Plan

River Basin	Watershed Character-ization	Watershed Managemen t Plan	Remarks for Watershed Characterization and Watershed Management Plan	Baseline Reforestation	Supporting of River Basin Council
Ilog-Hilabangan	○	○	• Initial preparation for the entire river basin • Revision every 5 years	Reforestation of Grass land (Total area in 26 years = 5.7% of land without forest in the basin)	○
Dungcaan	○	○	• Initial preparation for the entire river basin • Revision every 5 years	Reforestation of Grass land (Total area in 26 years = 5.7% of land without forest in the basin)	○
Meycauayan	○	○	• Initial preparation for the entire river basin • Environmental improvement along a river should be considered. • Revision every 5 years	N/A	○
Kinanliman	○	○	• Initial preparation for the entire river basin • Revision every 5 years	Reforestation of Grass land (Total area in 26 years = 5.7% of land without forest in the basin)	○
Tuganay	○	○	• Initial preparation for the entire river basin • Revision every 5 years	Reforestation of Grass land (Total area in 26 years = 5.7% of land without forest in the basin)	○
Dinanggasan	○	○	• Revision every 5 years	Reforestation of Grass land (Total area in 26 years = 5.7% of land without forest in the basin)	○

Note: ○: Recommended

Source: JICA Study Team

5.5 Rough Estimation of Cost

Cost for recommended baseline activities on watershed management is roughly estimated as shown in Table H.5.5.

Table H.5.5 Rough Cost Estimation for Recommended Baseline Activities on Watershed Management

	Preparation of Watershed Characterization & Watershed Management Plan (mil. Pesos)	Reforestation (mil. Pesos)	Supporting of River Basin Council (mil. Pesos)	Total (mil. Pesos)
Ilog-Hilabangan	12.00	220.53	10.40	242.93
Dungcaan	3.00	3.42	2.60	9.02
Meycauayan	6.00		5.20	11.20
Kinanliman	3.00	0.18	2.60	5.78
Tuganay	6.00	40.31	5.20	51.51
Dinanggasan	3.00	1.08	2.60	6.68

Cost brake down is shown in the following table:

Table H.5.6 Cost Breakdown for Recommended Baseline Activities on Watershed Management

Reforestation	Unit Cost/per area		Area (ha) per year	Cost		Year	Total Cost	
Ilog-Hilabangan	24500	pesos /ha	346.20	8.482	million pesos	26	220.53	million pesos
Dungcaan	24500	pesos /ha	5.36	0.131	million pesos	26	3.42	million pesos
Meycauayan	24500	pesos /ha	0.00	0	million pesos	26	0.00	million pesos
Kinanliman	24500	pesos /ha	0.28	0.007	million pesos	26	0.18	million pesos
Tuganay	24500	pesos /ha	62.79	1.538	million pesos	26	40.00	million pesos
Dinanggasan	24500	pesos /ha	1.69	0.041	million pesos	26	1.08	million pesos

Preparation of Watershed Characterization & Watershed Management Plan	Unit Cost/per basin/time		Increasing factor	Cost		Number of preperation during 26 years	Total Cost	
Ilog-Hilabangan	0.6	million pesos	4	2.4	million pesos	5	12	million pesos
Dungcaan	0.6	million pesos	1	0.6	million pesos	5	3	million pesos
Meycauayan	0.6	million pesos	2	1.2	million pesos	5	6	million pesos
Kinanliman	0.6	million pesos	1	0.6	million pesos	5	3	million pesos
Tuganay	0.6	million pesos	2	1.2	million pesos	5	6	million pesos
Dinanggasan	0.6	million pesos	1	0.6	million pesos	5	3	million pesos

Supporting of River Basin Council	Unit Cost/year		Increasing factor	Cost		Year	Total Cost	
Ilog-Hilabangan	0.1	million pesos	4	0.4	million pesos	26	10.4	million pesos
Dungcaan	0.1	million pesos	1	0.1	million pesos	26	2.6	million pesos
Meycauayan	0.1	million pesos	2	0.2	million pesos	26	5.2	million pesos
Kinanliman	0.1	million pesos	1	0.1	million pesos	26	2.6	million pesos
Tuganay	0.1	million pesos	2	0.2	million pesos	26	5.2	million pesos
Dinanggasan	0.1	million pesos	1	0.1	million pesos	26	2.6	million pesos

6 RECOMMENDATION ON OTHER MEASURES

6.1 Issues and Recommendations for Further Improvement of Disaster Management for Flood-related Disaster for Model River Basins

In general, disaster management activity is very active for the model river basins. In the present study, recommendation for further improvement is summarized based on the result of field survey. The issues and recommendations are summarized in Annex H.2. General recommendations for all model river basins are, as follows:

- Enhancement of disaster management activities at community level
- Necessity of periodical refinement of disaster management plan
- Necessity of preparation and dissemination of hazard map for excess flood after completion of structural measures

6.2 Recommended Other Measures for Model River Basins

6.2.1 Ilog-Hilabangan River

Recommended other measures for the Ilog-Hilabangan River Basin are as follows:

(a) Preparation of flood hazard map

- Preparation of flood hazard map is generally not enough. It is recommended to prepare the flood hazard map to show flooding patterns for whole downstream reach of the Ilog-Hilabangan River during the next stage of the study such as Feasibility Study, together with structural measures. Technical assistance including how to express flooding process in the flood prone area and evacuation place should be provided to CDCC and MDCC.

(b) Enhancement of communication between neighboring LGUs

- MDCC/CDCC workshop to establish communication and support from neighboring LGUs is recommended. Exchange of know-how of disaster management each other is also recommended.

6.2.2 Dungcaan River

Recommended other measures for the Dungcaan River Basin are as follows:

(a) Enhancement of evacuation system

- People living in wet land, who meet inundation almost every year, are get used to evacuate. Because structural measures may not give significant improvement of flood condition in the wet land area, enhancement of evacuation system should be considered.
- To place park stations to be utilized not only for sight seeing for mangrove area but also temporal evacuation center and stock yard during flood is proposed. It may give more ensured evacuation in the wet land area.

(b) Information & education campaign

- People who live along river bank and are threatened by bank erosion do not want to evacuate. The proposed structural measures can reduce the risk of bank erosion. However, people should recognize that they are living in potentially dangerous area.
- Information Education Campaign for those people is required. Furthermore, the constructed structure should be properly maintained. It is desirable for the residents living nearby to corporate to the activity of maintenance of the structure.

6.2.3 Meycauayan River

Recommended other measures for the Meycauayan River Basin are as follows:

(a) Resettlement of Informal Settlers

- Informal settlers are living at dangerous area in river channel. To avoid causality by flash flood, it is recommended for the informal settlers to be resettled properly.

(b) Community-based environmental improvement along channel including solid waste management

- To keep living conditions along rivers and to prevent rapid accumulation of garbage in rivers, community-based solid waste management, environmental improvement is recommended.

(c) Landuse regulation

- The Meycauayan River Basin is highly urbanized. There is a plan for future landuse. However, if urbanization precedes more, runoff volume will be increased and as a result, the safety level of structural measures will be decreased. It is necessary to prevent further urbanization than that is planed. Landuse regulation is necessary to keep landuse condition as it is planned.
- In the middle and upper reach of Meycauayan and Marilao Rivers, it is highly possible for new residential area to be developed. It is recommended to keep buffer zone along rivers so that residential area will not be located in flood risk zone along rivers. It is necessary to identify flood risk zone along the middle and upper reach of those rivers, using detailed river and topographic survey and hydrologic and hydraulic simulation. Then identified risk zone should be kept as buffer zone.

(d) Enhancement of communication between neighboring LGUs

- MDCC/CDCC workshop to establish communication and support from neighboring LGUs is recommended. Exchange of know-how of disaster management each other is also recommended. It will also help to overcome the difficulty between inter-Region communication between Region 3 and NCR.

6.2.4 Kinanliman River

Recommended other measures for the Kinanliman River Basin are as follows:

(a) Enhancement of disaster management activities at community level

- After 2004 disaster, municipality of Real has been very active for disaster management. This activity at municipality level should be continued. Activity at more local level such as poblacion should be more enhanced. For example, information, education campaign and evacuation drill should be considered.

(b) Installation of water level gauge

- After 2004 disaster, municipality of Real has already introduced its own rain gauge. In addition to this, installation of water level gauge at Kinanliman River is recommended.

(c) Preparation against excess flood and debris flow

- Hazard map to show dangerous area for very severe flood (more than 1/25) and for debris flow should be prepared and disseminated to the people

6.2.5 Tuganay River

Recommended other measures for the Tuganay River Basin are as follows:

(a) Assessment of existing dike system and Hazard map which shows danger of breach of dike

- The Tuganay River Basin, especially lower reach, is well-known as flood prone area. People have already known that they area living in flood prone area. The nature of the flood is that the water level gradually increases. Therefore, people can adapt to slowly changing flood with almost no causality. However, if the dike system collapses, very rapid flow and sudden increase of water level can occur, which people have not yet experienced. In this case, it is very high risk for causality. Many new dikes are constructed not only by governmental organization but also private companies. The updated condition of the dike system should be investigated and those risks against flood should be assessed. Based on the assessment, hazard map should be prepared to show potential risk as if dike system collapses. Preparedness plan should also be prepared against the dike collapse.

(b) Landuse regulation for banana plantation

- Banana plantation supports regional economic growth. However, it could bring about more rapid run-off than before, although more scientific observation may be required. The first thing to do is to monitor the possible change of run-off pattern by introduction of banana plantation. Then, if change of the run-off pattern is scientifically detected, proper land use regulation should be considered to prevent further increase of peak discharge.

(c) Enhancement of communication between neighboring LGUs

- MDCC/CDCC workshop to establish communication and support from neighboring LGUs is recommended. Exchange of know-how of disaster management each other is also recommended.

6.2.6 Dinanggasan River

Recommended other measures for the Dinanggasan River Basin are as follows:

(a) Enhancement of disaster management activities at community level

- In the Dinanggasan River Basin, disaster management for flood-related disaster is very active. This seems to be mainly because of the previous JICA study for non-structural measures. The activity should be continued.However, condition of disaster management seems to be different from one barangay to another barangay. For example, Barangay Looc, which was not selected as pilot barangay at the previous JICA study, feels that their condition is not so good. More support should be provided to such barangay to enhance their condition. BDCC workshop between neighboring BDCCs to exchange of know-how of disaster management and to enhance communication each other is recommended.

(b) Revision of flood hazard map

- One important thing, which was pointed out during the meeting with stakeholders, is the necessity of updating hazard map based on the latest flood. Experience of different floods would bring more updated knowledge on flood condition and dangerous area. The updated knowledge on the flood condition should be reflected to the hazard map and it should be disseminated to communities.

Annex H.1

Calculation Sheets

for

Possible Benefit by Flood Warning System

Ilog-Hilabangan River

Ilog-Hilabangan River
Ref Point = 15km

Current condition without proposed structural

Time of Concentration (min)	A	939	
Threshed Discharge (m3/s)	B	2400	2400
Time for Response (min)	C	*120*	
Maximum Efficiency	D	*0.8*	
Maximum Mitigation Time (min)	E	259	
Maximum Warning Time (min)	F = E - C	139	
Reduction by Day's Curve	G	0.06625	
Reduction with Efficiency	H = G x D	**0.05300**	
Damage of Build-up Area for 1/25 Flood (Mil Pesos)	I	2130	
Coefficient for Annual Ave. Excess Damage	J = I x D	0.127	
Annual Ave. Damage Reduction by FWS (Mil Pesos)	K = I x H x J	**14.34**	
Total Benefit Index (Mil Pesos)	L = K x 3.4	**48.75**	

Condition with proposed structural measures

Time of Concentration (min)	A	939
Threshed Discharge (m3/s)	B	3690
Time for Response (min)	C	120
Maximum Efficiency	D	*0.8*
Maximum Mitigation Time (min)	E	248
Maximum Warning Time (min)	F = E - C	128
Reduction by Day's Curve	G	0.06148
Reduction with Efficiency	H = G x D	**0.04919**
Damage of Build-up Area for 1/25 Flood (Mil Pesos)	I	2130
Coefficient for Annual Ave. Excess Damage	J = I x D	0.046
Annual Ave. Damage Reduction by FWS (Mil Pesos)	K = I x H x J	**4.82**
Total Benefit Index (Mil Pesos)	L = K x 3.4	**16.39**

Current condition without proposed structural

Return Period	Probability	Peak Discharge (m3/s)	Ratio	Maximum Potential Warning Time, Twp (min)	Detection Time, Tr (min)	Maximum Mitigation Time, Tw (min)	
2	0.5000	920	0.000	0	0	0	
5	0.2000	1880	0.000	0	0	0	
10	0.1000	2630	0.913	950	740	210	14.100
25	0.0400	3690	0.650	680	420	260	5.500
50	0.0200	4540	0.529	600	310	290	3.050
100	0.0100	5430	0.442	540	220	320	3.200
						Total	25.850
						E [Tw] (min)	**259**

Condition with proposed structural measures

Return Period	Probability	Peak Discharge (m3/s)		Maximum Potential Warning Time, Twp (min)	Detection Time, Tr (min)	Maximum Mitigation Time, Tw (min)	
2	0.5000	920	0.000	0	0	0	
5	0.2000	1880	0.000	0	0	0	
10	0.1000	2630	0.000	0	0	0	
25	0.0400	3690	1.000	1130	1130	0	
50	0.0200	4540	0.813	810	600	210	2.350
100	0.0100	5430	0.680	710	450	260	2.600
						Total	4.950
						E [Tw] (min)	**248**

Dungcaan River

Dungcaan River
Ref Point = 1.5km

Current condition without proposed structural			
Time of Concentration (min)	A	264	
Threshed Discharge (m3/s)	B	437	220
Time for Response (min)	C	*30*	
Maximum Efficiency	D	0.8	
Maximum Mitigation Time (min)	E	69	
Maximum Warning Time (min)	F = E - C	39	
Reduction by Day's Curve	G	0.02008	
Reduction with Efficiency	H = G x D	**0.01607**	
Damage of Build-up Area for 1/20 Flood (Mil Pesos)	I	109	
Coefficient for Annual Ave. Excess Damage	J = I x D	0.170	
Annual Ave. Damage Reduction by FWS (Mil Pesos)	K = I x H x J	**0.30**	
Total Benefit (Mil Pesos)	L = K x 3.4	**1.01**	

Condition with proposed structural measures		
Time of Concentration (min)	A	264
Threshed Discharge (m3/s)	B	655
Time for Response (min)	C	30
Maximum Efficiency	D	*0.8*
Maximum Mitigation Time (min)	E	67
Maximum Warning Time (min)	F = E - C	37
Reduction by Day's Curve	G	0.01902
Reduction with Efficiency	H = G x D	**0.01521**
Damage of Build-up Area for 1/20 Flood (Mil Pesos)	I	109
Coefficient for Annual Ave. Excess Damage	J = I x D	0.057
Annual Ave. Damage Reduction by FWS (Mil Pesos)	K = I x H x J	**0.09**
Total Benefit (Mil Pesos)	L = K x 3.4	**0.32**

Current condition without proposed structural

Return Period	Probability	Peak Discharge (m3/s)	Ratio	Maximum Potential Warning Time, Twp (min)	Detection Time, Tr (min)	Maximum Mitigation Time, Tw (min)	
2	0.5000	345	0.000	0	0	0	
5	0.2000	437	1.000	320	320	0	
10	0.1000	527	0.829	235	175	60	3.125
20	0.0500	655	0.667	200	135	65	0.650
25	0.0400	669	0.653	195	130	65	1.450
50	0.0200	818	0.534	170	90	80	0.825
100	0.0100	984	0.444	150	65	85	0.850
					0	Total	6.900
						E [Tw] (min)	**69**

Condition with proposed structural measures

Return Period	Probability	Peak Discharge (m3/s)		Maximum Potential Warning Time, Twp (min)	Detection Time, Tr (min)	Maximum Mitigation Time, Tw (min)	
2	0.5000	345	0.000	0	0	0	
5	0.2000	437	0.000	0	0	0	
10	0.1000	527	0.000	0	0	0	
20	0.0500	655	1.000	320	320	0	
25	0.0400	669	0.978	300	250	50	1.150
50	0.0200	818	0.801	230	165	65	0.725
100	0.0100	984	0.666	200	120	80	0.800
						Total	2.675
						E [Tw] (min)	**67**

Meycauayan River

Meycauayan River
Ref Point = 9km

Current condition without proposed structural			
Time of Concentration (min)	A	362	
Threshed Discharge (m3/s)	B	690	405
Time for Response (min)	C	*60*	
Maximum Efficiency	D	0.8	
Maximum Mitigation Time (min)	E	99	
Maximum Warning Time (min)	F = E - C	39	
Reduction by Day's Curve	G	0.02017	
Reduction with Efficiency	H = G x D	**0.01613**	
Damage of Build-up Area for 1/30 Flood (Mil Pesos)	I	2913	
Coefficient for Annual Ave. Excess Damage	J = I x D	0.157	
Annual Ave. Damage Reduction by FWS (Mil Pesos)	K = I x H x J	**7.38**	
Total Benefit (Mil Pesos)	L = K x 3.4	**25.09**	

Condition with proposed structural measures		
Time of Concentration (min)	A	362
Threshed Discharge (m3/s)	B	990
Time for Response (min)	C	60
Maximum Efficiency	D	*0.8*
Maximum Mitigation Time (min)	E	89
Maximum Warning Time (min)	F = E - C	29
Reduction by Day's Curve	G	0.01492
Reduction with Efficiency	H = G x D	**0.01194**
Damage of Build-up Area for 1/30 Flood (Mil Pesos)	I	2913
Coefficient for Annual Ave. Excess Damage	J = I x D	0.037
Annual Ave. Damage Reduction by FWS (Mil Pesos)	K = I x H x J	**1.29**
Total Benefit (Mil Pesos)	L = K x 3.4	**4.37**

Current condition without proposed structural

Return Period	Probability	Peak Discharge (m3/s)	Ratio	Maximum Potential Warning Time, Twp (min)	Detection Time, Tr (min)	Maximum Mitigation Time, Tw (min)	
2	0.5000	510	0.000	0	0	0	
5	0.2000	690	1.000	456	456	0	
10	0.1000	820	0.841	330	250	80	4.500
20	0.0500	930	0.742	295	195	100	1.708
30	0.0333	990	0.697	280	175	105	1.433
50	0.0200	1080	0.639	265	155	110	1.125
100	0.0100	1210	0.570	245	130	115	1.150
						Total	9.917
						E [Tw] (min)	**99**

Condition with proposed structural measures

Return Period	Probability	Peak Discharge (m3/s)		Maximum Potential Warning Time, Twp (min)	Detection Time, Tr (min)	Maximum Mitigation Time, Tw (min)	
2	0.5000	510	0.000	0	0	0	
5	0.2000	690	0.000	0	0	0	
10	0.1000	820	0.000	0	0	0	
20	0.0500	930	0.000	0	0	0	
30	0.0333	990	1.000	456	456	0	
50	0.0200	1080	0.917	360	290	70	0.825
100	0.0100	1210	0.818	320	225	95	0.950
						Total	1.775
						E [Tw] (min)	**89**

Kinanliman River

Kinanliman River
Ref Point = 0.9km

Current condition without proposed structural

Time of Concentration (min)	A	48	
Threshed Discharge (m3/s)	B	280	190
Time for Response (min)	C	*30*	
Maximum Efficiency	D	0.8	
Maximum Mitigation Time (min)	E	12	
Maximum Warning Time (min)	F = E - C	-18	
Reduction by Day's Curve	G	-0.00954	
Reduction with Efficiency	H = G x D	**-0.00763**	
Damage of Build-up Area for 1/25 Flood (Mil Pesos)	I	71	
Coefficient for Annual Ave. Excess Damage	J = I x D	0.048	
Annual Ave. Damage Reduction by FWS (Mil Pesos)	K = I x H x J	**-0.03**	
Total Benefit (Mil Pesos)	L = K x 3.4	**-0.09**	

Condition with proposed structural measures

Time of Concentration (min)	A	48
Threshed Discharge (m3/s)	B	380
Time for Response (min)	C	30
Maximum Efficiency	D	*0.8*
Maximum Mitigation Time (min)	E	10
Maximum Warning Time (min)	F = E - C	-20
Reduction by Day's Curve	G	-0.01063
Reduction with Efficiency	H = G x D	**-0.00851**
Damage of Build-up Area for 1/25 Flood (Mil Pesos)	I	71
Coefficient for Annual Ave. Excess Damage	J = I x D	0.048
Annual Ave. Damage Reduction by FWS (Mil Pesos)	K = I x H x J	**-0.03**
Total Benefit (Mil Pesos)	L = K x 3.4	**-0.10**

Current condition without proposed structural

Return Period	Probability	Peak Discharge (m3/s)	Ratio	Maximum Potential Warning Time, Twp (min)	Detection Time, Tr (min)	Maximum Mitigation Time, Tw (min)	
2	0.5000	201	0.000	0	0	0	
5	0.2000	281	0.998	56	56	0	
10	0.1000	323	0.868	45	35	10	0.690
25	0.0400	380	0.738	39	26	13	0.260
50	0.0200	413	0.679	36	23	13	0.135
100	0.0100	459	0.610	33	19	14	0.140
						Total	1.225
						E [Tw] (min)	**12**

Condition with proposed structural measures

Return Period	Probability	Peak Discharge (m3/s)		Maximum Potential Warning Time, Twp (min)	Detection Time, Tr (min)	Maximum Mitigation Time, Tw (min)	
2	0.5000	201	0.000	0	0	0	
5	0.2000	281	0.000	0	0	0	
10	0.1000	323	0.000	0	0	0	
25	0.0400	380	1.001	58	58	0	
50	0.0200	413	0.921	49	41	8	0.095
100	0.0100	459	0.828	43	32	11	0.110
						Total	0.205
						E [Tw] (min)	**10**

Tuganay River

Tuganay River
Ref Point = 8km

Current condition without proposed structural			
Time of Concentration (min)	A	492	
Threshed Discharge (m3/s)	B	271	175
Time for Response (min)	C	*60*	
Maximum Efficiency	D	0.8	
Maximum Mitigation Time (min)	E	143	
Maximum Warning Time (min)	F = E - C	83	
Reduction by Day's Curve	G	0.04113	
Reduction with Efficiency	H = G x D	**0.03290**	
Damage of Build-up Area for 1/25 Flood (Mil Pesos)	I	1298	
Coefficient for Annual Ave. Excess Damage	J = I x D	0.168	
Annual Ave. Damage Reduction by FWS (Mil Pesos)	K = I x H x J	**7.17**	
Total Benefit (Mil Pesos)	L = K x 3.4	**24.39**	

Condition with proposed structural measures		
Time of Concentration (min)	A	492
Threshed Discharge (m3/s)	B	543
Time for Response (min)	C	60
Maximum Efficiency	D	*0.8*
Maximum Mitigation Time (min)	E	125
Maximum Warning Time (min)	F = E - C	65
Reduction by Day's Curve	G	0.03283
Reduction with Efficiency	H = G x D	**0.02626**
Damage of Build-up Area for 1/25 Flood (Mil Pesos)	I	1298
Coefficient for Annual Ave. Excess Damage	J = I x D	0.048
Annual Ave. Damage Reduction by FWS (Mil Pesos)	K = I x H x J	**1.64**
Total Benefit (Mil Pesos)	L = K x 3.4	**5.56**

Current condition without proposed structural

Return Period	Probability	Peak Discharge (m3/s)	Ratio	Maximum Potential Warning Time, Twp (min)	Detection Time, Tr (min)	Maximum Mitigation Time, Tw (min)	
2	0.5000	135	0.000	0	0	0	
5	0.2000	271	1.000	590	590	0	
10	0.1000	387	0.700	380	270	110	7.800
25	0.0400	543	0.499	300	150	150	3.100
50	0.0200	634	0.427	280	120	160	1.650
100	0.0100	732	0.370	260	90	170	1.700
						Total	14.250
						E [Tw] (min)	**143**

Condition with proposed structural measures

Return Period	Probability	Peak Discharge (m3/s)		Maximum Potential Warning Time, Twp (min)	Detection Time, Tr (min)	Maximum Mitigation Time, Tw (min)	
2	0.5000	135	0.000	0	0	0	
5	0.2000	271	0.000	0	0	0	
10	0.1000	387	0.000	0	0	0	
25	0.0400	543	1.000	590	590	0	
50	0.0200	634	0.856	460	350	110	1.200
100	0.0100	732	0.742	400	270	130	1.300
						Total	2.500
						E [Tw] (min)	**125**

Dinanggasan River

Dinaggasan River
Ref Point = 0.1km

Current condition without proposed structural

Time of Concentration (min)	A	72	
Threshed Discharge (m3/s)	B	178	1200
Time for Response (min)	C	*30*	
Maximum Efficiency	D	0.8	
Maximum Mitigation Time (min)	E	19	
Maximum Warning Time (min)	F = E - C	-11	
Reduction by Day's Curve	G	-0.00599	
Reduction with Efficiency	H = G x D	**-0.00479**	
Damage of Build-up Area for 1/20 Flood (Mil Pesos)	I	88	
Coefficient for Annual Ave. Excess Damage	J = I x D	0.057	
Annual Ave. Damage Reduction by FWS (Mil Pesos)	K = I x H x J	**-0.02**	
Total Benefit (Mil Pesos)	L = K x 3.4	**-0.08**	

Condition with proposed structural measures

Time of Concentration (min)	A	72
Threshed Discharge (m3/s)	B	216
Time for Response (min)	C	30
Maximum Efficiency	D	*0.8*
Maximum Mitigation Time (min)	E	17
Maximum Warning Time (min)	F = E - C	-13
Reduction by Day's Curve	G	-0.00717
Reduction with Efficiency	H = G x D	**-0.00573**
Damage of Build-up Area for 1/20 Flood (Mil Pesos)	I	88
Coefficient for Annual Ave. Excess Damage	J = I x D	0.057
Annual Ave. Damage Reduction by FWS (Mil Pesos)	K = I x H x J	**-0.03**
Total Benefit (Mil Pesos)	L = K x 3.4	**-0.10**

Current condition without proposed structural

Return Period	Probability	Peak Discharge (m3/s)	Ratio	Maximum Potential Warning Time, Twp (min)	Detection Time, Tr (min)	Maximum Mitigation Time, Tw (min)	
2	0.5000	156	0.000	0	0	0	
5	0.2000	178	1.001	88	88	0	
10	0.1000	196	0.910	72	58	14	0.960
20	0.0500	216	0.826	64	48	16	0.170
25	0.0400	226	0.789	61	43	18	0.370
50	0.0200	249	0.715	56	37	19	0.190
100	0.0100	272	0.654	52	33	19	0.190
						Total	1.880
						E [Tw] (min)	**19**

Condition with proposed structural measures

Return Period	Probability	Peak Discharge (m3/s)		Maximum Potential Warning Time, Twp (min)	Detection Time, Tr (min)	Maximum Mitigation Time, Tw (min)	
2	0.5000	156	0.000	0	0	0	
5	0.2000	178	0.000	0	0	0	
10	0.1000	196	0.000	0	0	0	
20	0.0500	216	1.002	88	88	0	
25	0.0400	226	0.958	78	64	14	0.310
50	0.0200	249	0.868	68	51	17	0.175
100	0.0100	272	0.794	61	43	18	0.180
						Total	0.665
						E [Tw] (min)	**17**

Annex H.2

Issues and Recommendations
for
Further Improvement of
Disaster Management for Flood-related
Disaster for Model River Basins

Ilog-Hilabangan River

Stage	Item	Issues
Mitigation (Non-Structural Measure Only)	Flood proofing structures (houses)	・ Insufficient fund ・ No specific ordinance
Preparedness	Emergency, evacuation and post-flood plan Hazard map (Including evacuation place and route) Emergency material and equipment IEC Monitoring / Flood forecasting and warning	・ There are no PAGASA station that is directly used for monitoring and warning for flood in the basin. Currently, information provided by media for precipitation is the main source for decision making for CDCC or MDCC. ・ Establishment of flood warning system utilizing rain and water level gauges in the basin is definitely necessary for improving preparedness. Not only equipment but also training should be provided. ・ Preparation of flood hazard map is generally not enough. Technical assistance including how to express flooding process in the flood prone area should be provided to CDCC and MDCC. ・ In Ilog area, emergency material such as food can not be prepared by calamity fund before declaration of calamity. ・ Another aspect for long term is that possible change of people's attitude against flood after structural measures will be completed. Fewer floods may result in less preparation against flood. The safety level of the structural measures proposed here is 1/25, which means very severe flood (more then 1/25) can still occur even after the structural measures will be completed. This fact should be informed to the people and preparation against very severe flood should be made. For example, hazard map to show dangerous area when very severe flood (more than 1/25) occurs should be prepared and disseminated to the people.
Response	Information dissemination Flood fighting Evacuation Reporting of disaster condition Rescue activity Supporting from neighboring LGUs	・ In Ilog Municipality area, flooding is very usual. People in there get used to evacuate. On the other hands, in Kabankalan city area, flooding occurs only when very large amount of water come from upstream (currently about once several years). For both areas, evacuation seems to be fairly done according to interview to the related people for disaster management. ・ Flood fighting is not active, because of lack of equipment and training. ・ Some municipalities feel necessity of straightening relation between other LGUs rescue team. ・ MDCC/CDCC workshop to establish communication and support from neighboring LGUs is recommended. Exchange of know-how of disaster management each other is also recommended.
Recovery	Post-flood damage assessment Rehabilitation Insurance	・ In Ilog Municipality, reporting of damage after flood is not well-organized. Each sector reports individually to its parent's organization. It sometimes makes conflicting information among different sectors. The information of disaster should be firstly reported to MDCC and MDCC should arrange all information. After the arrangement, it should be reported to PDCC. Strengthening of MDCC capability is required. ・ Lack of funds for rehabilitation in general

Dungcaan River

Stage	Item	Issues & Recommendations
Mitigation (Non-Structural Measure Only)	Flood proofing structures (houses)	・ Insufficient fund
Preparedness	Emergency, evacuation and post-flood plan Hazard map (Including evacuation place and route) Emergency material and equipment IEC Monitoring / Flood forecasting and warning	・ Base on interview, the people who live along river bank and are threatened by bank erosion do not want to evacuate. The proposed structural measures can reduce the risk of bank erosion. However, people should recognize that they are living in potentially dangerous area. Information Education Campaign for those people is required. Furthermore, the constructed structure should be properly maintained. It is desirable for the residents living nearby to corporate to the activity of maintenance of the structure. ・ Precipitation data of PAGASA stations at Southern Lyte University is not directly utilized for decision making for disaster management. ・ Establishment of flood warning system utilizing rain and water level gauges in the basin is definitely necessary for improving preparedness. Not only equipment but also training should be provided.
Response	Information dissemination Flood fighting Evacuation Reporting of disaster condition Rescue activity Supporting from neighboring LGUs	・ Based on interview, the people living in wet land, who meet inundation almost every year, are get used to evacuate. Because structural measures may not give significant improvement of flood condition in the wet land area, enhancement of evacuation system should be considered. To place park stations to be utilized not only for sight seeing for mangrove area but also temporal evacuation center and stock yard during flood is proposed. It may give more ensured evacuation in the wet land area. ・ Flood fighting is not active, because of lack of equipment and training and also fear for flood. ・ Rescue activity seems to be almost OK. However, more man power, training and funding are desirable to enhance it. ・ To set small bridges and park stations is proposed. The mangrove area around river mouth is potential Natural Park. It can be utilized for sight seeing nearby Baybay city. Small bridges are to keep access road to Mangraove area. Park stations can be utilized not only for sight seeing purpose but also for evacuation places and stock yard for emergency material during flood.
Recovery	Post-flood damage assessment Rehabilitation Insurance	・ Lack of man power, communication and accessibility sometimes causes problem for post-flood damage assessment. ・ Lack of funds for rehabilitation in general

Meycauayan River

Stage	Item	Issues & Recommendations
Mitigation (Non-Structural Measure Only)	Flood proofing structures (houses)	・ Insufficient fund
Preparedness	Emergency, evacuation and post-flood plan	・ Many cities and municipalities are aware of importance of disaster management and very active for the activity related to disaster management. This should be kept. Periodical update of management plan including hazard map, which reflects updated information of disaster, is important. Budget to do so should be prepared. ・ Establishment of flood warning system utilizing rain and water level gauges including tidal gauges in the basin is recommended to reduce tangible damage. Not only equipment but also training should be provided. ・ Another aspect for long term is that possible change of people's attitude against flood after structural measures will be completed. Few floods may result in less preparation against flood. The safety level of the structural measures proposed here is 1/30, which means very severe flood (more then 1/30) can still occur even after the structural measures will be completed. This fact should be informed to the people and preparation against very severe flood should be made. For example, hazard map to show dangerous area when very severe flood (more than 1/30) occurs should be prepared and disseminated to the people.
	Hazard map (Including evacuation place and route)	
	Emergency material and equipment	
	IEC	
	Monitoring / Flood forecasting and warning	
Response	Information dissemination	・ Some municipality and cities feel that Information dissemination is not so good condition, especially for barangay level. More budgets may be necessary to conduct more activities and prepare proper equipment to enhance it. ・ Some municipalities, especially ones in Bulacan, feel that reporting of disaster condition is not so efficient. Establishment of standard procedure may improve the situation. ・ Supporting from neighboring LGUs is generally not so active. MDCC/CDCC workshop to establish communication and support from neighboring LGUs is recommended.
	Flood fighting	
	Evacuation	
	Reporting of disaster condition	
	Rescue activity	
	Supporting from neighboring LGUs	
Recovery	Post-flood damage assessment	・ Lack of funds for rehabilitation in general
	Rehabilitation	
	Insurance	

Kinanliman River

<table>
<tr><th>Stage</th><th>Item</th><th>Issues & Recommendations</th></tr>
<tr><td>Mitigation
(Non-Structural Measure Only)</td><td>Flood proofing structures (houses)</td><td>・ Insufficient fund</td></tr>
<tr><td rowspan="5">Preparedness</td><td>Emergency, evacuation and post-flood plan</td><td rowspan="5">・ After 2004 disaster, municipality of Real has been very active for disaster management. This activity at municipality level should be continued. Activity at more local level such as poblacion should be more enhanced. For example, information, education campaign and evacuation drill should be considered.

・ Considering active DCC activities in this area, community based flood warning system is recommendable. After 2004 disaster, municipality of Real has already introduced its own rain gauge. In addition to this, installation of water level gauge at Kinanliman River is recommended.

・ Another aspect for long term is that possible change of people's attitude against flood after structural measures will be completed. Fewer floods may result in less preparation against flood. The safety level of the structural measures proposed here is 1/25, which means very severe flood (more then 1/25) can still occur even after the structural measures will be completed. This fact should be informed to the people and preparation against very severe flood should be made. For example, hazard map to show dangerous area when very severe flood (more than 1/25) occurs should be prepared and disseminated to the people.</td></tr>
<tr><td>Hazard map (Including evacuation place and route)</td></tr>
<tr><td>Emergency material and equipment</td></tr>
<tr><td>IEC</td></tr>
<tr><td>Monitoring / Flood forecasting and warning</td></tr>
<tr><td rowspan="6">Response</td><td>Information dissemination</td><td rowspan="6">・ Because flood comes very quickly, flood fighting is very difficult to be applied.

・ Evaluation for information dissemination and evacuation is very different from one poblacion to another problacion.

・ In general, resources for rescue activities seem to be not enough.</td></tr>
<tr><td>Flood fighting</td></tr>
<tr><td>Evacuation</td></tr>
<tr><td>Reporting of disaster condition</td></tr>
<tr><td>Rescue activity</td></tr>
<tr><td>Supporting from neighboring LGUs</td></tr>
<tr><td rowspan="3">Recovery</td><td>Post-flood damage assessment</td><td rowspan="3">・ Lack of funds for rehabilitation in general</td></tr>
<tr><td>Rehabilitation</td></tr>
<tr><td>Insurance</td></tr>
</table>

Tuganay River

Stage	Item	Issues & Recommendations
Mitigation (Non-Structural Measure Only)	Flood proofing structures (houses)	・ Insufficient fund
Preparedness	Emergency, evacuation and post-flood plan	・ In Carmen municipality, preparedness plan has been prepared. This is a clue for active disaster management activity in this area. However, the following should be additionally considered for further improvement. ・ 1) Preparedness plan not only for usual flood but also for flood by dike collapse should be urgently prepared, considering the current situation of dike system. ・ 2) More localized evacuation place with available space for livestock should be considered. ・ Tuganay river basin, especially lower reach, is well-known as flood prone area. People have already known that they area living in flood prone area. The nature of the flood is that the water level gradually increases. Therefore, people can adapt to slowly changing flood with almost no causality. However, if the dike system collapses, very rapid flow and sudden increase of water level can occur, which people have not yet experienced. In this case, it is very high risk for causality. ・ In the Tuganay river basin, many new dikes are constructed not only by governmental organization but also private company related to plantation. The updated condition of the dike system should be investigated and those risks against flood should be assessed. ・ Based on the assessment, hazard map should be prepared to show potential risk as if dike system collapses. Preparedness plan should also be prepared against the dike collapse.
	Hazard map (Including evacuation place and route)	
	Emergency material and equipment	
	IEC	
	Monitoring / Flood forecasting and warning	
Response	Information dissemination	・ Flood fighting is not active, because of lack of equipment and training. ・ There is no permanent evacuation center. ・ Some municipalities feel necessity of straightening relation between other LGUs rescue team.
	Flood fighting	
	Evacuation	
	Reporting of disaster condition	
	Rescue activity	
	Supporting from neighboring LGUs	
Recovery	Post-flood damage assessment	・ Lack of funds for rehabilitation if big damage occurs
	Rehabilitation	
	Insurance	

Dinanggasan River

Stage	Item	Issues & Recommendations
Mitigation (Non-Structural Measure Only)	Flood proofing structures (houses)	・ Insufficient fund
Preparedness	Emergency, evacuation and post-flood plan Hazard map (Including evacuation place and route) Emergency material and equipment IEC Monitoring / Flood forecasting and warning	・ In Camiguin island, the rain gauge of PHIVOLCS plays an very important role, because there is no PAGASA stations in the island. ・ Based on the previous JICA study for non-structural measures, community based-flood warnings system including setting of rain gauges monitored by community has been established. The system should be monitored if it would work properly or not. ・ One important thing, which was pointed out during the meeting with stakeholders, is the necessity of updating hazard map based on the latest flood. Experience of different floods would bring more updated knowledge on flood condition and dangerous area. The updated knowledge on the flood condition should be reflected to the hazard map and it should be disseminated to communities. ・ Another aspect for long term is that possible change of people's attitude against flood after structural measures will be completed. Fewer floods may result in less preparation against flood. The safety level of the structural measures proposed here is 1/20, which means very severe flood (more then 1/20) can still occur even after the structural measures will be completed. This fact should be informed to the people and preparation against very severe flood should be made. For example, hazard map to show dangerous area when very severe flood (more than 1/20) occurs should be prepared and disseminated to the people.
Response	Information dissemination Flood fighting Evacuation Reporting of disaster condition Rescue activity Supporting from neighboring LGUs	・ In the Dinanggasan river basin, disaster management for flood-related disaster is very active. This seems to be mainly because of the previous JICA study for non-structural measures. The activity should be continued. ・ However, condition of disaster management seems to be different from one barangay to another barangay. For example, Barangay Looc, which was not selected as pilot barangay at the previous JICA study, feels that their condition is not so good. More support should be provided to such barangay to enhance their condition. ・ BDCC workshop between neighboring BDCCs to exchange of know-how of disaster management and to enhance communication each other is recommended. ・ For flood fighting, more practice and drill is required.
Recovery	Post-flood damage assessment Rehabilitation Insurance	・ Evaluation is again different from one barangay to another barangay. ・ Lack of funds for rehabilitation