Chapter 5

Basic Plan for Disaster Prevention of the Bogotá Metropolitan Area

CHAPTER 5 BASIC PLAN FOR DISASTER PREVENTION OF THE BOGOTÁ METROPOLITAN AREA

5.1 General

As the results of the disaster damage estimations, the most serious damage is earthquake damage and its secondary effects. Earthquake damage will extend to the whole Study Area, while other disaster damages are limited to small areas. Despite big impact on the earthquake damage, the existing disaster management plan has not or a little interested in earthquake damage mitigation and rescuer operation.

The study team focuses on earthquake disaster prevention plans, which are composed of preparedness for disaster prevention and emergency responses, because the existing disaster prevention plans have a limitation for handling relatively small area of disaster, such as landslide and flood. Moreover, the existing disaster prevention plan has not considered emergency responses after an earthquake disaster. The earthquake disaster prevention plan addresses improvement of urban area, public awareness and emergence responses in the Study Area. The first step for this issue is to establish disaster prevention and emergency response organizations at national, Bogotá City and Cundinamarca prefecture, and local government levels. Those organizations would act as the facilitators for the disaster management system in the Study Area.

5.1.1 Basic Concept

The Basic Plan aims to establish and strengthen the existing government organization for disaster prevention and emergency responses. The existing organizations of the Bogotá Metropolitan Areas have coped with landslides and floods, however, it is necessary for the Bogotá Metropolitan Area to arrange the organizations to cope with a disaster by earthquakes. Even the damages by the Case-3 scenario earthquake (subduction), of which the estimated damages are the smallest among the three earthquake scenarios, will cause the Bogotá Metropolitan Area by far bigger damages than that of the 1999 Quindio Earthquake in Quindio. It is urgent for the Bogotá Metropolitan Area to arrange the government entities of the National, the Bogotá D.C. and the Prefecture of Cundinamarca in order to prepare against seismic disasters.

5.1.2 Basic Disaster Response

The basic disaster responses are required for the Bogotá Metropolitan Area to establish the government entities of the national, Bogotá D.C. and the Cundinamarca Prefecture levels to cope with disasters, to alleviate the damages with preparedness for disaster prevention, and optimum emergency responses properly before, in and after a seismic disaster. The basic disaster responses required for the Bogotá Metropolitan Area are planned and summarized as follows:

Table 5.1.1 Basic Disaster Responses for the Bogotá Metropolitan Area

	Short Term	Midterm	Long Term
	2002-2004	2005-2007	2008-2010
1. Arrangement of Executing system			
	Arrangement and establishment of executing systems, Preparation of action plans	Arrangement and improvement of executing systems, Review of action plan	Arrangement and improvement of executing systems, Review of action plans
2. Disaster Prevention Plan **2.1 Strengthen the urban area**			
1) Strengthen public buildings	Seismic diagnosis study, Implementation of reinforcement of buildings of 1st priority.	Implementation of reinforcement of buildings 2nd priority,	Implementation of reinforcement of buildings of 3rd priority,
2) Strengthen private buildings	Promotion of construction of seismic resistant buildings, Strengthening or rehabilitation of existing buildings,	Promotion of construction of seismic resistant buildings, Strengthening or rehabilitation of existing buildings,	Promotion of construction of seismic resistant buildings, Strengthening or rehabilitation of existing buildings,
3) Strengthening of infrastructure	Promotion of seismic diagnosis study, Implementation of Strengthening or rehabilitation of infrastructure of 1st priority,	Implementation of Strengthening or rehabilitation of infrastructure of 2nd priority,	Implementation of Strengthening or rehabilitation of infrastructure of 3rd priority
4) Strengthening of lifeline structures	Promotion of Seismic diagnosis study, Implementation of strengthening of lifeline structures of 1st priority、 Study on emergency response facilities	Construction of seismic resistant lifeline facilities of 1st priority, Implementation of emergency response facilities of 1st priority,	Construction of seismic resistant lifeline facilities of 2nd priority, Implementation of emergency response facilities of 2nd priority,
5) Preparation of open spaces in urban area,	Arrangement of open spaces in urban areas, Study on emergency response facilities,	Implementation of emergency response facilities of 1st priority,	Implementation of emergency response facilities of 2nd priority,
6) Arrangement of infrastructure of vulnerable urban area,	Study on infrastructure of vulnerable urban areas,	Implementation of infrastructure of urban vulnerable areas of 1st priority,	Implementation of infrastructure of urban vulnerable areas of 2nd priority,
7) Promotion of countermeasures for the liquefaction area,	Promotion of countermeasures for the liquefaction area of 1st priority,	Promotion of countermeasures for the liquefaction area of 2nd priority,	Promotion of countermeasures for the liquefaction area of 3rd priority
8) promotion of countermeasures for hazard materials	Study on storage of hazard materials	Promotion of safety measures for hazard materials	Promotion of safety measures for hazard materials
2.2 Enhancement of public awareness			
1) Enhancement of awareness for disaster prevention	Promotion of public education	Promotion of public education	Promotion of public education
2) Promotion of cooperation system of support inter-regions	Preparation of a cooperation system of support inter-region,	Strengthening of a cooperation system of support inter-region	Strengthening of a cooperation system of support inter-region
2.3 Arrangement of Emergency response system			
1) Strengthening of communication system	Improvement of disaster management information system	Strengthening of disaster management information system	Strengthening of disaster management information system
2) improvement and strengthening executing agencies	Establishment of executing agencies, Preparation of action plan	Improvement of action plan	Improvement of action plan
3) Improvement and strengthening of rescue and support system	Establishment of executing agencies,	Strengthening of the executing agencies,	Strengthening of the executing agencies
4) Arrangement of recovery system after a disaster	Arrangement of executing agencies, Study on rebuilding plan	Review of the rebuilding plan	Review of the rebuilding plan
5) Arrangement of cooperation system	Arrangement and strengthening cooperation system	Strengthening of cooperation system,	Strengthening of cooperation system,
6) Promotion of study and investigation,	Promotion of study and investigation	Promotion of study and investigation	Promotion of study and investigation

5.1.3 Basic Assumption for the Plan

The basic assumption is summarized as follows:

- A major seismic disaster will cause numerous fatalities and injuries, property loss, and disruption of life support systems, and will have an impact on the regional economy.
- The extent of casualties and damages will reflect factors such as time of occurrence, severity of impact, weather condition, distribution of population density, building density by types, and possible triggering of secondary events such as landslides and fires.
- When a large number of casualties, a heavy damage to buildings, basic infrastructures and lifeline structures, and disruption of essential public services overwhelm the capabilities of the local Bogotá City Governments D.C. and Cundinamarca to meet the needs of the situation, the central government shall take emergency responses.

5.1.4 Basic Concept for Operation

The basic concept for operation is:

- Most of the disasters and emergency responses in the Bogotá Metropolitan Area are to be handled by the Bogotá City and Cundinamarca governments. The central government is called upon to provide supplemental assistance when the consequence of a disaster exceeds the capabilities of the local governments.
- Following a disaster, immediate response operation to save lives and protect property has precedence over recovery and mitigation.
- Setting up a Primary Coordinating Agency for the Bogotá Metropolitan Area to promote preparedness for disaster prevention, and to conduct emergency responses and recovery activities. The primary coordinating agency requires to execute a wide range of administrative, programmatic, and specialized tasks, providing logistics management; communications and information technology, financial management, community relations, public information, information collection, analysis, and dissemination.

5.1.5 Basic Plan

In order to reduce the vulnerabilities to the disaster in the Bogotá Metropolitan Area, the Basic Plan is to be composed of preparedness, emergency responses, support functions before, in and after a disaster. The support plan is further divided into the three subsections, recovery and rebuilt, emergency health and medical services and disaster management information system. The structure of the basic plan is shown as follows:

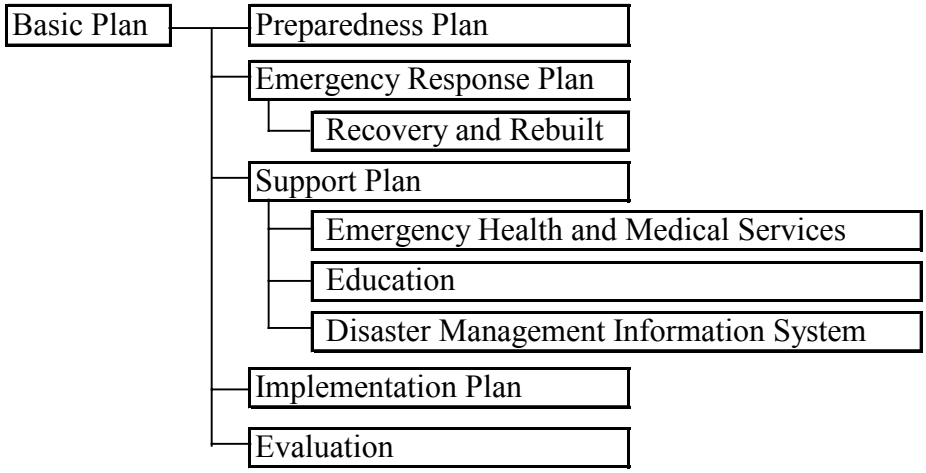


Figure 5.1.1 Structure of Basic Plan

(1) Preparedness for disaster prevention

The Bogotá Metropolitan Area requires to arrange the government entities of the National government, Bogotá D.C. and Cundinamarca against disasters. In order to reduce the existing vulnerabilities, the responsible government entities are necessary to strengthen the strategic public buildings, infrastructure and lifeline structures in the Bogotá Metropolitan Area against a seismic disaster. Also it is very important to strengthen the buildings in general in order to reduce the building damages in a seismic disaster.

Also it is necessary for the Bogotá Metropolitan Area to improve the existing communication systems and monitoring systems for establishing a disaster management information system, strengthen health and medical services and enhance public education for disaster prevention and emergency responses.

(2) Emergency response

It is necessary for the Bogotá Metropolitan Area to establish an emergency response system among the related government and non-government entities due to their responsibilities and functions before, in and after a disaster. Their responsibilities or functions as primary or support agencies, are to be decided duly. Also during the preparation stage, recovery or rebuild plan are to be prepared. The support functions required in and after a disaster are categorized as follows:

- Transportation.
- Communication.
- Public works and engineering.
- Fire-fighting.
- Information and planning.
- Mass care.
- Resource support.

- Health and medical services.
- Urban search an rescue.
- Hazardous materials.
- Food.
- Energy.

(3) Primary coordinating agency

For preparation and operation of disaster prevention plan and emergency responses, the Bogotá City Area requires to decide a Primary Coordinating Agency and strengthen it.

5.2 Preparedness for Disaster Prevention Plan

5.2.1 Emergency Management Entities

1) Basic Concept

The government entities related to Bogotá Metropolitan Area consist of three administrative levels i.e. the Bogotá City Government, the Cundinamarca Government Prefecture and the National governments. Each of them has had a Committee for Prevention and Attention of Disaster, but it is necessary for them to arrange the government entities for disaster prevention and emergency responses as soon as possible due to the responsibilities in preparedness for disaster prevention and in emergency responses before, in and after a seismic disaster. Though the required entities have already been existing, it is necessary for the Bogotá City Government D.C. to arrange the related government entities through the District Committee for Emergency Prevention and Attention, for the Cundinamarca government Prefecture to arrange them through the Regional Committee for Prevention and Attention of Disasters of Cundinamarca, and for the National Government to arrange them through the National Committee for Emergency Prevention and Attention conduct their responsibilities and functions. The primary [5-1-1] and support[5-1-2] agencies for preparedness for disaster prevention and for emergency responses are identified and listed as follows:

2) Responsible Agencies in Preparedness

Responsible or supporting agencies identified in the Study are as follows:

(1) Bogotá:

1) Leading Agency: DAPD
2) Coordinating Agency: DPAE-FOPAE
3) Primary responsible agencies are:

- Government Secretary
- District Administrative Department of Planning (DAPD)
- Health Secretary
- DAMA
- DPAE-FOPAE
- EAAB
- IDU
- Education Secretary
- Metrovivienda
- District Institute of Recreation and Sport

[5-1-1] Primary Agency : Responsible for Coordination
[5-1-2] Support Agency : Supporting Primary Agency

4) Support agencies are:

- Treasury Secretary
- Firemen Official Bodies
- Civil Defense
- Red Cross
- Metropolitan Police
- District Administrative of Social Welfare
- Transit police
- EEB/CODENSA
- ETB/TELECOM
- ECOPETROL
- LOCAL MAYOR

(2) Cundinamarca prefecture:

1) Leading agency: Government Secretary
2) Coordinating agency: Government Secretary/OPAD
3) Primary responsible agencies:

- General Secretary
- Firemen Official Body
- Health secretary
- Government Secretary /OPAD
- Secretary of Public works
- Secretary of Education
- Local Mayoralties

4) Support agencies:

- Military Brigade
- National Police
- CAR
- Civil Defense
- Red Cross
- Secretary of Planning
- Secretary of Agriculture and Rural Development
- Secretary of Treasure
- Secretary of Environment
- Secretary of Social Development
- Housing Institute
- Traffic and Transportation Administration
- CUNDEPORTE

(3) National:

1) Leading Agency: Ministry of Interior
2) Coordinating Agency: DGPAD
3) Primary responsible agencies:
   - DGPAD
   - Ministry of Health
   - Ministry of Communication
   - Ministry of Education
   - Ministry of Development
   - Colombian Civil Defense
4) Support agencies:

- Ministry of Interior
- Ministry of Finance and Public Credit
- Ministry of National Defense
- Ministry of Environment
- National Department of Planning
- Colombian Red Cross
- Colombian Chamber of Construction
- Society of Construction Engineer
- National Police
- National Institute of Roads (INVIAS)
- Military Force (FF.MM)
- TELECOM
- National Institute of Familiar Comfort (ICBF)
- National System of Fire Fighter
- Ministry of Agriculture
- Ministry of Energy
- National University

5.2.2 Structural Measures

1) Strength Important Public Building

(1) Identification of strategic building

After the earthquake disaster, collapse of the important public building would be delay or insufficient emergency operation. The important public building should be free from disaster damage and those buildings should reinforce its structure to seismic resistance. It is essential to identify public building for priory repair.

The field survey done by the study team found that many of the public buildings are insufficient for seismic resistance. The Table 5.2.1 shows the existing building conditions for the public buildings.

Table 5.2.1 Existing Conditions for Public Building

Facility Name within Bogotá	Number of Buildings			No. of Facilities with Vulnerability Study	No of Facilities with Reinforcement
	Masonry	Concrete Frames	Others		
Bogota City					
Emergency Commanding Center	3	3	-	2	4
Fire Fighting Stations	14	2	-	9	3
Police Stations	26	2	-	-	-
Civil Defense	-	19	-	-	-
Red Cross	-	3	-	-	-
Hospitals	29	132	1	27	1
Army	71	44	13	-	-
Locality Offices (Commanding Centers)	11	8	-	-	-
Ministries	14	15	1	-	-
Airport	2	20	-	22	-
Bus Terminal	-	1	-	-	-
Goods Storage Place (Corferias)	-	21	4	11	11
Food Storage Place (Corabastos)	1	29	3	-	-
Kindergartens and Community Centers	54	34	7	-	-
Cundinmarca					
Emergency Commanding Center (Locality Offices)	7	5	2	1	1
Fire Fighting Stations	4	3	-	-	-
Police Stations	12	6	-	-	-
Civil Defense	2	2	-	-	-
Red Cross	3	-	2	-	-
Hospitals	25	28	1	1	-
Army	1	-	-	-	-
Schools (Public and Private)	11	8	-	-	-

Source: JICA Study Team

In order to identify important public buildings, the study team proposed to set criteria for the selection:

Table 5.2.2 Criteria for Building Selection

Priority	Building Type
First Priority	Commanding center Headquarter of rescuer operation organization Important Hospital
Second priority	Rescue operation building Hospitals Regional evacuation site buildings
Third priority	Other potential evacuation buildings Other important government buildings

Source: JICA Study Team

According to these criteria, the study team identifies the important public buildings in the study area.

(2) Lists of priority building

The list of priority building is shown in Table 5.2.3 and 5.2.4.

Table 5.2.3 Priority Building for Reinforcement in Bogotá City

Category	Facility Name	Building Type	Floor Area (m²)	Remarks
FIRST PRIORITY:				
Emergency Command Centers	Ministry of Interior (Kra 8 #8-09)	Masonry	3,861	Very old buildings from 1860
	OPAD (Kra 58 # 10-05)	Masonry	600	Common neighborhood house
	Cundinamarca´s Prefecture (Avenida El Dorado # 47-73)	Concrete	38,187	Built one year before the new building code NSR-98 was passed
	19 Locality Offices	Masonry	19,420	Not possible to collect data for Ciudad Bolívar Locality only
		Concrete	17,740	
Organizations for Rescue Operation	Police Headquarters La Estanzuela (Av. Caracas # 6-51)	Concrete	8,500	Operative Police Headquarters and available force in emergency cases
	Civil Defense Headquarters (Kra 27A # 52-60 - Galerías)	Concrete	720	Operatve and Administrative Headquarters for Bogotá only
	Red Cross Headquarters (Avenida 68 # 66-31)	Concrete	9,800	Red Cross National Headquarters and Emergency Services
	Central Command of Army (Avenida El Dorado - Kra 52)	Concrete	31,800	Buildings built almost 50 years ago
Important Hospitals	38 Hospitals and Clinics with Level III Service	Masonry	97,234	Level III Hospitals have more than 30 beds and offer surgery services. Several of them have vulnerability study or is undergoing one.
		Concrete	500,518	
SECOND PRIORITY:				
Category	Facility Name	Building Type	Floor Area (m²)	Remarks
Rescue Operation Buildings	13 Fire Fighting Stations	Masonry	9,866	7 of 13 Fire Fighting Stations have Vulnerability Study
		Concrete	4,136	
	27 Police Stations	Masonry	149,620	Source of information is the Construction and Maintenance Group of the Bogotá Police
		Concrete	900	
	14 Civil Defense Branches	Concrete	11,770	Mainly neighborhood houses
	124 Army Buildings	Masonry	79,815	Mainly buildings of 30 to 40 years old. Building type "Others" includes prefabricated and steel frames.
		Concrete	179,665	
		Others	25,848	
Hospitals	15 Hospitals and Clinics	Masonry	8,468	Hospitals and Clinics of Levels I and II
		Concrete	50,740	
Regional Evacuation Sites	Parks & Open Spaces	Concrete	68,236	Information source is the IDRD
		Steel	22,675	
THIRD PRIORITY:				
Category	Facility Name	Building Type	Floor Area (m²)	Remarks
Other Potential Evacuation Sites	84 Kindergarten Buildings	Masonry	21,367	Information source is the DABS. Several kindergartens are operated in neighborhood houses.
		Concrete	8,942	
		Others	1,788	
Other Important Government Buildings	28 Ministries Buildings	Masonry	20,962	There are many buildings over 70 years old. Buildings of steel type belong to the Agriculture Ministry.
		Concrete	247,834	
		Steel	10,000	
Transportation	Airport(Passenger & Cargo Terminals)	Masonry	1,639	
		Concrete	149,065	
	Bus Terminal of Bogotá	Concrete	37,665	Built in 1984 (better to check)
Goods Storage Site	Corferias - Exhibition Center	Concrete	39,811	16 buildings are without reinforcement at the moment; 11 have reinforcement works
		Steel	5,597	
Food Storage Site	Corabastos	Masonry	5,422	Correspond to 33 buildings within the food storage complex
		Concrete	65,046	
		Steel	15,900	

Source: JICA Study Team

Table 5.2.4 Priority Reinforcement Building in Cundinamarca

Within Cundinamarca:

FIRST PRIORITY:				
Category	**Facility Name**	**Building Type**	**Floor Area (m²)**	**Remarks**
Emergency Command Centers	Local Major's Offices	Masonry	5,768	Correspond to 14 buildings. Building type "Other" is over 100 years old.
		Concrete	8,614	
		Other	2,340	
Organizations for Rescue Operation	Fire Fighting Stations	Masonry	394	Correspond to 5 of the municipalities with Fire Fighting Force
		Concrete	2,568	
	Police Stations	Masonry	4,128	Information source is field survey of 14 police buildings
		Concrete	4,266	
	Civil Defense	Masonry	261	Only 4 municipalities have Civil Defense Force
		Concrete	475	
	Red Cross	Masonry	72	About 1815 m² of "Other" building type have adobe frames.
		Other	1,865	
	Army	Masonry	498	Air Force Maintenance Facility located in Madrid
Important Hospitals	Hospitals and Clinics	Masonry	4,340	Hospitals and clinics of Levels I and II (public and private)
		Concrete	8,079	
SECOND PRIORITY:				
Category	**Facility Name**	**Building Type**	**Floor Area (m²)**	**Remarks**
Hospitals	Health Consulting Centers	Masonry	13,978	Include 46 Health Consulting Centers (public & private) in the eight municipalities
		Concrete	38,149	
Regional Evacuation Sites	Parks & Open Spaces	Concrete	15,800	Municipal Stadiums in Facatativá and Mosquera
THIRD PRIORITY:				
Category	**Facility Name**	**Building Type**	**Floor Area (m²)**	**Remarks**
Other Potential Evacuation Sites	Schools & Kindergarten Buildings	Masonry	49,659	Correpond to 415 school and kindergarten (public and private) buildings in the eight municipalities
		Concrete	133,427	
		Other	15,542	

Source: JICA Study Team

2) Masonry Building Improvement

The building database shows that more than 81 percent of the buildings are masonry structure. The masonry building, however, would have affected most damage among the other building structures. Since the human casualty and injured person is linked with the building damage, the building damage would cause major part of earthquake damage. Therefore, reduction of building damage could contribute earthquake damage decrease.

It is urgent that weak buildings improve its structure for seismic resistance structure. Most of masonry structure building is used for the residential purposes and owned by the resident. The

improvement of masonry structure building, therefore, is responsible for each owner. However, most of building owner has a little motive of improvement of the weak housing because of ignorance of earthquake building damages.

The other issue is stop construction of new masonry building. The Curadurias Urbanas is responsible for authorizing and controlling licenses of urban development and building construction. The responsibility of the organization includes in the examination of construction licenses, yet the capacity of the office is not enough to cover constructed new house in each year. The capacity of the Curaduria Urbanas should increase to cover new construction house.

The summary of the number of the building is shown as follows:

Table 5.2.5 Number of Weak Building in the Study Area

	Number of Buildings		
	Bogotá	**Cundinamarca**	**Total**
Estrato 1 and 2	340,989	36,482	377,471
Estrato 3 and 4	304,168	73,260	377,428
Estrato 5 and 6	20,215	2,233	22,448
Total	**665,372**	**111,975**	**777,347**

Those buildings should improve its structure for seismic resistance. In order to improve seismic resistance, the government should consider following points. The problems of the improvement of the weak building can be categorized into three items: 1) insufficient technical accumulation for improvement of masonry building, 2) lack of financial support and 3) lack of public awareness for weak building improvement.

3) Road and Bridge

(1) Emergency road network

A. General

Under regional scale of the urban disaster event, collapsed road facility and obstacle on road would disturb major part of the present road network. Failure of road network system would cause rescuer to face difficulty to access damage site, because emergency vehicles could not pass the road. The study team found the expected collapsed items are summarized as follows:

Table 5.2.6 Summary of the Collapsed Items

Facility	Items
Road Facility	collapsed bridge girders of road and pedestrian, street lighting poles, traffic signals and poles, traffic and guide signboards and poles, fallen street trees, etc.
Lifeline Facility	collapsed electric and telephone poles, short-circuit by downed electric cables, flood by collapsed water pipes and sewers, gush out natural gas and fire/explosion from collapsed pipe, etc.
Falling Object	collapsed building, wall brick and window glass of damaged building, sign and bill boards, brick fences/wall, water high tanks, etc.

The major part of a traffic signal system will not work properly due to physical damage on the system and power failure. Moreover, the narrow roads may not be passed due to collapsed items. Since private vehicle often disturbs the emergency vehicle operation, it should be restrict to pass the road.

B. Emergency road network

The existing road network in the Study Area has constructed to form hierarchy road network system. The primary road has enough space for more than 100 meter of width and has formulated basic urban structure. The secondary road network also well developed in the Study Area.

After a disaster, the emergency transportation is the fundamental operation for emergency response. In order to secure emergency transportation, transport means and route should be established before the disaster situations. The basic idea of emergency road network is summarized as follows:

- Emergency road should be connected between the Study Area and other region.
- Emergency road network should be hierarchy road system.
- The alternative routes should be considered before the disaster.
- Emergency road allows operating only emergency vehicles and traffic police should control the traffic.
- Emergency road should have first priority for clearing activities.

Emergency road network system should be established in the Study Area. The emergency road network is defined as the emergency transportation network to operate search and rescue, first aid and medical treatment, lifeline repair and transport of emergency goods. The emergency road network should connect important emergency response organizations and facilities within the area.

The emergency road network should be formed as hierarchy system as shown below:

Table 5.2.7 Criteria for Emergency Road Network Selection

Classification	Descriptions
Primary Network	Commanding center Important government buildings Important transportation facilities, such as airport
Secondary Network	Emergency response organizational buildings Lifeline companies Hospitals Other important facilities for emergency operation

Source: Regional Disaster Prevention Plan (1998), Tokyo Metropolitan Government

C. Selection of emergency road network

The study team identifies primary and secondary emergency road network in the Study Area. The primary road network has connected important emergency commanding centers at local and regional level. The secondary network covers the important emergency response organizational buildings and facilities.

The primary emergency road network is almost same as primary road network in the Study Area. The secondary emergency road network is primary road as well as secondary road network in the Study Area. The emergency road network covers the whole stud area and connects important buildings and facilities.

The study team identifies regional food supply corridor, which connects other regions and the Study Area. Five national roads are identified for this purpose: Via Melgar, Via Sasaima, Autopista Medellin, Via a Tunja and Via Villavicencio.

Bogotá City has depended on the food and logistic supply from outside region and those roads are the most important road for this purpose. Therefore, the regional food supply corridor is the same importance as emergency road network.

The Figure 5.2.1 shows the emergency road network.

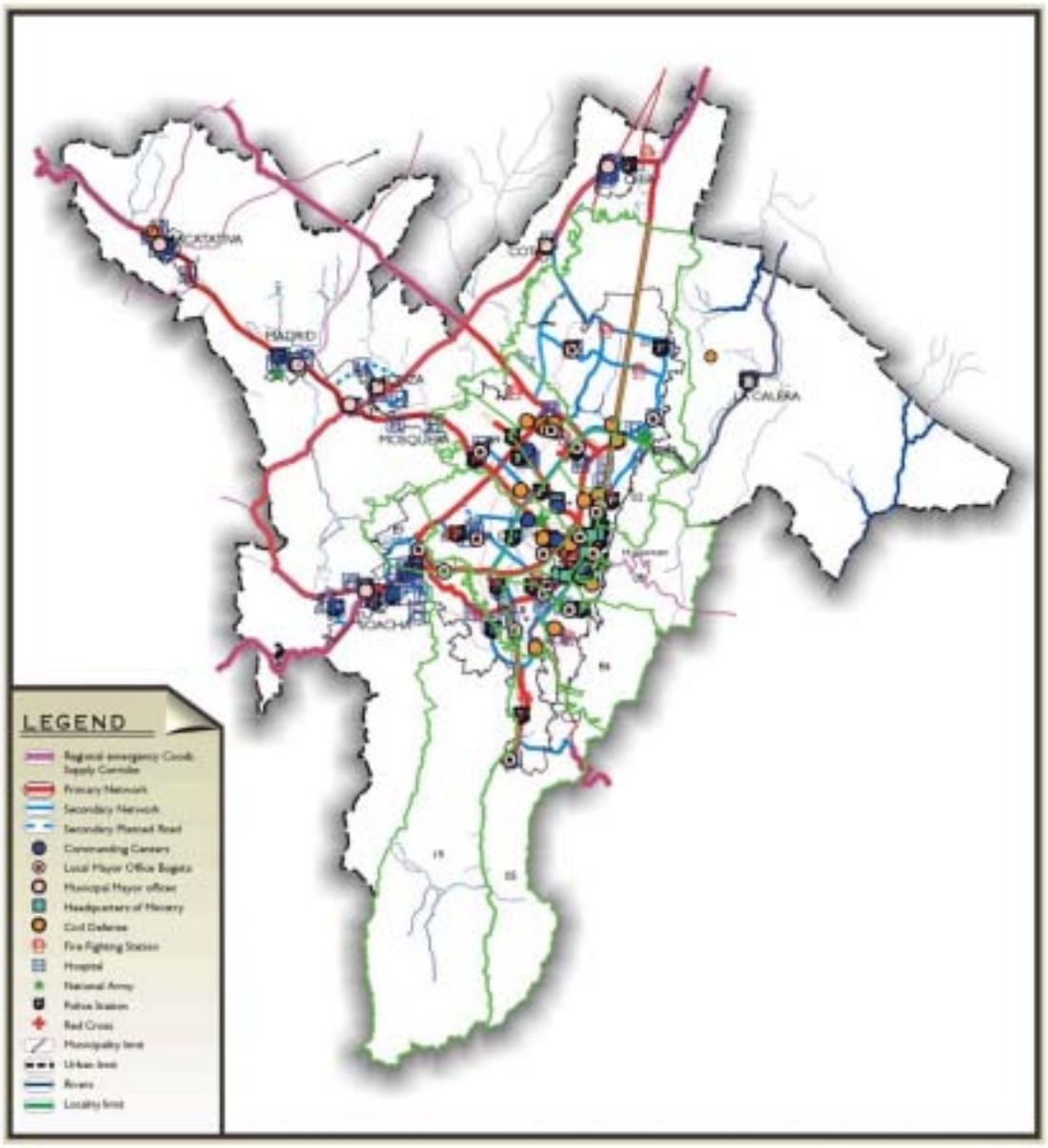


Figure 5.2.1 Emergency Road Network

D. Clearing for the emergency road network after disaster

On the emergency road network, it is required to clear-up activities due to the earthquake damage. The road network would not work properly just after the disaster because of collapsed obstacles and damages on the lifeline system.

The government should designate responsible organizations for such activities. The responsible organizations (Bogotá city: IDU, Cundinamarca prefecture: INVIAS, Cundinamarca and Municipalities) should prepare the teams and heavy equipment or machinery for the clean-up activities in the responsible areas.

(2) Bridge

A. Bridge reinforcement

58 bridges are anticipated to collapse during heavy earthquake by the Study. 80% of those bridges are located in southern part of Bogotá city, Kennedy, Puente Aranda, Tunjuelito, Rafael Uribe, etc. where high liquefaction potential is anticipated. Table 5.2.8 shows the list of bridges anticipated to collapse. 46 bridges are on the emergency roads. 37 bridges are located in liquefaction area.

Table 5.2.8 List of Bridges Anticipated to Collapse

	Bridge Location	BRIDGE_ID	TYPE	ER	Liq Area
1	Avenida Boyaca Carrera25 (Rio Tunjuelito)	R13	River		○
2	Autopista Sur (Rio Tunjuelito)	R15	River	◎	○
3	Autopista Sur (Rio Tunjuelito)	R16	River	◎	○
4	Autopista Sur (Canal)	R17	River	◎	○
5	Autopista Sur (Canal de la Albana)	R18	River	◎	○
6	Avenida Ontario (Canal de la Albana)	R19	River		○
7	Avenida Boyaca (Rio Fucha)	R2	River		○
8	Avenida 27 Sur (Canal de la Albana)	R20	River		○
9	Avenida Caracas (Canal de la Albana)	R21	River	○	○
10	Carrera 40 (Canal)	R22	River		○
11	Avenida 1 de Mayo (Canal)	R23	River	○	○
12	Avenida 1 de Mayo (Canal de la Albana)	R24	River	○	○
13	Autopista Sur (Rio Fucha)	R25	River	◎	○
14	Avenida Ontario (Rio Fucha)	R26	River	◎	○
15	Avenida la Hortua (Rio Fucha)	R27	River		○
16	Avenida la Hortua (Rio Fucha)	R27A	River		○
17	Avenida Caracas (Rio Fucha)	R28	River	◎	○
18	Avenida del Libertador (Rio Fucha)	R29	River	○	○
19	Carrera 7 (Rio San Cristobal)	R30	River		○
20	Calle 20 Sur (Rio San Cristobal)	R31	River	○	○
21	Carrera 86 (Rio TTunjuelito)	R32	River		
22	Avenida las Americas (Rio Fucha)	R33	River	○	○
23	Carrera 68 (Rio Fucha)	R34	River	○	○
24	Carrera 68 (Canal)	R35	River	○	○
25	Transversal 40 (Rio Fucha)	R36	River		○
26	Avenida Jorge Gaitan Cortes (Rio Tunjuelito)	RA27	River		○
27	Avenida Ciudad Villavicencio (Rio Tunjuelito)	RA28	River	◎	
28	Avenida Ciudad de Quito por Calle 13	V1	Vehicle	◎	○
29	Avenida Ciudad de Quito por Calle 68	V10	Vehicle	◎	
30	Avenida Ciudad de Quito por Calle 80	V12	Vehicle	◎	
31	Avenida Ciudad de Quito por Calle 80	V13	Vehicle	◎	
32	Avenida Ciudad de Quito por Calle 92	V14	Vehicle	◎	
33	Avenida Ciudad de Quito por Calle 92	V15	Vehicle	◎	
34	Avenida Calle 26 por Av. 68	V28	Vehicle	◎	
35	Avenida Calle 26 por Av. Boyaca	V30	Vehicle	◎	
36	Autopista Norte por Calle 100	V37	Vehicle	◎	
37	Autopista Norte por Calle 116	V39	Vehicle	◎	
38	Autopista Norte por Calle 134	V41	Vehicle	◎	
39	Autopista Norte por Calle 170	V44	Vehicle	◎	
40	Avenida Boyacá por Av. Villavicencio	V45	Vehicle	◎	○
41	Avenida Boyacá por Av. Villavicencio	V46	Vehicle	◎	
42	Avenida Boyacá por Av. 1o. De Mayo	V47	Vehicle	○	○
43	Avenida Boyacá por Av. 1o. De Mayo	V48	Vehicle	○	○
44	Avenida Boyacá por Av. 1o. De Mayo	V48A	Vehicle	○	○
45	Avenida Boyacá por Calle 13	V49	Vehicle	◎	○
46	Avenida Boyacá por Calle 80	V51	Vehicle	◎	
47	Avenida Boyacá por Calle 80	V52	Vehicle	◎	
48	Avenida Boyacá por Autopista Sur	V53	Vehicle	◎	○
49	Avenida Boyacá por Autopista Sur	V53A	Vehicle	◎	○
50	Avenida Carrera 68 por Calle 13	V56	Vehicle	◎	
51	Avenida Carrera 68 por Calle 68	V57	Vehicle	○	
52	Avenida Carrera 68 por Calle 80	V58	Vehicle	◎	
53	Avenida de las Américas por Av. Ciudad de Quito	V61	Vehicle	◎	
54	Avenida de las Américas por Av. El Espectado	V67	Vehicle	○	○
55	Avenida de las Américas por Av. Boyaca	V68	Vehicle	○	○
56	Avenida de las Américas por Av. Boyaca	V69	Vehicle	○	○
57	Avenida Ciudad de Quito por Calle 53	V7	Vehicle	◎	
58	Avenida Circunvalar por Barrio Egipto - Cra. 4a. E No. 10 - 26	V70	Vehicle		○

Note: ER(Emergency Road Network) : ◎ Primary Road Network, ○ Secondary Road Network
Liquification area ○
Source: JICA Study Team

Damages of vehicular flyover bridges are anticipated at intersections of main roads, such as intersections of Autopista Norte at Avenida Ciudad de Quito and at Avenida de Espana and Avenida 100, of Autopista Medellin at Avenida Boyaca, at Avenida de Espana and at Avenida Ciudad de Quito, of Autopista el Dorado.

Table 5.2.9 Classification of Priority for Bridge Improvement

Priority	Descriptions
Priority 1	- Vehicle bridge on the emergency road - Pedestrian bridges on the emergency road
Priority 2	- Vehicle bridges in the liquefaction areas - Pedestrian bridges in the liquefaction area
Priority 2	- All collapsed vehicle bridge - All pedestrian bridge except other bridges

Besides the number of pedestrian bridges on the emergency road is around 140 and about 30 of 140 are located in liquefaction area. Table 5.2.10 shows the recommendation of priority of bridge improvement considering the emergency road and liquefaction area.

Table 5.2.10 Priority of Bridge Improvement

	Bridge Location	Bridge ID	Priority	Detour
1	Avenida Boyaca Carrera25 (Rio Tunjuelito)	R13	Priority 3	N
2	Autopista Sur (Rio Tunjuelito)	R15	Priority 1	N
3	Autopista Sur (Rio Tunjuelito)	R16	Priority 1	N
4	Autopista Sur (Canal)	R17	Priority 1	Y
5	Autopista Sur (Canal de la Albana)	R18	Priority 1	N
6	Avenida Ontario (Canal de la Albana)	R19	Priority 3	N
7	Avenida Boyaca (Rio Fucha)	R2	Priority 3	N
8	Avenida 27 Sur (Canal de la Albana)	R20	Priority 3	N
9	Avenida Caracas (Canal de la Albana)	R21	Priority 1	Y
10	Carrera 40 (Canal)	R22	Priority 3	N
11	Avenida 1 de Mayo (Canal)	R23	Priority 2	N
12	Avenida 1 de Mayo (Canal de la Albana)	R24	Priority 2	N
13	Autopista Sur (Rio Fucha)	R25	Priority 1	Y
14	Avenida Ontario (Rio Fucha)	R26	Priority 1	Y
15	Avenida la Hortua (Rio Fucha)	R27	Priority 3	N
16	Avenida la Hortua (Rio Fucha)	R27A	Priority 3	N
17	Avenida Caracas (Rio Fucha)	R28	Priority 1	Y
18	Avenida del Libertador (Rio Fucha)	R29	Priority 2	Y
19	Carrera 7 (Rio San Cristobal)	R30	Priority 3	Y
20	Calle 20 Sur (Rio San Cristobal)	R31	Priority 2	Y
21	Carrera 86 (Rio TTunjuelito)	R32	Priority 3	N
22	Avenida las Americas (Rio Fucha)	R33	Priority 2	N
23	Carrera 68 (Rio Fucha)	R34	Priority 2	N
24	Carrera 68 (Canal)	R35	Priority 2	N
25	Transversal 40 (Rio Fucha)	R36	Priority 3	N
26	Avenida Jorge Gaitan Cortes (Rio Tunjuelito)	RA27	Priority 3	N
27	Avenida Ciudad Villavicencio (Rio Tunjuelito)	RA28	Priority 1	N
28	Avenida Ciudad de Quito por Calle 13	V1	Priority 1	Y
29	Avenida Ciudad de Quito por Calle 68	V10	Priority 1	Y
30	Avenida Ciudad de Quito por Calle 80	V12	Priority 1	Y
31	Avenida Ciudad de Quito por Calle 80	V13	Priority 1	Y
32	Avenida Ciudad de Quito por Calle 92	V14	Priority 1	Y
33	Avenida Ciudad de Quito por Calle 92	V15	Priority 1	Y
34	Avenida Calle 26 por Av. 68	V28	Priority 1	Y
35	Avenida Calle 26 por Av. Boyaca	V30	Priority 1	Y
36	Autopista Norte por Calle 100	V37	Priority 1	Y
37	Autopista Norte por Calle 116	V39	Priority 1	Y
38	Autopista Norte por Calle 134	V41	Priority 1	Y
39	Autopista Norte por Calle 170	V44	Priority 1	Y
40	Avenida Boyacá por Av. Villavicencio	V45	Priority 1	N
41	Avenida Boyacá por Av. Villavicencio	V46	Priority 1	N
42	Avenida Boyacá por Av. 1o. De Mayo	V47	Priority 2	Y
43	Avenida Boyacá por Av. 1o. De Mayo	V48	Priority 2	Y
44	Avenida Boyacá por Av. 1o. De Mayo	V48A	Priority 2	Y
45	Avenida Boyacá por Calle 13	V49	Priority 1	Y
46	Avenida Boyacá por Calle 80	V51	Priority 1	N
47	Avenida Boyacá por Calle 80	V52	Priority 1	N
48	Avenida Boyacá por Autopista Sur	V53	Priority 1	Y
49	Avenida Boyacá por Autopista Sur	V53A	Priority 1	Y
50	Avenida Carrera 68 por Calle 13	V56	Priority 1	Y
51	Avenida Carrera 68 por Calle 68	V57	Priority 1	Y
52	Avenida Carrera 68 por Calle 80	V58	Priority 1	Y
53	Avenida de las Américas por Av. Ciudad de Quito	V61	Priority 1	Y
54	Avenida de las Américas por Av. El Espectado	V67	Priority 2	Y
55	Avenida de las Américas por Av. Boyaca	V68	Priority 2	Y
56	Avenida de las Américas por Av. Boyaca	V69	Priority 2	Y
57	Avenida Ciudad de Quito por Calle 53	V7	Priority 1	Y
58	Avenida Circunvalar por Barrio Egipto - Cra. 4a. E No. 10 - 26	V70	Priority 3	Y

Source: JICA Study Team

4) Lifeline

(1) Disaster prevention of facility

Disaster prevention of facility is quite important role in disaster preparedness. Usually, following factors are considered in disaster prevention of facility

- Inspection and maintenance of Purifier, Distribution tanks, pipeline, mechanical and electrical equipment etc.
- Seismic vulnerability study for plant and pipeline
- Reinforcement of earthquake resistance of intake, purifier, distribution tank, pipeline, supply equipment
- Renewal or replacement of aged pipeline and installation of seismic resistant joint and tube where necessary
- Reinforcement of mechanical and electrical equipment
- Installation of emergency shut down valve
- Reinforcement of effective volume for preparation as emergency response measures
- Block supply system; diversification of facilities and mutual connection, Large blocks and small blocks for confining damaged supply area
- Reinforcement of Backup function; mutual supplement within large block and among large blocks, bypass
- Seismic resistant of trunk and supply pipeline (joint, expansive and flexible pipe piece), preparation of emergency equipment
- Countermeasure as total water supply system
- Pluralization of facility, installation of bypass route at distribution tank etc.,
- multi-flow line,
- Securing of material & equipment
- Custody of drawings and document
- Education and Training
- Order of reinforcement/repair

The following facilities are recommended as priority first. Especially facilities located in high liquefaction potential area should have high priority.

- Facility apt to cause the secondary disaster
- Facility apt to affect important facility such as evacuation place, hospital, prevention base, etc
- Upstream facility

The Study Team recommends seismic vulnerability study and reinforcement work should be performed to the tank and pump station located in high liquefaction potential area and purification plant, pipeline in the priority as shown in table 5.2.11.

Table 5.2.11 Priority of Seismic Vulnerability and Reinforcement

Priority	Facility	Remarks
Priority 1	Distribution Tank Santa Lucia with pump station Jalisco Castillo El Volador Casa Blanca with pump station Sierra Morena II with pump station Sierra Morena III Cazuca Cazuca IV Julio Rincón with pump station	Those tank facilities are located in high liquefaction potential area are seem to be reinforced where necessary for emergency water supply.
Priority 2	Transportation and distribution pipe laid in weak soil	Upstream facility is more important. Large movement is anticipated if those facilities are located in weak soil.
Priority 3	Purification plant and distribution plant Laguna plant with tank Laguna Tank Uval with pump station Tank Monteblanco with pump station	Those facilities are located in relatively high ground acceleration area.
Priority 4	Supply facility 1) Reinforcement of branch	Small leakage is usually found at branch
Priority 5	Other plant, pipeline and facility	Other plant, pipeline and facility seem to have less damage and last priority is allocated for reinforcement.

Source: JICA Study Team

(2) Target volume for emergency water supply

It is recommended to prepare minimum target volume plan after disaster break out. Target volume of storage for emergency water supply has to be estimated based on the minimum target volume. The minimum target volumes are set stepwise according to the elapsed time after disaster. An example of Japan is shown as follows;

- Supply water to keep life by manual transportation within 3 days after disaster
- Temporary water supply and each house supply within 2 weeks after disaster
- To maintain and reinforce water supply system to usual operation and to wider supply

The example of minimum target volumes in Japan is shown as follows:

- Up to 3rd day: 3 litters/person
- From 4th to 10th day: 20 to 30 litters/person
- From 11th to 20 day: 30 to 40 litters/person

Table 5.2.12 shows the capacity of existing distribution tanks and water volume per person in locality wise.

Present allowable water volume per person is 55litter in Bogotá city as a whole and 0.7 litter in Eight Municipalities.

Only four localities, Chapinero, Santa Fe, San Cristobal and Usme have certain water supply capacity by existing tank facility. But it is insufficient capacity except Santa Fe.

The study team recommends installing emergency water supply facilities as shown priority.

- The existing water purification tanks improve to emergency water facilities
- Every regional parks should install emergency waster tanks
- The southern part of Bogotá should have priority for improvement of emergency tanks

The recommended tanks with volume are shown in Table 5.2.12.

Table 5.2.12 Recommended Emergency Water Tank Installation

Locality	Existing Water Tank			Proposed Emergency Tanks (m3)			
	Volume (m3)	Population	Capacity (liter)	Unit	Total	Total Volume	Capacity (liter)
Bogota							
Usaquén	4,106	421,320	9.7	2,500x2	5,000	9,106	21.6
Chapinero	8,619	122,991	70.1	-	-	8,619	70.1
Santa Fé	133,600	107,044	1,248.1	-	-	133,600	1248.1
San Cristóbal	22,886	455,028	50.3	-	-	22,886	50.3
Usme	9,000	244,270	36.8	-	-	9,000	36.8
Tunjuelito	0	204,367	-	5,000x1	5,000	5,000	24.5
Bosa	0	410,099	-	2,000x5	10,000	10,000	24.4
Kennedy	0	912,781	-	2,500x6 4,500x1	19,500	19,500	21.4
Fontibón	0	278,746	-	6,000x1	6,000	6,000	21.5
Engativa	0	749,068	-	2,500x6	15,000	15,000	20.0
Suba	6,000	706,528	8.5	1,000x3 2,000x4	11,000	17,000	24.1
Barrios Unidos	0	176,552	-	1,000x4	4,000	4,000	22.7
Teusaquillo	0	126,125	-	1,000x3	3,000	3,000	23.8
Los Martires	0	95,541	-	2,000x1	2,000	2,000	20.9
Antonio Nariño	0	98,355	-	1,000x2	2,000	2,000	20.3
Puente Aranda	0	282,491	-	3,000x2	6,000	6,000	21.2
La Candelaria	0	27,450	-	600x1	600	600	21.9
Rafael Uribe	0	384,623	-	2,000x4	8,000	8,000	20.8
Ciudad Bolivar	167,710	575,549	291.4	-	-	167,710	291.4
Bogota	**351,921**	**6,378,928**	**55.2**	**-**	**97,100**	**449,021**	**70.4**
Cundinamarca							
Chia	0	61,783	-	1,500x1	1,500	1,500	24.3
Cota	0	14,784	-	400x1	400	400	27.1
La Calera	0	24,188	-	600x1	600	600	24.8
Facatativá	0	90,266	-	1,000x2	2,000	2,000	22.2
Funza	0	51,808	-	1,200x1	1,200	1,200	23.2
Madrid	0	52,110	-	600x2	1,200	1,200	23.0
Mosquera	0	27,753	-	800x1	800	800	28.8
Soacha	400	283,889	1.4	2,000x3	6,000	6,400	22.5
Cundinamarca	**400**	**606,581**	**0.7**	**-**	**13,700**	**14,100**	**23.2**

Source: JICA Study Team

The emergency tanks are arranged at localities where water supply capacity is short for emergency supply. Thus emergency water tank is not allocated in Chapinero, Santa Fe, San Cristobal and Usme which have enough supply capacity for emergency.

Emergency water tank volume are provided to supply almost of target volume which are decided on condition that inhabitant endure one week after disaster with a minimum water consumption of 3 litter/day/person. It means water supply system should be recovered somewhat at least one week after disaster.

Sewerage pipeline is also recommended to install nearby or in the regional evacuation place to ensure a minimum sanitary life for evacuated people. Necessary valves, pipe installation and faucet should be provided for sewerage pipeline.

(3) Electrical supply system

In all substations where vulnerability study is already performed, adequate vigilance, general maintenance, neatness and cleanliness are made according to the vulnerability study report.

The following items are generally recommended for preparing or detailing of the disaster preparedness plan:

- Sufficient Seismic design where necessary
- Vulnerability study for each plant and facility first should be performed.
- Disaster preparedness plan and emergency response plan should be prepared based on the vulnerability study result.
- It is preferable to select the important facility and to prepare those plans with respect to the selected facility as concretely as possible.
- It is recommended to refer to JICA study result for preparing concrete plans.

A. Vulnerability study of existing plant and facility

Vulnerability study should be carried out to existing plant and facility in order to clarify where the vulnerability exist in each plant and facility.

According to the existing vulnerability study, there found two main details of vulnerability that should be reinforced as soon as possible. They are reinforcement of the fixing of the voltage transformers to the foundation base and of the brace of some cooling tanks for this kind of transformers. Proper device should be prepared to prevent the derailing of transformer.

Bushing equipment should be seismically reviewed and if necessary reinforced

The buildings where instrumentation and control panels are accommodated, should be reviewed and if necessary revised, taking in consideration the seismic resistant code for buildings.

If some weak structures are found by the vulnerability study, they should be reinforced as seismic prevention measures.

Relatively high damages to overhead cable are anticipated in such localities as San Cristobal, Usme, Kennedy, Teusaquillo, Puente Aranda, Rafael Uribe Ciudad Bolivar and Soacha. Those localities are almost located in high liquefaction potential area and in relatively high seismic intensity based on the result of the Study.

Plant and facility located in those localities seem to have high priority to perform vulnerability study.

B. Proper seismic design for new construction or reinforcement of plant and facility

Proper seismic design is recommended to building, structure and equipment etc. in accordance with the relevant design codes as well as the result of 1997 Micro-Zonation Study and to apply rational measures to reinforce earthquake resistance if necessary.

C. Stable supply of electricity

Whole electricity supply system consists power generation, transmission, substation, and distribution. In addition, transmission is connected with the national transmission system most part of which institution, ISA (Interconexión Eléctrica S.A.) is in charge of.

Stable supply will be ensured during seismic disaster in the Bogotá Metropolitan Area. But the system around Bogotá City area is divided into major 3 institutions as mentioned before.

It is recommended to have close cooperation among major institutions for stable electric supply in an emergency.

Also, It is recommended to install additional transmission line to important one in order to have redundancy as dual line. Especially, transmission line, which is installed in high liquefaction area, has high priority to consider the dual line system or reinforce properly to increase redundancy.

D. Organization

It is necessary to establish coordination committee among the related institutions in order to discuss and prepare disaster preparedness plan considering electric supply system as a whole.

(4) Gas supply system

A. General

Increase of seismic resistance in structure and pipeline is major factor for disaster preparedness. It is required to implement rational seismic prevention measures considering the importance of the facilities.

The following is recommendation for preparation of disaster preparedness plan because Gas Natural doesn't prepare any specific disaster preparedness plan and there is a little information on the plan.

B. Disaster prevention of facility

If there is a plan to construct new facility, rational seismic design based on current design procedure should be applied considering liquefaction where necessary.

Existing facility should be evaluated against seismic resistance and be reinforced if necessary.

Further study is recommended to perform to the pipeline network and other facilities referring to JICA study result in order to know, in detail, the necessity of reinforcement of emergency shutdown device and other reinforcement against earthquake disaster.

Current materials such as steel pipe and polyethylene pipe are recommended to use in a newly constructed pipeline because those material are high seismic resistant.

Renewal or replacement of aged pipeline is recommended especially in high liquefaction potential area.

Promotion of block supply system is recommended in order to distinguish supply stop area and continuous supply area.

The Study Team visited the City Gate receiving station. Followings are recommendation based on the site visit.

The support of pipe and fittings is recommended to reinforce because the pipe support seems vulnerable against earthquake due to that support is somewhat slender and no bundle or other fixing device is not applied at saddle support.

Reinforcement of control house is also recommended to examine earthquake vulnerability because all control equipment is accommodated in the house.

C. Measures and installation of equipment for emergency situation

Importance for emergency measures is to prevent secondary disaster due to damage during earthquake. Necessary equipment or emergency measures is recommended to apply to facility and routine training should be planned for emergency use. Those measures and equipment are listed as follows;

- Monitoring and alarm devices; seismic sensor, leakage sensor, fire alarm, where necessary
- To divide distribution pipeline into certain blocks of network
- Installation of emergency shutdown valves where necessary

(5) Telecommunication system

A. General

As above mentioned, there is no information available for present disaster preparedness and emergency response plan, only requisite recommendation is made for preparation of those plans.

B. Recommendation for disaster preparedness plan

It is recommended that securing of telephone communication network, rational measures to reinforce earthquake resistance considering importance of facilities and reduction of congestion of telephone line after disaster be incorporated into the plans. Besides, promotion of fire-preventive structure and buildings are recommended for disaster preparedness.

The following items are generally recommended for preparing or detailing of the disaster preparedness plan:

- Vulnerability study for each plant and facility should be performed first.
- Disaster preparedness plan should be prepared based on the vulnerability study result.
- It is preferable to select the important facility and to prepare the plan with respect to the selected facility as concretely as possible.
- It is recommended to refer to the Study result for preparing concrete plans.

a) Disaster preparedness of buildings and facility

Vulnerability study of existing buildings and facility

Vulnerability study should be carried out not only to the building but also to cables and structures in order to clarify where the vulnerability exist in buildings, cables and structures.

If some weak portions are found by the vulnerability study, they should be reinforced as seismic prevention measures.

Relatively high damages to overhead and underground cable are anticipated in such localities as Chapinero, Santa Fe, San Cristobal, Usme, Bosa, Kennedy, Puente Aranda, Rafael Uribe Ciudad Bolivar and Soacha. Those localities are almost located in high liquefaction potential area and in relatively high seismic intensity based on the result of the Study.

Facility located in those localities seems necessary to have redundancy and to have high priority to perform vulnerability study and if necessary, reinforcement.

Proper seismic design for new construction or reinforcement of plant and facility

Proper seismic design is recommended to building, structure, equipment and cable installation, etc. in accordance with the relevant design codes as well as the result of 1997 Micro-Zonation Study and to apply rational measures to reinforce earthquake resistance if necessary.

Preparation of equipment for ensuring of communication supply in disaster

The followings are recommended to consider for preparation of equipment for disaster.

- Installation of wireless communication equipment,
- Preparation of movable radio station, electricity generator car & movable generator,
- Optical fiber cable for emergency response, portable satellite communication equipment, others

Back up measures

It is recommended take following back-up measures in order to increase of reliability of telecommunication system to keep communication;

- Loop system of main transmission line,
- Multi-transmission system,
- Diversification of monitoring and control system,
- Alternative monitoring and control system,
- Manual for reducing congestion of communication lines after disaster

Especially, facilities, transmission line, which are located in high liquefaction area has high priority to consider proper reinforcement to increase redundancy.

5) Reduction of Vulnerable Area by Urban Redevelopment

(1) Priority areas for development

A. General

In order to identify high risk area for the earthquake damage, the Study Team analyze the area by using variables of evacuation place, population density and building damage ratio. The identfied areas should be priority for the urban re-development.

B. Selection of Priority Area

The result of regional risk classification done in Chapter 3.3 for earthquake was used for the analysis. A unit of analysis is Urban Planning Zone (UPZ) and micro zones, which is established in the study, because it is applied to the urban planning practice in Bogotá. The Study Area can be divided five classifications the following rules.

- Zone 1 where includes the point 5
- Zone 2 where is covered 50% or more with the point 4
- Zone 3 where is covered 50% or less with the point 4
- Zone 4 where is covered by point 3
- Zone 5 where is covered by point 2 and 1

Based on this classification, the priority areas are selected. The results are shown in figure 5.2.2.

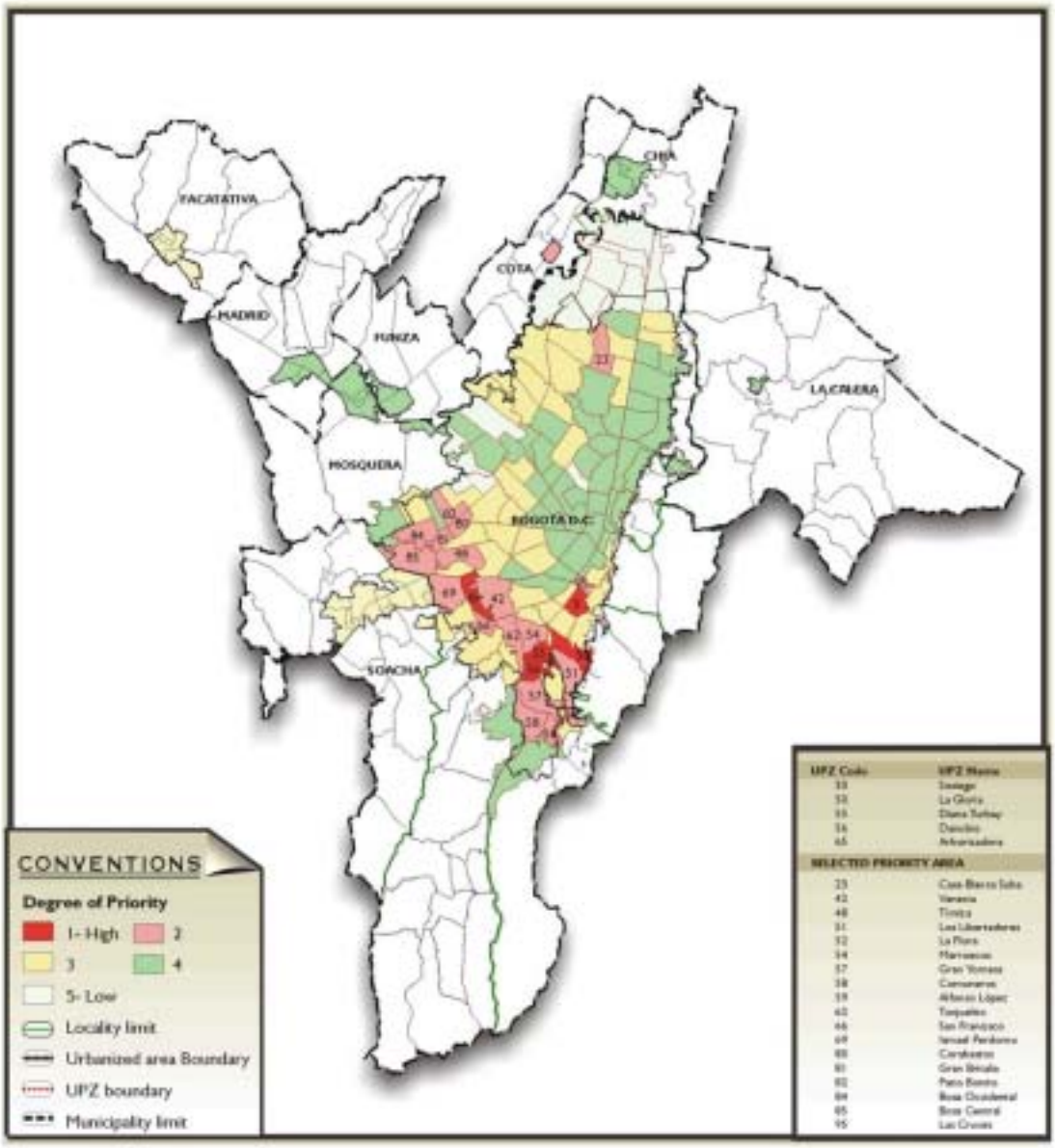


Figure 5.2.2 Priority Area

It is selected five priority areas in the Study Area. The list of the priority area is shown as follows:

Table 5.2.13 Priority Area by UPZ

Locality	UPZ	Ha
San Cristobal	33 Sosiego	235.49
San Cristobal	50 La Gloria	385.88
Usme	56 Danubio	268.11
Rafael Uribe	55 Diana Turbay	182.12
Ciudad Bolivar	65 Arborizadora	326.97
Total		1398.57

The priority area can be categorized by insufficient open space, high density of population and concentration of weak residential buildings. Those areas should have first priority for urban re-development.

The classification results show that send priority area, called selected area for urban re-development. Selected area should have the second priority for urban development.

Table 5.2.14 Selected Area for Urban Re-development

Locality	UPZ	Ha
Santa Fe	95 Las Cruces	98.48
San Cristobal	51 Los Libertadores	389.08
Usme	52 La Flora	206.88
Usme	57 Gran Yomasa	530.24
Usme	58 Comuneros	483.22
Usme	59 Alfonso Lopez	233.54
Bosa	84 Bosa Occidental	717.45
Bosa	85 Bosa Central	402.24
Kennedy	48 Timiza	431.38
Kennedy	80 Corabastos	187.51
Kennedy	81 Gran Britalia	179.41
Kennedy	82 Patio Bonito	314.21
Suba	23 Casa Blanca Suba	419.92
Rafael Uribe	54 Marruecos	358.6
Ciudad Bolivar	66 San Francisco	182.34
Ciudad Bolivar	69 Ismael Perdomo	554.89
Total		5689.39

The integrated risk point for each UPZ is summarized in Appendix 5.2.4. The risk point of each UPZ by the disaster type will be an indicator to the locality and municipality.

The methods of development are summarized as follows:

(1) Redevelopment program

This program is applied to the area of residential or residential and commercial, where the weak buildings are concentrated. It will include the all aspect of disaster mitigation measures to the targeted areas. The development of urbanized area included widening of narrow road and provision of park.

(2) Public education and enlightenment

In order to promote disaster resistance urbanized area, it is important to make a consensus on urban disaster management. The public education and enlightenment is one of the important tools for agreement for the urban development.

(3) Road development program

This program is applied to the area where is composed of narrow roads and concentrated weak buildings. It will include the aspect of only the road widening; however, the widened road will be effective to the disaster mitigation and can be used as the evacuation route.

(4) Open space development program

This program is applied to the area where don't have enough developed open spaces. It aims to create new open space where can be used as the evacuation site in case of emergency.

6) Open Space

After a disaster, evacuation of the residence is required to secure the safety of the victims and to provide effective support to the victims. The evacuation place also formulated as a hierarchy system and organized with evacuation route. The evacuation places and routes should be identified before the disaster situation. In general, the victims would evacuate the community evacuation place after the disaster and move to the regional evacuation place through identified evacuation route.

The evacuation place is classified in the Table 5.2.15.

Table 5.2.15 Summary of Evacuation Place

Level of evacuation place	Descriptions
Community level	Each community should identified evacuation places such as primary school, community park etc. After the disaster situations, the victims are expected to gather in community level evacuation place to identify the lost personnel and then establish community rescue operation.
Regional level	Regional evacuation place required relative huge area. After the disaster situations, secure the life and safety of the victims. The area is utilized for disaster management center at local level.
Temporary shelter	The victims who lost house are expected to provide temporary housing from the government.

Source: Regional Disaster Prevention Plan (1998), Tokyo Metropolitan Government

A. Community level

Identification of the community level evacuation place is matter of urgency. The locality government should select an open space as a community level evacuation place in cooperation with the residents. The possibility of the community level evacuation place is primary or

secondary school, parks and open space etc. Each community member should know his or her evacuation place.

Information and communication system should be established each community before a emergency situation and the community leader should report their damages, causality, injured personnel etc., to the commanding center at local level. The community organization should take initiative to guide the community members in cooperation with police and locality staff after the disaster.

B. Regional level

Regional level evacuation will be taken place when the victims may face the danger of the life and safety at the community level. The residents should move to regional evacuation place after the instruction from the government. The government should inform the community before the disaster situation where the regional evacuation place would be in each community. The respective government should designate the regional evacuation place. The conditions of the regional evacuation place are to keep safety from disaster and the capacity of the evacuation place is sufficient.

The functions of the regional evacuation place are as follows:

- To keep the safety of the victims
- To provide first aid and water supply
- To provide temporary housing space.

In this study, the regional evacuation place is proposed to select whole Study Area. In order to select regional evacuation place, the study team sets the criteria for the regional evacuation place.

- Regional evacuation place is less than 2 km from each community
- Area for one person is 2 m^2
- Total area is more than 5 ha

At first, the study team established the evacuation boundaries for each locality and selected the regional evacuation places in each boundary. The candidates for the regional evacuation places should fulfill the following conditions:

- Public owned land and facilities
- Park, open space and sport ground
- Without any designated and identified natural hazard area
- Without any hazardous chemical facilities in and surrounding area

The public land is the first priority, but some of the localities cannot find public open space. Then the study team selects private land for proposed regional evacuation place. The private land, however, is not appropriate for the regional evacuation place in the long run. The governments should identify another land for the evacuation place.

The list of the proposed regional evacuation places are shown as follows:

Table 5.2.16 List of Regional Evacuation Place in Bogotá City

WITHIN BOGOTA :					
No	*Locality*	*Name of the Place*	*Address*	*Area (Ha)*	*Remarks*
1	1 - Usaquén	Cementerio Jardines de Paz	Autopista Norte Km. 14	59.7	Private Cementery
2	1 - Usaquén	Country Club	Diagonal 129 Carrera 15	92.2	Private Club - Big Golf Curt
3	2 - Chapinero	Parque El Virrey	Calle 87 Y 88 Carrera 15 Y Autopista Norte	16.1	Urban Park, 45% Tree Planted
4	3 - Santa Fé	Parque Nacional	Calle 26 Avenida Circunvalar	14.1	58% Tree Planted , 3% Water Surface
5	4 - San Cristóbal	Parque Nueva Granada	Carrera 1 B No. 20 A 97 Sur	7.4	Barrio Park
6	4 - San Cristóbal	Parque San Cristóbal 1° de Mayo	Calle 18 Y 13 Sur Carrera 3 Y 5 Este	23.0	70% Area available for Evacuation
7	5 - Usme	Parque Famaco	Calle 91 Sur Carrera 53B 55A Este	5.6	85% Available Area , 4% Water Surface
8	5 - Usme	Parque San José	Calle 97 Sur Avenida Caracas	20.5	Metropolitan Propossed (Designed)
9	6 - Tunjuelito	Parque El Tunal	Avenida Mariscal Sucre Carrera 24 y Calle 48B Sur Avenida Boyacá	66.0	89% Available Area , 1% Water Surface
10	7 - Bosa	Parque Laureles Naranjo	Calle 70A Carrera 86 - Diagonal 3A Calle 14C	5.0	Zonal Park
11	7 - Bosa	Parque Villa del Rio II	Calle 55 Sur Carrera 67 I	8.9	Barrio Park
12	7 - Bosa	Parque el Recreo	Proyecto Metrovivienda	15.0	Under design - Zonal Park
13	7 - Bosa	Parque del Rio	Carrera 99A Nº 74A - 09	10.5	Zonal Park, 20% Tree Planted
14	7 - Bosa	Parque Tibanica	Diagonal 73F Sur Transversal 83	20.4	Metropolitan Propossed (Designed)
15	8 - Kennedy	Parque Mundo Aventura	Carrera 71 - 71B Calle 26 Sur	18.3	40% Area available for Evacuation
16	8 - Kennedy	Parque Marsella	Carrera 68 B Avenida Américas a Calle 10	9.5	Barrio Park
17	8 - Kennedy	Parque Cayetano Cañizares	Carrera 86 Entre Calles 40 Y 42D Sur	11.6	20% Built in concrete frames
18	8 - Kennedy	Parque Timiza	Calle 39 a 40 Sur Carrera 70 a 68A	52.0	9% Built (concrete), 40% Water Surface
19	8 - Kennedy	Parque El Tintal	Carrera 84 Calle 13A Y 13B	5.5	6% Built in concrete frames
20	8 - Kennedy	Parque La Igualdad	Avenida Américas - 3A Sur Carrera 68F - Rio Fucha	5.9	Zonal Park Propossed in Recovering
21	8 - Kennedy	Parque Urapanes	Transversal 62A Y 62D Calle 42 Sur	6.9	Barrio Park
22	9 - Fontibón	Parque Canal Boyacá	Carrera 74 Calle 43B	17.5	25% Tree Planted
23	10 - Engativa	Parque Ciudadela Colsubsidio	Carrera 110 a 112 C Entre Calles 83 A 89 B	12.9	30% Tree Planted
24	10 - Engativa	Parque Bonanza	Avenida Boyacá con Calle 72A	9.9	Barrio Park
25	10 - Engativa	Parque San Andrés	Calle 82 Carrera 100	7.4	20% Tree Planted
26	10 - Engativa	Parque Jardín Botánico	Avenida Rojas Calle 63	20.3	65% Tree Planted
27	10 - Engativa	Unidad Deportiva El Salitre	Avenida 68 con Calle 63	25.2	70% Area available for Evacuation
28	10 - Engativa	Parque La Florida	Avenida Engativá Rio Bogotá	279.5	18% Tree Planted , 2% Water Surface
29	11 - Suba	Parque La Gaitana	Carrera 116 con Transversal 116	6.4	30% Tree Planted
30	11 - Suba	Canal Salitre	No Address	7.2	Urban Park
31	11 - Suba	Parque Mirador de Los Nevados	Cerros de Suba	6.6	Urban Park
32	11 - Suba	Carmel Club Campestre	Diagonal 154 Carrera 43	51.1	Private Club
33	11 - Suba	Club Campestre El Rancho	Calle 195 Carrera 45	42.5	Private Club
34	11 - Suba	Club Deportivo Los Arrayanes	Vía Suba - Cota Desviación Carretera Aeropuerto Guaymaral Km.13	78.3	Private Club
35	11 - Suba	Club Los Lagartos	Diagonal 103 Carrera 61	55.1	Private Club
36	12 - Barrios Unidos	Parque Deportivo El Salitre	Calle 63 Carrera (Avenida) 68	66.1	20% Tree Planted , 5% Water Surface
37	12 - Barrios Unidos	Centro de Alto Rendimiento	Calle 63 Carrera 38	57.3	5% Built mainly in concrete frames
38	12 - Barrios Unidos	Parque de Los Novios - El Lago	Calle 63 Carrera 30	22.7	28% Water Surface (Lake mainly)
39	12 - Barrios Unidos	Escuela Militar de Cadetes José María Córdoba	Calle 80 Carrera 38	43.9	Army School
40	13 - Teusaquillo	Parque Virgilio Barco	Calle 63 Carrera 38	14.5	70% Area available for Evacuation
41	13 - Teusaquillo	Parque Central Simón Bolívar	Calle 63 Carrera (Avenida) 68	101.1	58% Available Area , 12% Water Surface
42	13 - Teusaquillo	Universidad Nacional	Carrera 30 Calle 45	121.8	State University - No Data available
43	15 - Antonio Nariño	Parque Villa Mayor Principal	Avenida - Carrera 30-35 Calle 34-30A Sur	7.9	Zonal Park
44	15 - Antonio Nariño	Parque Ciudad Jardin	Avenida Carrera 10 y Avenida Caracas y los 2 costados del Canal	8.1	Zonal Park
45	16 - Puente Aranda	Parque Ciudad Montes	Carrera 38 a 41C Calle 10 a Diagonal 16 Sur	6.8	18% Tree Planted , 5% Water Surface
46	16 - Puente Aranda	Parque Milenta - Tejar San Eusebio	Diagonal 17A a Calle 18 Sur entre Transversal 5	7.9	Zonal Park
47	18 - Rafael Uribe	Parque Bosque San Carlos	Calle 27A Sur Diagonal 39A Sur Carrera 13A y 12 Bis	22.7	40% Tree Planted
48	18 - Rafael Uribe	Parque Diana Turbay	Carrera 1A Y 2A Este Calle 48 R Sur	5.5	Zonal Park
49	18 - Rafael Uribe	Parque Estadio Olaya Herrera	Calle 22 y 27 Sur Carrera 21 y Avenida 19	5.1	Zonal Park, 10% Built In Concrete Frames
50	18 - Rafael Uribe	Parque Santa Lucía	Diagonal 36 Sur Carrera 16 B	10.7	Urban Park, 7% Built, 50% Tree Planted

Source: JICA Study Team

Table 5.2.17 List of Regional Evacuation Place in Cundinamarca

No	*Locality*	*Name of the Place*	*Address*	*Area (Ha)*	*Remarks*
51	Chia	17501 - Urban Place to define	Undefined	-	Urban Place to define with municipalities
52	Cota	21401 - Urban Place to define	Undefined	-	Urban Place to define with municipalities
53	La Calera	37701 - Urban Place to define	Undefined	-	Urban Place to define with municipalities
54	Facatativá	Estadio Municipal de Facatativá	Not Available	7.5	Urban Park, 20% Built in Concrete
55	Facatativá	26901 - Urban Place to define	Undefined	-	Urban Place to define with municipalities
56	Madrid	Estadio Municipal de Madrid	Not Available	6.6	Urban Park
57	Madrid	43001 - Urban Place to define	Undefined	-	Urban Place to define with municipalities
58	Mosquera	Villa Olímpica Municipio de Mosquera	Not Available	11.6	With possible Expansion, 7% Built
59	Soacha	75401 - Urban Place to define	Undefined	-	Urban Place to define with municipalities
60	Soacha	75402 - Urban Place to define	Undefined	-	Urban Place to define with municipalities
61	Soacha	75403 - Urban Place to define	Undefined	-	Urban Place to define with municipalities

Source: JICA Study Team

The study team analyzes the capacity of parks and the required evacuation area in the each locality. The results of analysis are shown in Table 5.2.18.

Table 5.2.18 Analysis of Regional Park

Locality	*Urban Population*	*Park Area (Ha)*	*Required Area (Ha)*	*Capability Area (Ha)*
Within Bogota				
1 - Usaquén	421,321	151.82	84.26	67.56
2 - Chapinero	122,994	16.12	24.60	-8.48
3 - Santa Fé	107,046	14.11	21.41	-7.30
4 - San Cristóbal	455,030	30.32	91.01	-60.69
5 - Usme	244,268	26.09	48.85	-22.76
6 - Tunjuelito	204,365	65.99	40.87	25.12
7 - Bosa	410,099	59.76	82.02	-22.26
8 - Kennedy	912,782	109.77	182.56	-72.79
9 - Fontibón	278,745	17.55	55.75	-38.20
10 - Engativa	749,072	355.17	149.81	205.36
11 - Suba	706,529	247.26	141.31	105.95
12 - Barrios Unidos	176,549	189.90	35.31	154.59
13 - Teusaquillo	126,126	237.35	25.23	212.12
14 - Los Mártires	95,541	0.00	19.11	-19.11
15 - Antonio Nariño	98,356	15.95	19.67	-3.72
16 - Puente Aranda	282,488	21.56	56.50	-34.94
17 - La Candelaria	27,451	0.00	5.49	-5.49
18 - Rafael Uribe	384,627	43.95	76.93	-32.98
19 - Ciudad Bolívar	575,549	0.00	115.11	-115.11
Within 8 Municipalities (Cundinamarca) :				
Chia	61,783	0.00	12.36	-12.36
Cota	14,784	0.00	2.96	-2.96
Facatativá	90,266	7.50	18.05	-10.55
Funza	51,808	0.00	10.36	-10.36
La Calera	24,188	0.00	4.84	-4.84
Madrid	52,110	6.58	10.42	-3.84
Mosquera	27,753	11.56	5.55	6.01
Soacha	283,889	0.00	56.78	-56.78

Source: JICA Study Team

The results show that the some of twelve localities are not enough regional evacuation areas and seven municipalities in Cundinamarca cannot provide enough regional evacuation places, especially Soacha. Those localities and municipalities should identify the regional evacuation place.

7) Landslide

The priority areas are selected among the landslide areas caused by human factors. La Carbonera and El Espino in Bogotá city are typical area of this kind, where sewer and surface drainage are not installed along with the installation of potable water supply.

It is also appropriate to choose the landslide area where implementation of countermeasures has not yet been enough in spite that the investigation and design of countermeasures were fully performed. Jerusalen, Montebello San Luis and El Paraiso in Bogotá City are typical of this kind. La Carbonera is also in this kind. These five areas are selected to have priority because essential countermeasures are not implemented yet though relocation has been applied in some areas for mitigating landslide disaster.

The countermeasures for these five landslide areas are described as follow.

(1) La Carbonera

The construction of a surface water drainage system, which covers the expanding area, is urgently required.

(2) El Espino

Sewerage and surface water drainage works, which are countermeasures against seepage of surface water into landslide areas, are urgently required. The total cost of existing design is 214,464,162 Colombian pesos.

(3) Jerusalen

The recommended procedure of countermeasure is as follows: Initial stabilization of the steep slope should be done. After that, installation of drainage works at the upper side of the slope is recommended.

(4) Montebello San Luis

The countermeasures according to existing design are counterweight fill work and drainage drilling. Study of piling work in upper part is required since possibility of soil pressure increase due to lateral flow, which is caused by progress of landslide in the upper part, is still a concern.

(5) El Paraiso

The total length of anchoring is 1020m, 341million pesos. Pilling works is 460m3, 267million pesos. Underground drainage is 400m, 18million pesos, horizontal drainage drillings are 207m, 17million pesos. However, all of these have not implemented yet.

As for eight municipalities, the most of investigation, design and installation of countermeasures are not performed, yet it is inappropriate to describe measures against landslide in eight municipalities comparing with that in Bogotá City.

Briefly mentioning, relocation of the houses, which occupy illegally, is necessary at El Atico in Soacha, where rock fall is anticipated. Concrete spray or other proper slope protection is necessary at the road slopes along the road to Granada in Soacha. Removal of overhung rock is necessary along the road at the foot of Majuy hill in northern part of Madrid, where rock fall is anticipated during heavy earthquake.

8) Flood

(1) Proposed structural measures

The structural measures for flood mitigation are composed of dredging, enlargement of the river channel, re-construction and improvement of the riverbanks, improvement of existing structures, etc.

The structural measures against the flood prevention are summarized in the following table.

Table 5.2.19 Summary of Structure Measures Against Flood

Name of River	Design Return Period	Contents of Improvement	City	Remarks
Rio Bogotá	100-year	River improvement from Alicahin to Conejera - Relocation of left dike from the existing position to 30 m behind, - Heightening of the relocated dike by 3 m - Channel excavation for the widened area.	Bogotá Chia Cota Mosquera Soacha	Based on EAAB study
Rio Tunjuelo	100-year	Improvement of the flood control structures	Bogotá	
Rio Botello	10-year	River improvement by canalization.	Facatativa	Hydrological/ hydraulic study is necessary.
Rio Soacha	10-year	River improvement by dredging and widening of existing stream.	Soacha	Hydrological/ hydraulic study is necessary.
Qda. Toma	10-yeqr	Improvement of water course and drainage pipe located in the urban areas	La Calera	Hydrological/ hydraulic study is necessary.

Appendix 5.2.1 and 5.2.2 shows the sections to be improved and proposed cross sections of Rio Bogotá, respectively. And Appendix 5.2.3 shows the image of improvement of the flood control structures in Rio Tunjuelo.

(2) Recommendations on proposed structural measures

A. Consideration of seismic resistance

The structures such as dike, flood control structure, etc. should have resistance against earthquake especially the structures located in the zone of liquefaction. Therefore it is recommended to carry out the seismic analysis on the structure.

B. Alignment of Rio Bogotá

The recommended river improvement work for Rio Bogotá is the same of the conclusion of EAAB study. Since EAAB is responsible for the flood management in Bogotá City, widening of the river was proposed by relocation of dike on left bank. The left bank of Rio Bogotá was urbanized and it is necessary to relocate some houses/buildings while the right bank of Rio Bogotá has not been highly urbanized. It is, therefore, recommended that the alignment of the river should be reconsidered to minimize the adverse impact to the habitants who is forced to relocate involuntary with good coordination of related agencies.

C. Implementation of Rio Bogotá

It is difficult to implement all the work in same time because of the constraining of budget and other resources necessary for the project, less coordination among the related organizations, etc., so that, the stepwise river improvement would be proposed as follows:

- **Short/medium term plan: (Target flood = once in 50-year)**
  - Relocation of left dike with an enough height of 50-year flood
  - Heightening of right dike to the design water level of once in 50-year flood
- **Long term plan: (Target flood = once in 100-year)**
  - Heightening of dikes on both side to the design water level of once in 100-year flood
- **Reconsideration of Purpose of Cantarrana Dam**

Proposed Cantarrana Dam, located in the mid-stream of Rio Tunjuelo (location is shown in Appendix 5.2.1, H = 30 -35 m, V = 10,000,000 m^3) to regulate the flood discharge of Rio Tunjuelo. EAAB also have a plan to construct proposed La Regadera II Dam (H = 30 m, V = 3,000,000 m^3) at just downstream of existing La Regadera Dam for the water supply purpose.

It is usually not convenient to construct two dams with the different purpose within the same river system from the viewpoints of effective water resources development and investment.

Since Cantarrana Dam is located in the downstream of La Regadera II Dam, Cantarrana Dam would have an advantage for both water resources development and flood control. Therefore, it is recommended that the purpose of Cantarrana Dam should be reconsidered as a multipurpose dam of water supply as well as flood control.

9) Industrial Facilities

In the industrial facilities where hazardous materials, high-pressure gas or toxic materials are handled, the equipment failure leads to leaks, spills, fire or explosion. It is probable that they can be breeding grounds for catastrophic disaster. Countermeasures for prevention of earthquake disaster are briefed as follows:

(1) Countermeasures for the prevention of earthquake disaster

Some of the countermeasures for the prevention of earthquake disaster are described as follows:

A. Countermeasures for the hazardous materials

a) Storage tanks

Conduct a check of the following items; if reinforcement is required, this should be done as soon as possible.

- Anti-seismic checkup should be done for the petroleum liquid holding tanks like gasoline or propane by API etc. (API 620 9th edition ADDENDUM3, December 1998 "SEISMIC DESIGN OF STORAGE TANKS, API650 9th edition, July 1993), Japanese FIRE SERVICE LAW Technical Standard).
- Connecting pipe to the tank must be fixed by strong support and flexible hose or flexible joint must be installed to absorb the movement change between pipe and tank.
- Automatic emergency shut-off valve should be installed in the continuous line of supply pipe to the supplier by detecting PGA reading on seismometer.
- If oil happens to be discharged, dike should have enough volume and anti-seismic strength to prevent the spread of oil to other places. Prepare sandbags in case of dike damage to protect from the spreading oil.

b) Fixing method of gas cylinders

There are a lot of examples that the combustible gas holding cylinderor connecting pipes are destroyed because the cylinders break off and fall. The holding gas leaks and explosion occurs. Fixing methods are as follows:

- Each cylinder is fixed on the rigid wall by chain or wire.
- If more than two cylinders are placed, the pedestal made by steel, which is anchored with the foundation, should be used.

c) Safety measures for hazardous materials

Prevention of breakage of chemical bottles

- Shelf that accommodates chemical bottles should be incombustible and rigid.
- Shelves should be fixed on wall or pillar.

- Separation box or partition should be installed so that chemical bottles do not turn over and break.

Caveat for handing of chemicals

- Bottles should be non-breakable and tightly shut off.
- Pay attention to incompatibility and store bottles separately so that there will be no fire break out in case of chemicals mixing by bottle breakage.
- More dangerous chemicals should be stored in the lower shelves.
- Do not leave dangerous chemicals on the table for a long period of time.

B. Countermeasure for earthquake

a) Pedestal reinforcement

Reinforcement of pillars by concrete or installation of brace.

b) Installation of seismometer

Seismometers are installed where more important and dangerous equipment are located and the output seismometers are connected to emergency shut down system.

c) Plant emergency shut down system

If a PGA over 150 gal is detected, this signal goes to the emergency shut down system and plant will be automatically shut down.

d) Emergency isolation system

In the inlet and outlet pipe of the tanks holding hazardous materials and toxic materials, the emergency remote controlled valves are installed. If a PGA over 150 gal is detected, these valves are automatically shut off.

e) Piping flexibility

Flexible hose, joint or flexible piping system to absorb movement is installed at the tank inlet, outlet piping or upward piping from underground.

f) Tank sloshing

Sloshing is very dangerous at the time of resonance. It is important to control liquid level so that resonance will not occur.

5.2.3 Non-Structure Measure

1) Monitoring and Warning System

To reduce the damage of the disasters, monitoring of phenomena and provide early warning is very important. It is, therefore, establishment of monitoring and warring system is proposed as a part of the Plan.

Since the plan should be corresponded to multi kinds of disaster namely, earthquake, landslide, flood and industrial disaster, the monitoring and warning system should also be corresponded to them. However, as monitoring system for industrial disaster shall be provided by the entity who own the industrial facilities, the information on earthquake, landslide and flood are monitored by this system.

Figure 5.2.3 shows the image of monitoring and warning system.

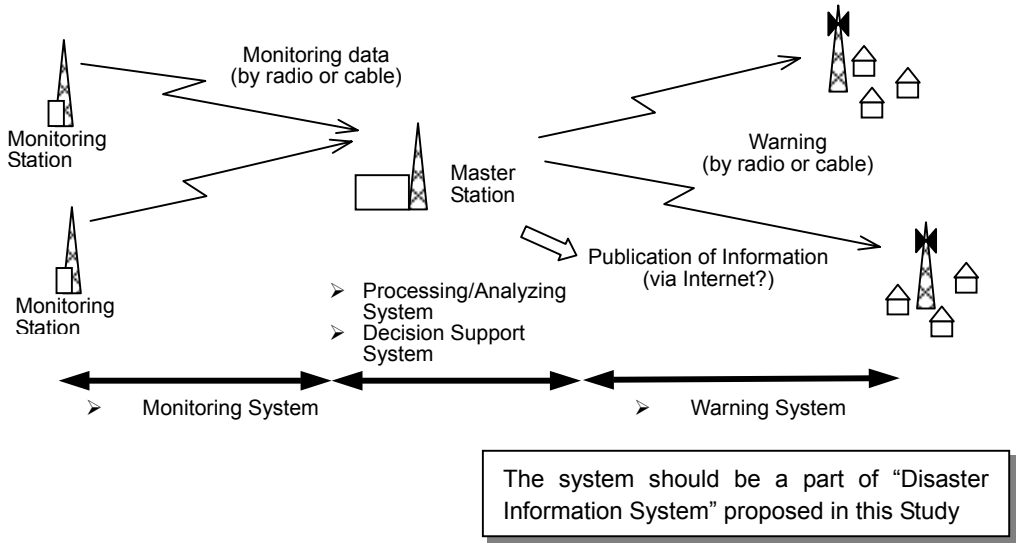


Figure 5.2.3 Image of Monitoring and Warning System

(1) Monitoring system

Many kinds of information (e.g. seismic wave, hydrological data, etc.) should be monitored to provide early warning. Table 5.2.20 summarizes the information to be handled by the monitoring system.

Table 5.2.20 Information to be Handled by Monitoring System

Kinds of Disaster	Information	Data Transmission Method	Frequency
Earthquake	Seismic wave	Telemetric (radio)	Continuous Event monitoring if amount exceeds pre-set criteria
Landslide	Movement of landslide mass	Telemetric Semi-Automatic Manual	Every 10 min. in normal Event monitoring if amount exceeds pre-set criteria
	Rainfall	Telemetric	Every 10 min. Event monitoring if amount exceeds pre-set criteria
	Groundwater level	Telemetric Semi-Automatic Manual	2 times/day in normal
Flood	Rainfall	Telemeter	Every 10 min. in normal Event monitoring if amount exceeds pre-set criteria Every 1 min. in pre-emergency and emergency
	Water level	Telemeter	2 times/day in normal Every 30 min. in pre-emergency Every 10 min. in emergency

Source: JICA Study Team

The monitored information should be transmitted to the master station and processed for the publish of warning.

A. Earthquake

Seismic wave monitoring station is necessary not only within the Bogotá City area but also nationwide. Since it is impossible to install nationwide monitoring system by local organizations, as for the Plan, nationwide seismic wave information will be collected from existing monitoring system and the information of local earthquake will be collected from the monitoring station installed by local organizations.

The monitored information shall be transmitted to master station by automated transmission system,

B. Landslide and flood

Monitoring items for warning of landslide are rainfall and movement of landslide block. The stations for movement monitoring should be located on the landslide block. Rainfall monitoring stations are not necessary located on each landslide block; however, rainfall monitoring station should be installed to represent all landslide blocks.

To publish the warning on flood, monitoring of rainfall and water level are necessary. The locations of station should be determined based on the considerations of topography, river system, density of monitoring station, etc.

The monitored information of rainfall can be utilized for both landslide and flood warning, therefore, locations of the station should be determined with the consideration of maximum utilization for both disasters.

Figure 5.2.4 shows the proposed location of rainfall and water level monitoring stations.

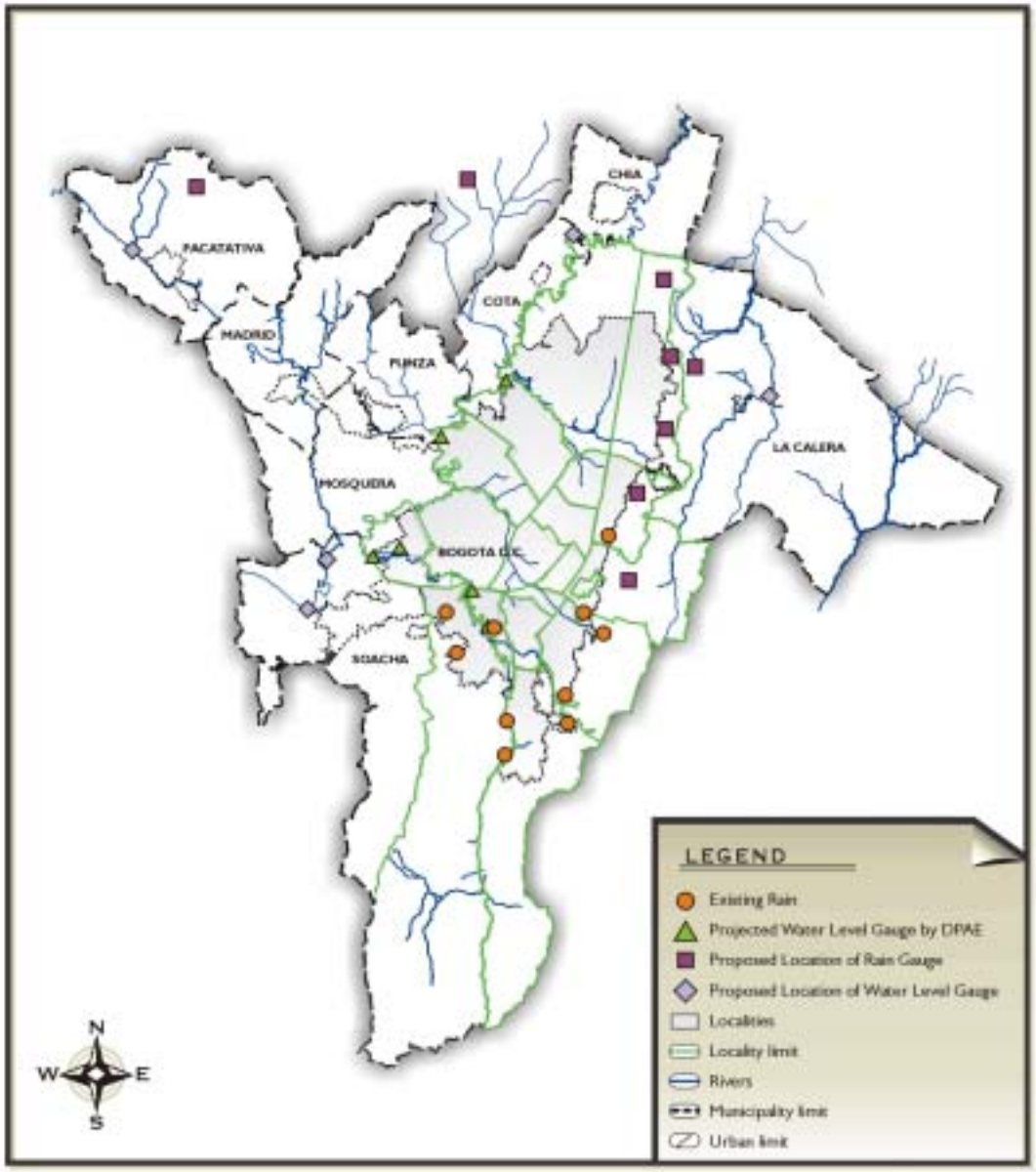


Figure 5.2.4 Proposed Location of Rainfall and Water Level Monitoring Station

(2) Warning system

Early warning system is effective in reduction of damage of disasters, especially effective on landslide and flood, of which the disasters can be predicted for its occurrence. Thus, the warning system planned to be installed to the high-risk areas of landslide and flood.

Wireless transmission/communication system with loudspeaker will basically applied for warning system. However, the transmission/communication method to inhabitants should be determined after the study on reliability of communication, social, etc.

2) Land Use Regulation

As for the disasters which the damage extent only limited areas such as landslide and flood, land use regulation is the one of most effective measure to prevent the damage. Therefore land use regulation for high risk area of landslide and inundation will be set up as a part of the plan.

Based on the risk map prepared, land use regulation should be imposed strictly. As it is very difficult to resettle the people once they immigrate in, the important thing is to prevent housing development in dangerous areas.

(1) Landslide area

Following regulation will be made for the landslide areas.

Risk Grade 1	Non-building, Non-residential Area (Utilize as green area, park, etc.)
Risk Grade 2	Building Regulation (Not permit public, large and important facilities)
Risk Grade 3	Not applied

(2) Flood area

In POT, Bogotá City and other cities, the municipalities designated the river area along Rio Bogotá and tributaries with 75 m and 50 m respectively, from the centerline of the river. Based on this plan, following regulation will made for the flood areas.

River Area	Rio Bogotá: 75 m each side from the centerline of the river
	Tributaries: 50 m each side from the centerline of the river
	Not permit any activities except environmental conservation activities
High Risk Area	Non-building, Non-residential Area (Utilize as green area, park, etc.)
Medium Risk Area	Building Regulation (raised floor)
Low Risk Area	Not applied

5.3 Emergency Response

In and after a major disaster, the disaster prevention organization is required to respond and undertake recovery activities rapidly and effectively, in order to track the disaster: saving lives, protecting property, and meeting basic human needs; restoring the disaster-affected area; and reducing vulnerability to future disasters. The necessary tasks and activities are to be compiled in manuals.

For conducting the tasks, the resources and assistance efforts required are as follows.

5.3.1 Resources

The resources to be prepared are:

- Specialized teams for damage assessment, emergency communications, medical assistance and support, urban search and rescue, etc.;
- Equipment and supplies required (food, water, power generators, camping goods, etc.) for affected areas; and
- Facilities and equipment required for disaster field office, disaster recovery centers, etc.
- Emergency support activities (opening critical transportation routes, establishment of shelters and feeding facilities),
- Financial support (loans and grants) for the victims to repair or replace damaged houses in order to reduce damages and recover after the disaster,
- Financial arrangement to repair roads and public buildings,
- Technical assistance to identify and implement mitigation opportunities to reduce future loss, and other assistance, including crises counseling, tax relief and legal services.

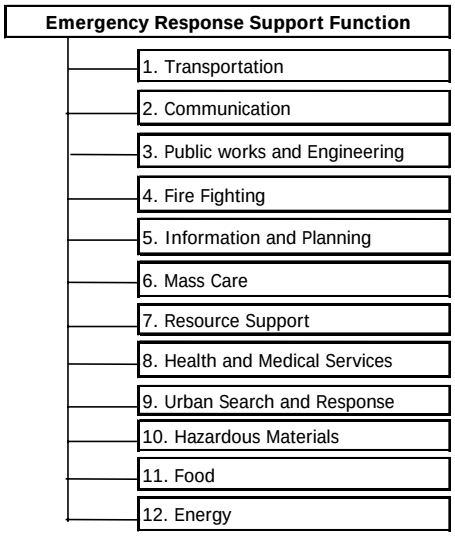
5.3.2 Types of Assistance

The assistance to be provided by the disaster prevention organizations cover the following:

- Immediate relief:
  a) Initial response resources including food and water,
  b) Emergency services to open critical transportation routes, shelters and feeding centers,
- After the disaster for reducing damages and recovery:
  a) Financial support (loans and grants) to repair or replace damaged housing,
  b) Financial arrangement to repair roads and public buildings,
  c) Technical assistance to identify and implement mitigation opportunities to reduce future loss, and
  d) Other assistance, including crises counseling, tax relief and legal services.

5.3.3 Emergency Response Plan

The emergency response plan establishes a process and organizational structure for coordination and effective delivery of assistance to the disaster areas. According to the Law 919 of Article 62 b) in 1989, each territorial entity or public service entities should act to handle emergency response during the disaster situations. Each public service entity's emergency response is attached in Appendix 5.3.1. Although the Study Area has no integrated emergency response plan, the basic structure of the emergency responses will be arranged as follows:



Source: FEMA and EMI

Figure 5.3.1 Structure of Emergency Response Support Functions

In order to minimize the damage in a disaster it is important for emergency response entities to prepare the following initial Responses.

- For arrangement of initial responses it is necessary for each emergency response entity to review the organization and prepare a manual for its initial activities,
- Arrangement of base offices for emergency response activities and preparation of necessary equipment for the base offices,
- For strengthening of disaster information management systems it is necessary for the related entities to reinforce the existing communication system and monitoring systems, and their equipment,
- For strengthening of rescue and support systems it is necessary for the related emergency response entities to arrange evacuation places, evacuation roads, and also to strengthen shelters, and to secure water and foods,

- For arrangement of fire fighting and rescue activities, it is necessary for the related emergency response entities to strengthen the fire fighting capacity, fire fighting apparatus and rescue equipment.
- For arrangement of first aid and medical care system it is necessary for the related emergency response entities to arrange first aide system, communication system, initial medical care system, back up medical facilities and medical care environment,
- For arrangement of transportation system it is necessary for the related emergency response entities to arrange emergency traffic control system, emergency transportation system, teams and equipment for opening of emergency transportation routes and airport facilities.

5.3.4 Emergency Response Organization

1) Primary and Support Agencies in Emergency Response

The Study team carried out discussion to identify emergency response organization at national, Cundinamarca and Bogotá City governments. Detailed organizations for emergency response and preparedness are shown in Appendix 5.3.2, which is the conclusion of the responsible organization. Primary and support agencies identified in the Study are as follows:

(1) Bogotá

1) Leading Agencies: DAPD
2) Coordinating Agencies: DPAE-FOPAE
3) Primary Agencies:

- Health Secretary
- Traffic and Transport Secretary
- District Administrative department of Planning (DAPD)
- DPAE-FOPAE
- Firemen Official Body
- District Administrative of Social Welfare
- IDU
- EEB/CODENSA
- ETB/TELCOM

4) Supporting Agencies:

- Government Secretary
- Treasury Secretary
- DAMA
- Civil Defense
- Red Cross
- Metropolitan Police
- Military Unit

- Transit Police
- EAAB
- Department of Community Action
- Local Mayor
- Concejo Colombiano Segridad (CCS)
- TRANSMILENIO
- Natural Gas

(2) Cundinamarca

1) Leading agency: Government Secretary
2) Coordinating agency: Government Secretary/OPAD
3) Primary agency:

- Firemen Official Body
- Secretary of Health
- Civil Defense
- Government Secretary/OPAD
- Secretary of Public Works
- Secretary of Social Development

4) Support agencies:

- General Secretary
- Military Brigade
- National Police
- CAR
- Red Cross
- Secretary of Planning
- Secretary of Agriculture and Rural Department
- Secretary of Treasure
- Secretary of Environment
- Traffic and Transport Administration Department
- Human Talent Administrative Department
- Alcalde Local
- Empresa Energy
- CODENSA
- TELECOM
- Community
- Concejo Colombiano de Seguridad (CCS)

(3) National

1) Leading agency: Ministry of Interior

2) Coordinating agency: DGPAD

3) Primary agencies:

- Ministry of Transport
- Ministry of Communication
- DGPAD
- National System of Fire Fighters
- National Institute of Familiar Comfort (ICBF)
- Ministry of Health
- Colombian Civil Defense
- Ministry of Energy

4) Support agencies:

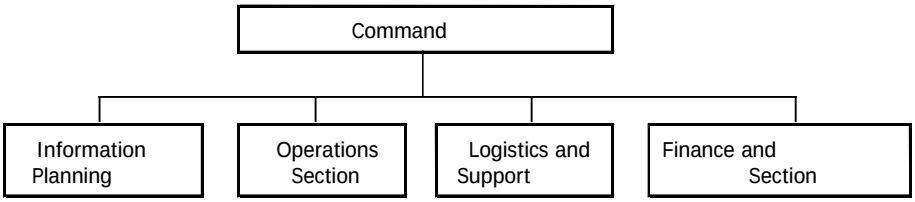
- Ministry of Interior
- Ministry of Finance and Public Credit
- Ministry of Environment
- National Department of Planning
- Colombian Red Cross
- Colombian Chamber of Construction
- Colombian Society of Construction Engineer
- National Institute of Roads (INVIAS)
- Military Force (FF.MM)
- TELCOM
- Ministry of Education
- Ministry of Agriculture
- Ministry of Development
- Concejo Colombiano de Segridad (CCS)

2) Basic Concepts of Organizational Structure

The emergency organization should be established prior to a disaster. Under normal situations, the organization is not in operation, but the emergency response organization is to be activated under the disaster situation. In normal situation, only the disaster management organization would act as the facilitator and coordinator of the disaster management. In case of emergency, the governmental organization at each level should activate the emergency response organization at each administrative unit.

The Federal Emergency Management Agency (FEMA) and Emergency Management Institute (EMI) propose to establish an emergency management system based on the Incident Command

System (ICS), which is the model for command, control and coordination. ICS organization is built on five major components: command, planning, operation, logistics and finance/administration [5-3-1].



Source: FEMA and EMI

Figure 5.3.2 Emergency Management Organization

According to FEMA and EMI, major responsibilities for each component are summarized as follows:

Table 5.3.1 Responsibility of Components

Component	Responsibility
Incident Commander	Commanding activities Protecting life and property Controlling personnel and equipment resources Maintaining accountability for responders and public safety, as well as for task accomplishment Establishing and maintaining an effective liaison with outside agencies and organizations.
Planning section	The responsibility for the planning section includes collection, evaluation, dissemination, and use of information about the development of the incident and status of resources.
Operation section	The Operation section is responsible for carrying out the response activities.
Logistics section	The Logistics section is responsible for providing facilities, services, and materials including personnel, to operate the requested equipment for the incident.
Finance and Administration section	The Finance and Administration section is critical for tracking incident costs and reimbursement accounts.

Source: FEMA and EMI

The Incident Command will have three command staff: information officer, safety officer and liaison officer. The responsibility for those officers are shown as follows:

- The information officer handles all media inquires and coordinates the release of information to the media.
- The safety officer monitors safety conditions and develops measures for ensuring the safety of all assigned personnel.
- The liaison officer is the on-screen contact for other agencies assigned to the incident.

[5-3-1] FEMA and EMI (1998) Independent Study Course: Incident Command System (ICS).

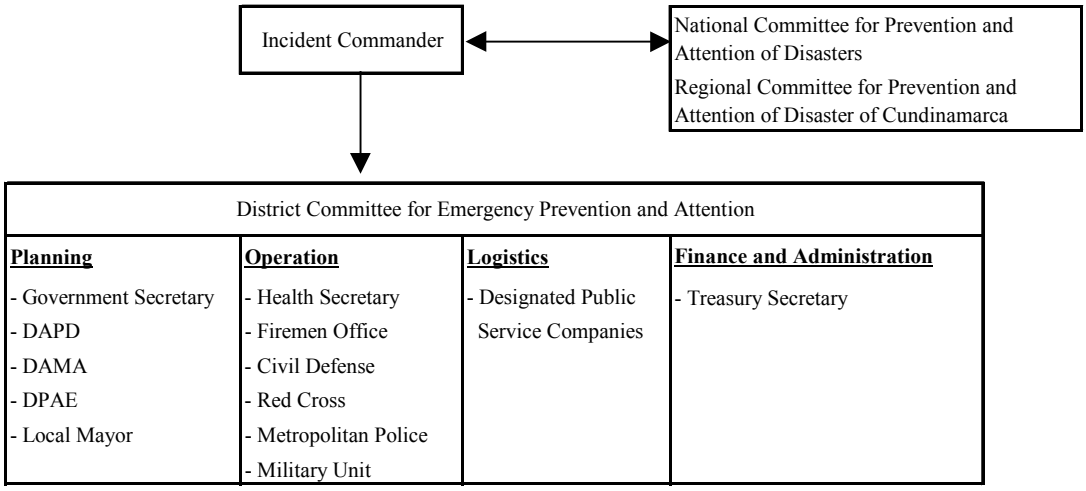
The emergency response organization should have those functions. Those basic ideas could be applied in the emergency response organization in the Study Area.

3) Emergency Response Headquarters

(1) Organization

The emergency response command center should be established in the Study Area from local level to regional and national levels. As to who should be the incident commander should be clarified by law. At the local level, the incident commander is local mayor, while for the Bogotá City or Cundinamarca governments, it should be the Mayor of Bogotá City or Governor of Cundinamarca, respectively. The members of district or regional emergency prevention committees should situate in emergency response headquarters.

The proposed organization for Bogotá City Area is shown as follows:



Source: JICA Study Team

Figure 5.3.3 Proposed Organizational Structure of Emergency Response Headquarters

Each disaster response organization is attached to the Emergency Response Headquarters. The incident commander has the power to direct all emergency response organizations.

(2) Functions

The function of the emergency response headquarters can be categorized into three items:

- Data collection and analysis
- Decision, discussion and coordination for disaster countermeasures
- Order and instruction to other organizations

The disaster management center should have disaster information system, data collection system, telecommunication system, damage information collection system and communication system to other disaster response organizations.

The sub-center should have the supplemental functions of headquarters. When the command center is rendered inoperable, sub-centers will replace its roles and functions.

4) Location and Buildings

The command center should have seismic resistance structure and should be equipped with the emergency facilities to operate emergency activities. Those buildings should furnish the emergency facilities as listed below:

- Seismic resistance structure
- Generators during emergency situation with storage of energy
- Water
- Toilet

In the Study Area, it is not clear where the command center would be. The proposal is possibly an emergency command center at regional and locality levels.

(1) Bogotá city

The secretary of health building seems to be the Bogotá City command center, yet the room has not been used under normal situation. Moreover, there is no information and communication facility in the room to connect disaster related organizations. The sub-center would be DPAE's building. DPAE has a disaster communication system, which operates 24 hours. However, there is no space for the commanding functions.

(2) Cundinamarca government

The disaster command center would be the Cundinamarca government building, and the sub-center would be OPAD office. It is not clear where the command center of the Cundinamarca government is.

(3) Locality and municipality

The locality or municipality should be the disaster management center in each locality. Each locality or municipality building should be a disaster management center in each locality or municipality.

The proposed locations of command centers are shown as follows:

Table 5.3.2 List of Proposed Emergency Response Center

Category	Name of Facility	Location	Building Information			Seismic Reinforcement
			Floor Area (m^2)	Structure	Year of Construction	
National Level	Ministry of Interior	Bogotá	3,861	Unreinforced Masonry	1860	No
	Health Secretary of Bogotá	Bogotá	35,827	Reinforced Concrete	1999	Yes
Regional Level	Department of Prevention and Emergency attention (DPAE)	Bogotá	1,015	Reinforced Concrete	1992	Yes
	Office for Prevention and Disaster Attention (OPAD)	Cundinamarca	600	Unreinforced Masonry	1986	No
	Major`s Office of Bogotá D.C.	Bogotá	6,825	Unreinforced Masonry	1900	Yes
	Cundinamarca Prefecture	Cundinamarca	38,187	Reinforced Concrete	1997	Yes
Local Level	Local Office of Usaquén	Bogotá	1,272	Unreinforced Masonry	1840	No
	Local Office of Chapinero	Bogotá	3,250	Reinforced Concrete	1975	No
	Local Office of Santa Fé	Bogotá	1,093	Reinforced Concrete	1993	Yes
	Local Office of San Cristóbal	Bogotá	776	Unreinforced Masonry	1980	No
	Local Office of Usme	Bogotá	2,538	Reinforced Concrete	1955	No
	Local Office of Tunjuelito	Bogotá	1,783	Unreinforced Masonry	1985	No
	Local Office of Bosa	Bogotá	1,144	Unreinforced Masonry	1982	No
	Local Office of Kennedy	Bogotá	4,176	Reinforced Concrete	1984	No
	Local Office of Fontibón	Bogotá	1,236	Unreinforced Masonry	1961	No
	Local Office of Engativá	Bogotá	800	Unreinforced Masonry	1997	Yes
	Local Office of Suba	Bogotá	1,330	Unreinforced Masonry	1928	No
	Local Office of Barrios Unidos	Bogotá	8,938	Unreinforced Masonry	1940	No
	Local Office of Teusaquillo	Bogotá	499	Unreinforced Masonry	1940	No
	Local Office of Los Mártires	Bogotá	640	Reinforced Concrete	1958	No
	Local Office of Antonio Nariño	Bogotá	2,268	Reinforced Concrete	1971	No
	Local Office of Puente Aranda	Bogotá	3,422	Reinforced Masonry	1978	No
	Local Office of La Candelaria	Bogotá	243	Unreinforced Masonry	1900	No
	Local Office of Rafael Uribe	Bogotá	1,752	Reinforced Concrete	1949	No
	Mayor's Office of Chía	Chía	1,680	Unreinforced Masonry	1939	No
	Mayor's Office of Cota	Cota	273	Reinforced Concrete	2000	Yes
	Mayor's Office of Facatativá	Facatativá	2,205	Reinforced Concrete	1989	Yes
	Mayor's Office of Funza	Funza	1,734	Reinforced Concrete	1960	No
	Municipal House of La Calera	La Calera	2,046	Unreinforced Masonry	1778	No
	Government Palace of Madrid	Madrid	1,488	Unreinforced Masonry	1890	No
	Mayor's Office of Mosquera	Mosquera	852	Unreinforced Masonry	1900	No
	Government House of Soacha	Soacha	4,675	Reinforced Concrete	1997	Yes

Source: JICA Study Team

5) Emergency Response Organization

(1) Required personnel

It is important to establish disaster management organizations based on the disaster level. The required personnel should be determined before the emergency situation. The proposed level of emergency is shown as follows:

Table 5.3.3 Proposed Emergency Level

Emergency Level	Disaster Situation	Organization
Level 1	It is expected that the disaster may happen within the territory. The mayor determines when to call all personnel.	The information collection and preparation for the rescue should be activated. It is also important to minimize damage.
Level 2	A limited area has been affected by disaster. The affected area is one locality.	The organization should be established to handle the situation.
Level 3	Several localities have been affected by a disaster and it is expected that damage will spread widely.	The organization should be established to handle more than one locality.
Level 4	The disaster damage has expanded to whole territory.	Whole governmental organization should be established to handle the disaster situation. The mayor calls for the district committee of emergency prevention and attention to deal with the situation.
Level 5	The president of Colombia declares a state of disaster in the territory.	It is required to call whole administrative staff for emergency response operation.

Source: JICA Study Team

The required personnel vary, depending on the disaster situation and emergency response plan. It should be noted that the emergency response personnel would be decreased depending on affected disaster situations because administrative staff will be victims of the disaster. Therefore, the plan allows implementing less administrative staff just after the disaster.

6) Responsibility of Each Organization

(1) Locality or municipality government

The locality or municipality government should convene their emergency local committee and implement emergency rescue operation based on their plan. The local mayor is the person responsible for this and makes the call for the required personnel. The local mayor also gives information to the other organizations.

(2) Bogotá city government

The primary responsibility of the Bogotá City government is to give assistance to the local government to be directly involved in the rescue operation. The Bogotá City government should establish operational procedures and construct disaster management organizations.

5.3.5 Data and Information Collection and Distribution

1) Basic Concepts of Data Collection

The disaster data collection is carried out by several governmental organizations. The following shows the communication system that has already been operated in the Study Area. Each organization should collect information based on its responsibility.

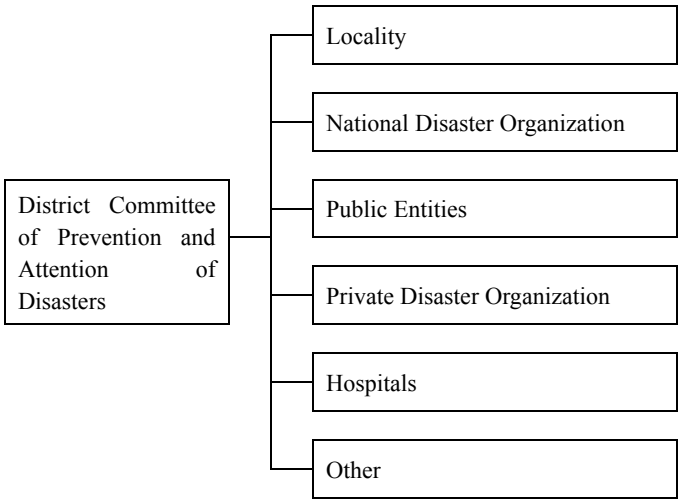
Table 5.3.4 Existing Communication System

Type of Communication System	Organization
Disaster Communication System	DGPAD DPAE OPAD
Seismic Information Network	Ingeominas
Security Communication System	Metropolitan Police Traffic Police Military Force Fireman's Office
Health Communication System	Secretary of Health
Other organization	Civil Defense Red Cross

Source: JICA Study Team

The information should be integrated and distributed among disaster related organizations to formulate accurate disaster response activities. Although several organizations have an information system to collect data for their respective purposes, not one system exists that allows a sharing of information among the related organizations. Moreover, there is no integrated disaster information system in the Study Area.

The figure below shows the proposed basic structure of the information system.



Source: JICA Study Team

Figure 5.3.4 Proposed Information System in the Study Area

The roles of the organizations are summarized as follows:

Table 5.3.5 Summary of Organizations' Roles

Organization	Descriptions
Locality or municipality	The mayors should collect the disaster information in their respective localities. The collected information is then transferred to the national and Bogotá City governments. Each locality should establish a means of communication during disaster situations. Each locality government should establish a disaster information system network among the police station, firemen's office and infrastructure companies.
Bogotá City government	DPAE has a disaster communication system within Bogotá City, which connects 16 disaster related organizations. These organizations have subscribed to disaster information communication. The DPAE also developed the SIRE, which is an information system using the Internet.
Cundinamarca government	Cundinamarca government established a disaster communication system under the secretary of government. The communication system connected 116 municipalities in the prefecture.
Other organizations	A communication system has been established in each organization. During disaster situation, these communication systems should be used for the response purposes.

Source: JICA Study Team

2) Data Collection and Distribution

Each organization should collect information for its own responsibility and report to the disaster command center. Also, each organization should have a disaster information system to connect to disaster command centers. The communication methods shall be established prior to disaster situations. The following figure shows the proposed disaster information network.

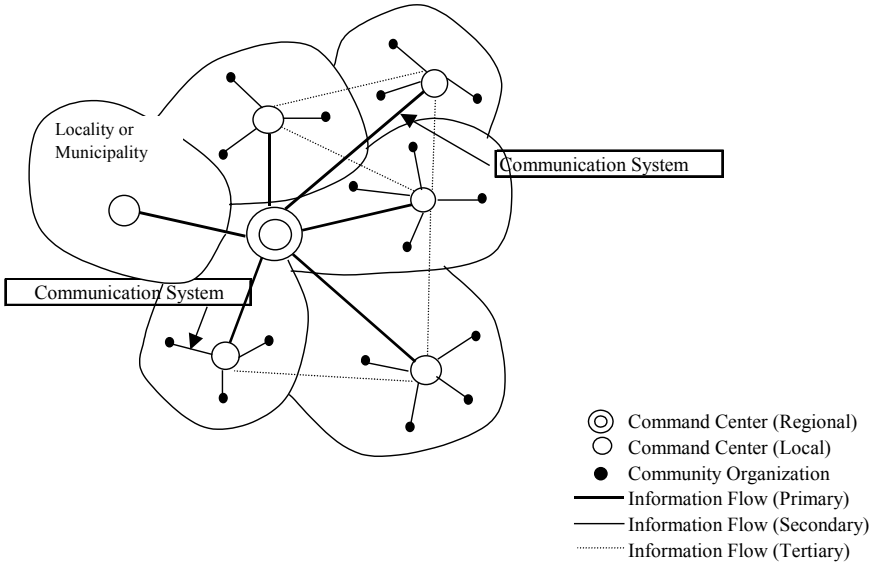
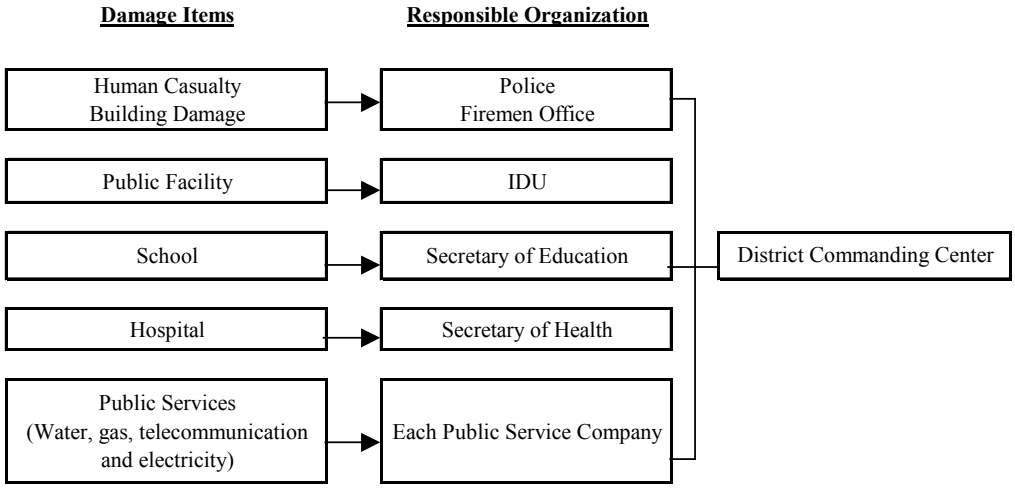


Figure 5.3.5 Disaster Information System

Each organization should determine the items to be reported to the disaster command center. The following figure shows the responsible organization and proposed report items to the command center.



Source: JICA Study Team

Figure 5.3.6 Proposed Damage Information Collection System

3) Information Distribution

The government should provide information on the disaster and damage situations as well as restoration of lifelines. The government and news media should work together to distribute information on what victims need the most. The methods of information provision should be established prior to the disaster. Each disaster management organization should define the contents and means of information distribution.

4) Emergency Broadcasting

The roles of broadcast companies for the emergency are important to disseminate information on disaster, damage and restoration of lifelines. The government should forge an agreement with them for emergency broadcast.

5.3.6 Coordination and Cooperation

1) Basic Concepts

Each government agency should establish the corresponding emergency response procedure for its own organizations. When damage expands to the whole Bogotá City, the government organization itself should proceed with the emergency response plan. However, it has formed an agreement for the disaster response activities with other local governments as well as private sector groups. The involvement of private sector groups is also important to handle situations. Therefore, the government should have agreements with other local governments and private sector groups and should create a network for the emergency response.

2) Areas

The areas for the agreement are classified into five categories. The following table shows the areas of agreements during disaster situations.

Table 5.3.6 Summary of Agreements

Areas of agreements	Organization	Contents
Local governments	Other local governments to support the emergency response.	Dispatch of personnel, machinery, materials Duration and location
Disaster related organization	Non-governmental organizations and private sector, which carries out the disaster operations	Dispatch of doctor Emergency broadcasting Supply of emergency vehicles and trucks Others
Other governmental organization	The agreement between other governmental organizations	National level government Other prefectural governments
Private sector	The private sector for the emergency assistance	Contents of emergency response Clearing work
Other organizations	Other organizations required for assistance	Supply of food stuff Clothes and daily necessities

Source: JICA Study Team

The Bogotá City governments and Cundinamarca agreed on the cooperation of disaster situations. The agreement is the first step towards the cooperation among the governments, yet the effort should be directed to make an agreement with other organizations.

5.4 Emergency Health and Medical Services

5.4.1 Planning Policies and Outlines

1) Planning Policies

In its "Methodology Guide for Elaboration of Hospital Emergency Plan," Secretary of Health, Bogotá, defines the preparation level for emergency situations into the following three, according to the magnitude of the disaster:

Level	Definition
I	Available human and physical resources are enough to face the situation.
II	Mobilization of all the hospital resources is necessary to face the situation.
III	Hospital capacity is surpassed and it is necessary to request external support.

Estimated magnitude of damages by any type of disaster analyzed in the Study corresponds to level III or even surpasses it to fall under level IV, if any (meaning, all the district health capacity is surpassed and it is necessary to seek national and international assistance). Only the system with a nation's strength behind it, that is, mobilizing national health resources in combination with international humanitarian assistance can cope with this overwhelming need. This significant result of the study consequently leads the Health Disaster Management Plan to target on a level III event situation. And preparedness for this kind of disaster is likely to be largely insufficient in the existing plan and ideas of the central and local authorities in the health sector.

Emergency health service in a massive disaster requires entirely different response procedures from an independent emergency event in normal time. Response policies to meet a Level III situation are summarized as follows:

(1) Give priority to life-saving care

It means exerting all efforts to attend to the patients who have a good chance to survive, since disaster medical services aim at providing 'the best for greatest number of victims'. Triage process plays a crucially important role from this point of view.

(2) Mobilize all health resources to attend to victims, in or about the metropolitan area

It means preventing many victims from converging spontaneously on some specific hospitals by guiding and transporting them to hospitals out of the affected area in as wide an area as possible.

(3) Respond systematically according to institutional service hierarchy

It means meeting the greatest needs by the response system with three levels of health zones: Provincial, Metropolitan and National. In order to establish this system, role and responsibility of all organizations involved in the health disaster management must be defined, and inter- and intra-institutional coordination mechanism among them should be worked out.

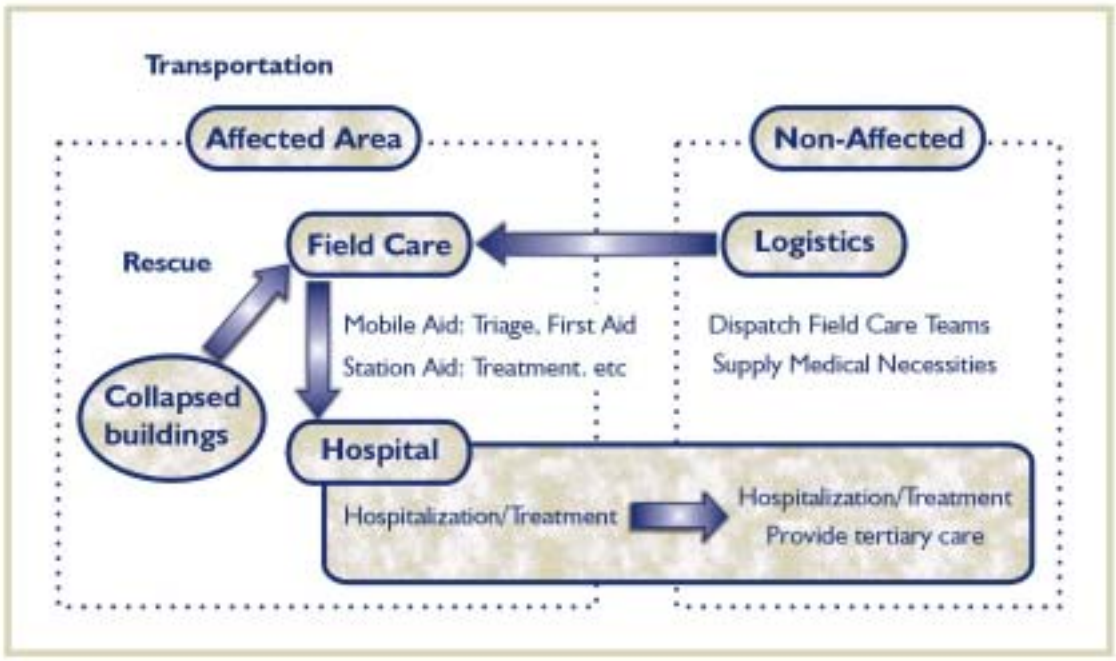
(4) Provide timely services to meet changing needs with time

It means responding to ever-changing health needs as time passes, that is, attending to serious injuries first, to acute internal diseases next, then to chronic cases, and finally to mental disorders.

2) Outline of the Plan

Health disaster management plan consists of two parts: Preparedness and Response. And both parts contain the following medical aid activities, which are composed of five essential sub activities. Figure 5.4.1 shows the flow of the injured according to these health activities.

- Information collection and distribution.
- Field care (Pre-hospital care).
- Hospital care.
- Logistics.
- Transportation.



Source: JICA Study Team

Figure 5.4.1 Flow of Medical Aid Activities in a Disaster

In the Preparedness plan, essential issues, which must be addressed before carrying out medical aid activities, are described. And in the Response plan, procedures of these activities and responsibilities of many health entities concerned are clarified.

5.4.2 Health Disaster Preparedness

The preparedness plan aims at showing important points to improve and strengthen existing health resources for disaster emergency response in the metropolitan area, with focus on mass casualty management.

1) Disaster Response Mechanism

The Ministry of Health, Bogotá D.C, and Cundinamarca set up a disaster response organization with three functional levels described below and arrange the definitive role of all its members.

Source: JICA Study Team

Figure 5.4.2 Three Levels of Disaster Response Mechanism

Response organization at any level should be strengthened to have appropriate staff, management and technical capacity to cope with a large-scale disaster under its responsibility. Especially it is urgently necessary to organize the system at locality/municipal level where preparedness is very behind.

2) Health Disaster Information Network

Health authorities need precise and comprehensive information on the status of their health facilities, health personnel, relief activities, lifelines, and roads/traffic etc., in order to make decisions and give commands/directions quickly. For this purpose, the following are essential:

- Bogotá D.C and Cundinamarca need to strengthen and upgrade their existing Radio Communication Centers for emergency services in CRU and CRUC into the 'Health Disaster Information and Command Center' in order to perform the following functions:
- Collection of information on damages- human damages and health facilities.

- Collection of information on health activities- field care teams, health institutions and transportation.
- Distribution of information- to media, population including patients' families, other relief agencies, international assistance agencies and NGOs.
- Bogotá D.C and Cundinamarca have to come up with a mechanism to collect and dispatch information of all disaster relief agencies as well as health information system and facilities, with the assistance of the Ministry of Health.

3) Transportation Arrangement

It is the responsibility of health authorities to make the proper arrangements for the transport of large numbers of disaster victims, health personnel and medical supplies over a very wide area. Especially airplanes are expected to play an important role in transporting severely wounded patients to other cities like Cali, Medellin, etc.

Table 5.4.1 Transport Measures by Administrative Level

Level	Area to cover	Measures
National	Nation-wide	Aircraft, Helicopter, Truck, etc.
Bogotá/Cundinamarca	Health aid stations-Hospitals, Hospitals-Hospitals, -Airport	Ambulance, Helicopter, Bus, Taxi, Truck, All kinds of vehicles
Locality/Municipality	Sites-Health aid stations	All kinds of vehicles

Bogotá D.C and Cundinamarca shall make specific arrangements with private transport operators (Ambulance/Bus/Taxi/Truck companies) to hire a number of vehicles during disaster emergency period.

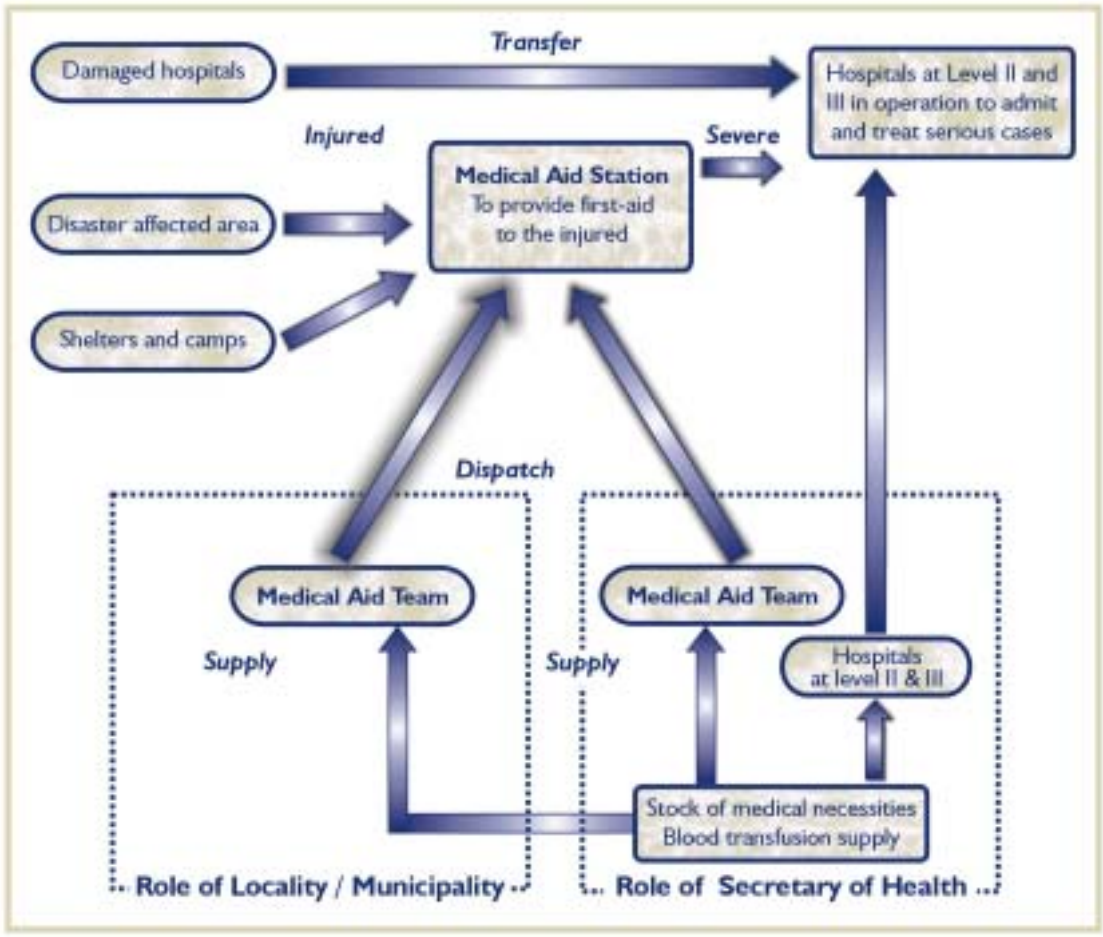
4) Pre-hospital Care System

Greatest needs for emergency care occur in the first few hours after the event of an earthquake. Thus, pre-hospital care is likely to be crucial because hospital resources are fatally short to meet massive needs in the metropolitan area. Health authorities have the responsibility to prepare and arrange the following components of pre-hospital care system in cooperation with agencies concerned:

- Spread knowledge and technique of first aid to citizens.
- Prepare to form a number of field care teams; and
- Prepare to set up a number of fixed first aid stations.

Localities in Bogotá D.C and Municipalities in Cundinamarca are primarily in charge of providing pre-hospital emergency care by mobile aid teams at the disaster sites. Secretary of Health, which plays a supporting role to localities and municipalities, shall also form and dispatch its own medical aid teams in the following cases:

- If a request is made by a locality or municipality for a medical aid team.
- If the *Secretary* deems it necessary to send a medical aid team.



***Note:** 1) In Tokyo, 2,410 teams at locality / municipal level and 213 at metropolitan level are scheduled to be formed in cooperation with Doctors Associations, Red Cross and Central government, etc. to cope with estimated 158,000 injured victims.

2) One team consists of one physician, one to three nurses, and one assistant, at the minimum.

Source: JICA Study Team

Figure 5.4.3 Conceptual Diagram of Medical Aid Procedures

(1) Activities of medical and other related aid teams

Three kinds of aid team, medical, dental and pharmacist teams, will take on the following responsibilities at appropriate sites in a disaster time cycle.

Table 5.4.2 Characteristics and Responsibility by Type of Aid Team

Team	Responsibility
Medical aid team	First aid to the injured Triage Treatment for severely injured cases who are not likely to bear transport, or health care for mild cases Urgent delivery Confirmation of death and identification of body
Dental aid team	Quick dental treatment to the injured Triage Cooperation in identification of bodies
Pharmacist team	Preparation of medicine and instruction to the injured at medical aid stations Handling and storage of drugs at aid stations

Table 5.4.3 Time, Place and Job Principle of Teams in the Aftermath

A. During emergency period -within 2 days after the event
Target: patients who are injured by hazard Work place: medical aid stations at sites with many victims and at health facilities Job principle: to provide care with rescue teams as well as at aid stations to carry out triage, give minimal treatment, and transport severe cases to hospitals to provide 24 hours service to have medical necessities for injured cases mainly
B. Post emergency period - 3 days after the event
Target: inhabitants at shelters and camps, and patients who need care at sites Work place: not always fixed- shelters/camps, and affected area by hazard Job principle: to transport severe cases to hospitals to provide 12 hours service to carry out dental aid activities to have medical necessities for internal, chronic, and mental cases mainly

5) Hospital Care System

Health authorities must mobilize whole medical institutions not only in the metropolitan area but also across the country. However, a systematic response is crucially important to provide intensive care to patients who may be saved. If the authorities and prehospital care system fail to properly manage the victims' condition for medical relief, it will bring ruin on the hospital care system. Health authorities shall arrange the following measures as the preparedness activities:

- To make the best use of surviving hospital resources by filling their specific role by level.

Table 5.4.4 Role of Hospitals by Level During the Disaster Period

Level	Role to play during the disaster
Level I	1. External Consultation: Triage, screening and providing initial treatment Base for activities of field care teams 2. Hospitalization: Momentary care till transport to Level II or III hospital
Level II	External Consultation: Triage, screening and providing initial treatment Hospitalization: Wounded intermediately
Level III	External Consultation: Not provided in principle but emergency care for patients transported from lower level institutions Hospitalization: Wounded severely and in critical condition

- Hospitalization of the severely wounded will be the responsibility of Level II and III hospitals in principle.
- Therefore, beds of level I hospitals will not be taken into account for the hospitalization capacity in the event of a massive earthquake.
- To fully utilize the capacity of private clinics to increase the hospitalization capacity, especially in Norte and Centro Occidente zone in Bogotá D.C.
- To make an effort to keep the balance of potential hospitalization needs against providing capacities by health system zone in Bogotá and by province in Cundinamarca.

Table 5.4.5 Spatial Planning Units of the Health Disaster Response

	Health Zone		Province
Bogotá D.C.	Norte-Occidente	**Cundinamarca**	Sabana Centro
	Sur-Occidente		Sabana Occidente
	Centro Oriente		Guavio
	Sur		Soacha

- To transfer the patients, who are already in hospitals at the time of the event, to hospitals in other provinces and prefectures, in order to increase the capacity of and allow the admission of casualties in the hospitals, as shown below.

Figure 5.4.4 Conceptual Diagram of Patients' Transfer

- To hospitals in Cundinamarca: Level II and III hospitals and clinics
- To hospitals in remote areas: Cali, Medellín and other major cities

It is necessary for the government to specify the hospitals and to make arrangements with those supporting hospitals on admitting patients in priority.

- To appoint some Disaster Medical Centers to play a central role for disaster relief. Role of the Disaster Medical Center is defined[5-4-1] as follows:
  a) To provide life-saving care to severely injured patients with multi-injuries, crash syndrome and burns all over the body.
  b) To manage the transfer of those injured severely; and
  c) To lend medical equipment to local hospitals.

Table 5.4.6 Required Conditions

*Required conditions for the disaster medical center
1. Seismic-resistant structure
2. Self-sustainable lifelines: water, electricity, fuel, sewerage, for three days at least
3. Tertiary emergency services with 1) inpatient beds, 2) ICU, 3) consultation room, 4) laboratory, 5) X-ray room, 6) operating room and 7) hemodialysis room
4. Enough space to admit twice as many patients and see five times more out-patients than those in ordinary time in case of a massive disaster
5. A terminal installation of wide-area disaster & emergency information system
6. Function to transport patients in and out over a wide-area:
1) having an emergency ambulance to transport patients
2) having a heliport with a medical doctor
7. Function to dispatch medical aid teams which are sustainable by themselves:
1) portable equipment for aid, drugs, triage tags, tent, power generator, water, food and daily necessities
2) stand-by system to dispatch medical aid teams in cooperation with fire fighting rescue teams
**Required conditions for the core disaster medical center
8. Function to lend equipment to health institutions in the area:
1) storage of equipment and supplies
2) simple beds, aid kits, etc.
9. Function to educate and train personnel of health institutions in the area

- To have enough open spaces next to or near Level III hospitals, in case there is a need to expand hospital services temporarily. Open spaces such as parks or unused fields must have enough area to accommodate at least 500 injured persons at a time.

6) Environmental Health and Disease Prevention Activities

Natural disasters, such as landslides, floods and small-scale earthquakes, do not always cause outbreaks of communicable diseases. However, it is likely to increase potential for them to occur considering that more than 40% of total buildings are predicted to be damaged severely in the study. Therefore, sanitary intervention should be started right after the event in parallel with medical relief. Secretary of Health will prepare the following planning and arrangements on disaster environmental health and disease prevention with participation of communities:

- To plan the organizational set-up and its operation plan for disaster environmental health and disease prevention. Since area and population to be covered will surpass the capacity of

[5-4-1] Reference: Japan's newly established system
To appoint one hospital as the disaster medical center* in one secondary health service zone.
To appoint one hospital as the core disaster medical center** in one prefecture. One prefecture consists of several secondary health service zones.

Secretary of Health, it is necessary to strengthen the capacity of *locality*/municipality to assume most of the responsibilities on environmental health.

- To plan the coordination and cooperation mechanism with *Ministerio de Salud* and other local governments to obtain external assistance.
- To prepare a detailed plan which shows responsibilities, procedures and operation methods for environmental health and disease prevention.
- To purchase and improve equipment and instruments for activities.
- To provide institutional training to health personnel on disaster environmental health and disease prevention. Secretary of Health needs to prepare Manuals for training/educational purposes; and
- To continue education and enlightenment activity for community with assistance of the Red Cross. Environmental health activities will not be effective and sustainable without the cooperation of community population.

7) Disaster Reduction in Hospitals

Destruction of hospitals is likely to give a definitely bad effect on the social stability of the area. It is predicted that most of hospital facilities surveyed in the metropolitan area will be damaged severely or will collapse when they are hit by a big earthquake, according to the sector study report on vulnerability analysis. Therefore, it is crucially important to execute the retrofitting plan of the hospitals as originally scheduled.

(1) Strengthen the structures

Retrofitting works of Level III public hospitals with key services will be given priority, followed by Level II hospitals. As to private clinics with level II and III, legislation should be considered to force them to comply with current building codes, or a government system should be created to subsidize the fund for the necessary reinforcing work.

(2) Keep the lifelines

It is also indispensable to increase the utility capacity of electric generators, water reservoir tanks, fuel and medical gases of level III hospitals in top priority.

Amount of fuel and water should be stored to sustain themselves for at least three days.

(3) Carry out disaster simulation exercises

It is strongly recommended that hospitals prepare a 'Disaster Response Manual' and carry out the disaster simulation exercises. In addition, Level III hospitals should store the essential emergency equipment such as stretchers to serve as temporary beds to be lent to level II hospitals.

8) Stockpile of Medical Necessities

Health institutions should have a stock of drugs and other medical necessities enough to keep operating for 72 hours without any replenishment.

(1) General policy

Stock that private wholesale traders have should be counted as well for the emergency purpose. To utilize privately owned stock in time of disasters, it is essential for the government to conclude agreements with concerned parties in advance. In addition to this, it is also important to prepare a list of essential drugs and necessities to avoid duplication of request for external assistance.

(2) Stockpile at health institutions

Hospitals at level II and III are strongly recommended to keep a stockpile for three days at least by adopting the so-called 'running stock method'.

(3) Stockpile at central storages

Medical necessities stocked at Central Storage will be for medical aid teams and level I public hospitals. Judging from the estimated number of injuries of about 260 thousand and more, an extensive amount of drugs and other supplies need to be stored. Health authorities need to estimate the necessary quantity.

In addition, there will not be enough space to store all these necessities in one place. Health authorities also need to decide how to improve the stock system, taking their administrative capacity into account. Potential methods are: a) one huge central storage system, b) dispersing system of four branch storages at each health service zone, and c) another dispersing system of 19 branch storages at each *locality* or municipality.

(4) Stock of blood for transfusion

Capacity of storage at Secretary of Health needs to be upgraded. It is strongly recommended that agreements with donor agencies be prepared to supply blood for transfusion in times of disaster, on the assumption that the supply in the metropolitan area is clearly not enough to meet the expected needs.

9) Education and Enlightenment on Disaster Emergency Care

Education and training for disaster health relief is definitely in short supply. Only education and training can make people build their capability to survive until a rescue team arrives and to make full use of a few resources in the disaster situation. Secretary of Health, with assistance of Ministry of Health, will spearhead the preparation of manuals for disaster health education and training.

(1) Prepare manuals for health disaster management

Secretary of Health will prepare several kinds of manuals and textbooks, with the cooperation of academic and hands-on professionals for disaster preparedness. Some titles of manuals are listed in Table 5.4.7. Result of the damage estimation study should be fully utilized to include more realistic information in the manuals.

Table 5.4.7 Manuals to be Prepared for Educational Purpose

No	Title	Targets
1	Disaster Medical Aid Activities - General	Disaster relief personnel
2	Disaster Medical Aid Activities - Locality	Locality/Municipality
3	Hospital Disaster Simulation Exercises	Hospitals
4	Practical Training Textbook for Triage	Hospitals, Medical aid teams
5	Guideline for Identification of the Dead	Locality, Police
6	Health Management at Refugee Camps/Shelters	Locality/Municipality
7	Disaster Health Environment Activities	Locality/Municipality
8	Disaster Activities of Secretary of Health	Secretary of Health
9	Leaflet ''First aid at disaster''	Community population

(2) Execute trainings for health professionals

Manuals and textbooks prepared will be used for disaster education and training to the targeted groups shown in Table 5.4.7. Target groups cover not only health professionals but also administration staff in the sector.

(3) Execute public education to provide citizens with knowledge and technique on first aid

Disaster victims are not likely to expect having organized relief activities nor medical aid activities for several hours, and if things come to worst, for one or two days after the initial impact. Consequently, public education on first-aid technique to community people will play a crucial role in the disaster.

10) Private Sector Involvement

Central and local health authorities shall conclude specific arrangements in advance with all health-related entities listed in Table 5.4.8, public or private, in any regions of the country, to give and take priority assistance in the event of a disaster.

Table 5.4.8 Entities to Conclude Arrangements with the Government

Sector	Name of entity	Arrangements
Media	Newspaper	Public information activities and hour-by-hour status reports of damage at a disaster. Activities of medical aid teams, health institutions and guidance for medical aid, etc.
	Television	
	Radio	
	Newspaper	
Transport	Ambulance	Cooperation of Patient's transportation Health personnel transportation Refugees transportation Supplies transportation
	Taxi	
	Bus	
	Truck	
	Airplane/Helicopter	
Health	Private Clinics	Emergency hospitalization services
	Doctors Association	Formation and dispatch of medical aid teams
	Red Cross	Emergency medical services and ambulances
	Dentists Association	Formation and dispatch of dental aid teams
	Pharmacists Association	Formation and dispatch of teams of pharmacists
	Drug/Consumables Suppliers Association	Priority supply of drugs and necessities in stock
	Equipment Supplier	Priority supply of equipment and parts in stock
	Medical Gas Supplier	Safety check and priority supply to hospitals
Infrastructure	Natural gas	Priority restoration and supply to health facilities
	Propane gas	Priority supply to health facilities
	Water supplier	Priority supply to health facilities
	Electricity	Priority restoration and supply to health facilities
	Sewerage	Priority restoration of health facilities
	Telephone	Priority restoration of health facilities Installation of priority lines to health facilities

Note: General goods for daily life such as food, fuel and linens, which are not specified in the health sector, are excluded from the list.

11) Arrangement with International Agencies on Humanitarian Assistance

Disaster never waits for the government to complete the preparation of physical and organizational set-ups for it. In addition, preparedness for disasters requires a huge fund and a long time to implement. This is a major reason to make the best use of international humanitarian assistance for disaster relief. Preparedness and arrangement are important even in this field to make clear what and how much are in short supply.

The Government of Colombian shall endeavor to fulfill the shortage of human resources and physical supply on its own at first, and then make arrangements with international agencies about the possibility of receiving assistance to supplement the shortages. Specific actions toward this effort are as follows:

- To clarify the health items which need to be supplemented by international humanitarian assistance.
- To have contact with assistance agencies to know what they are capable of providing; and
- To negotiate to make arrangements with suitable agencies about technical and physical assistance.

5.5 Recovery and Rebuilt

The disaster recovery in the Study Area should consider not only in Bogotá City itself but also in Colombia. The Bogotá City is the capital of Colombia as well as Cundinamarca prefecture. The capital functions should recover as soon as possible. Since Bogotá City also has developed economic linkages to the other regions in Colombia, economic damage may influence to the Colombian economy. Therefore, recovery plan should be formulated before a disaster.

The rehabilitation and reconstruction can be divided into the two categories: restoration of normal life and restoration of urban area. The government sector also involves in the restoration activities. The cooperation of the Bogotá City and Cundinamarca governments is the most important.

5.5.1 Restoration of Normal Life

The objectives of the restoration of normal life are to recovery of the life before the disaster situations. Many victims are lost their house, living conditions and jobs. The people who suffer the most in the disaster should be identified and the government should work together to restore the life.

The items for consideration are summarized as follows:

Table 5.5.1 Restoration of Normal Life

Items	Descriptions
Reconstruction of medical System	The priority should be given to the reconstruction of the damaged hospital. The temporary hospital is an alternative for reconstruction.
Sanitation and health	The governments should carry out the monitoring of sanitary conditions. The necessary measures should be taken when the problems have identified.
Education	The damaged school should be reconstruct by the governments. The damaged private school also should reconstruct in cooperation with the public sector.
Information and support	The government should open information and support office for the damaged victims.

5.5.2 Rehabilitation of Infrastructure

1) Infrastructure and Lifeline Company

(1) Financial aspects

All of the public organizations have to protect their possessions, properties and resources (Art.269, Constitution, Art.2, Law 87/1993). The General Board of Audit obliges the public organizations including lifeline service enterprises, whichever private or public, to have necessary disaster and fire insurance to protect their possessions, properties and resources (Art.101, Art.107 of Law

42/1993, Art.6 of Resolution 5145/2000 of the General Board of Audit). It will give sanction with a fine to the organizations without observance.

As the results of the survey, EAAB, TELECOM, ETB, Natural Gas Company, Madrid and Mosquera Aqueduct Enterprises have disaster insurance to cover their infrastructures, and IDU will introduce insurance from the 2002 fiscal year. However, it was found that not all of Colombian public organizations including Lifeline Service Enterprises have disaster insurance.

(2) Technical aspects

Each public service companies should prepare the rehabilitation and reconstruction plan prior to events.

2) Resident Building

(1) Laws and regulations

The Law 675 of 2001 obligates joint owners to have Disaster and Fire Insurance to protect properties of joint ownership like common facilities of apartments (Art.15). In Bogotá total amount of 1,004,254 million pesos were paid for damage insurance in 2000, the 13 % of which 127,999 million pesos were for fire insurance, and 9 % of which 89,465 million pesos were for earthquake insurance (FOSECOLDA). The earthquake insurance is not yet common in this country. The National Fire Fighting Fund receives 1 % of paid fees of fire insurance (Art. 28, Law 322/1996, Art.2, 3 Decree 2211/1997).

(2) Technical aspects

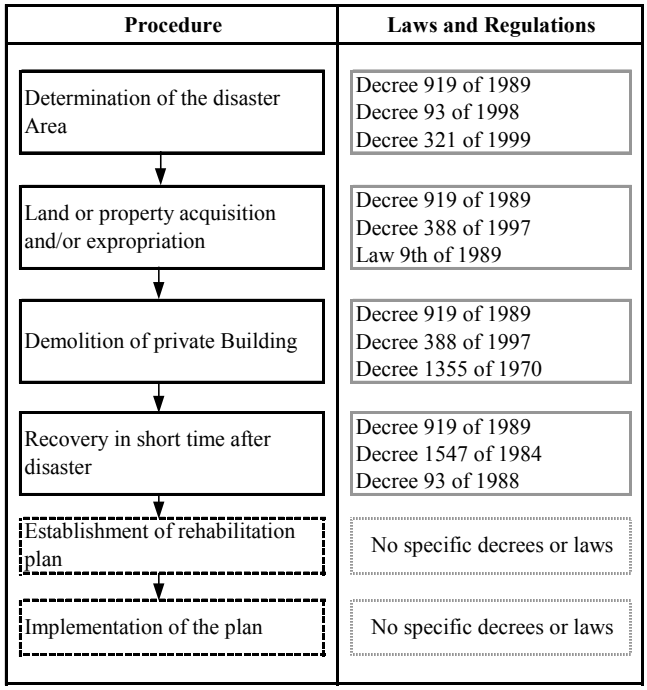
The governments should prepare reconstruction methods and procedures based on the existing laws and regulations.

5.5.3 Urban Area Reconstruction

1) Laws and Regulations

The existing laws and regulations show the procedure of urban rehabilitation and reconstruction process in the most affected area. The rehabilitation and reconstruction in public facilities are responsibility for the each government organization. For the public service organization, Law 142, 1994 regulates the responsibility for the public service companies. The each public service companies should take responsibility for primary responsibility in order to maintain the public facilities. The summary of the laws and regulation is shown in Appendix 5.5.1.

According to the existing laws and regulations, the procedure of the rehabilitation and reconstruction process is shown as follows:



Source: JICA Study Team

Figure 5.5.1 Rehabilitation and Reconstruction Process

2) Organization

The rehabilitation process includes many organizations. The primary organization for the rehabilitation and reconstruction is District Planning Department in Bogotá City and department of Planning in Cundinamarca. Those organizations should act as the coordinator of the rehabilitation.

5.6 Education Plan

5.6.1 Creation and Promotion of Public Awareness

1) Background

In order to build a strong society against disaster, it is very important that citizens take the initiative to make an effort by themselves. The dual concept that "People should protect their own lives by themselves" and that "Inhabitants should protect their own community by themselves" are basis of disaster prevention and mitigation. People are expected to increase active behaviors for disaster management under various circumstances. Additionally, the countermeasures for large-scale disaster can be effective, if there is concurrence between governmental measures and disaster prevention by local society such as community and industries. Based on the results of the analysis of the present conditions as well as workshops and seminars, it can be concluded that public awareness of disaster among the people is generally low. Even though there are some who are aware of disaster risks, they do not know what to do in case of disaster and how to access the appropriate information. Individual citizens should have enough awareness and continue the exercises in normal time to be prepared for the disaster. As one of the emergency support functions, public awareness should be created and increased for various target groups to operate emergency responses. The basis can be created from the daily enlightening and learning activities of disaster prevention. The aim of public awareness programs is to promote an informed, alert and self-reliant community, capable of playing its full part in support of and in cooperation with government, in all relevant disaster management matters.

2) Target Groups

Target groups for awareness creation and promotion for disaster prevention are as follows.

(1) Government staff

This includes government officials at all levels (especially, agencies handling disaster such as OPAD, DPAE, Secretariat of Education, Secretariat of Health, Fire Department, Police Department, Civil Defense, etc.)

(2) Educational staff

School teachers and other staff in public and private schools, universities

(3) Community

- Community leaders
- Community groups, coordinators, NGOs
- Local people including school children
- Private sector (business offices, factories, hotels, shops, etc.)

3) Approaches

(1) Measures

Main measures for increase of awareness of disaster prevention are categorized into the following three: public relations for information sharing, education for increase of awareness and enlightenment, and drill and training for acquisition of skill.

A. Public relations

In order to act based on one's best judgment in case of disaster, people should be enlightened by correct and adequate knowledge of disasters and countermeasures in advance. Depending on the local conditions, suitable ways should be utilized for enlightenment and dissemination of information in cooperation with government. In order to provide the citizens any time with whatever information they want to know, a system of public relations on disaster information should be improved. Public relations activities by private sector handling lifelines should also cooperate. In addition to the public relations, public hearing activities such as public opinion and questionnaire surveys can be considered in order to understand level of awareness and needs related to disaster prevention of the local people.

The format for communicating information to the public can vary. Some possible options are:

- Pamphlets, leaflets, posters
- Videos to be rented as requested
- PR paper, bulletin, notice and other publication issued by government
- Manual, guidebook
- A series of radio and TV broadcasts
- Fair (exhibition, demonstration)
- Symposium and talks utilizing experts with special knowledge
- Cartoon strip method for children including messages
- Designation of "Disaster Prevention Month" and implementation of a one-month campaign in cooperation with locality (award for best self-reliant groups and individuals for disaster prevention, organization of seminar and symposium, spot programs of radio and TV, exhibition of posters, photos, film showing of the topics, etc.)
- Message of disaster prevention printed in telephone directories and shopping bags
- Utilization of popular sporting events, concerts and rallies, etc. to display posters or banners
- Community gathering/meetings of various kinds including church, women and youth, etc.
- Utilization of the existing government-sponsored community schemes (as carriers for disaster-related information)
- Presentation of the disaster experience by the victims

- Establishment of Consulting Sections in the government

The citizens can access to the countermeasures and information related to disasters by each agency with designated works. General items related to disaster can be consulted at DPAE, OPAD, and CLE in each locality.

B. Education

The importance of disaster education to all people has been recognized in many countries. Education for school children and students, local inhabitants and staff in government, and industries/business offices is very important to create/enhance the public awareness and promote activities for disaster prevention. For the disaster with long cycle of occurrence especially, it is necessary to prepare for it over generation. Therefore, education should also play a role of passing down prevention techniques and lessons onto the next generation. It should be implemented in various opportunities such as school education and social education, through:

- School programs, which offer good long-term dividends, especially in developing an informed, alert and self-reliant community
- Publication
- Lectures, seminars, workshops and training courses
- Rallies, discussion meetings
- Manual, guide
- Drill, learning by experiences
- Voluntary activities
- Competition of posters, photos, slogans, essays, etc. by students, children, adults regarding disaster prevention
- Creation of safety map by community

Table 5.6.1 Basic Concept of Disaster Education

	School Education	Social Education
Objectives	To develop awareness of disaster To consider safety and act for disaster prevention in daily life	To get the concept of self-help and mutual-help To develop awareness of self-reliance To take measures in cooperation with local people, society and government
Place for Education	In school Outside school (in and out of community)	Various lectures, workshops and meetings Training session for main leaders and members of self-reliant groups of disaster
Materials	Side readers, teaching aids Textbooks	Distribution of pamphlets, leaflets to all households and self-reliant groups
Comprehensive Drills	Students and staff participate in drills organized by self-reliant groups in the community where they live	All activities necessary from proclamation of warning until rehabilitation supposing a large-scale earthquake, in cooperation with local government
Local Drills	All students and staff participate in the drills in school	Suppose a sudden earthquake, drill appropriate for the living area with initiative of the self-reliant groups

The guidelines and target of disaster education toward school children should be instructed and the implementation should be led using the following approaches:

- Through a whole package of educational activities such as subjects, classroom activities and school events, etc., the basic knowledge of various kinds of disaster and countermeasures in case of disaster should be provided.
- Voluntary learning should be expanded and the actual activities in case of supposed disaster should be implemented.
- Model schools for disaster education should be designated.
- Practical skills for first aid should be provided targeting secondary school students.

Education can be provided in various places and occasions. It is necessary to consider the best way for different target groups and their conditions. Basic knowledge on disaster prevention should be disseminated through various training, seminar, workshop and discussion meeting, etc. toward women groups, parents and teachers association and youth groups. The objective is to make the participants conscious of their role as a responsible member of the society and to increase awareness and capacity contributing to regional disaster prevention. The participants can spread their experience to other members in offices, groups, families, etc. Managers and chief operators in the facilities dealing with dangerous items, and places where many people come in and out such as department stores and theaters, etc. also should be enlightened for preparation and implementation of the emergency plan. Other occasions such as the course of driver licenses acquisition/renewal, the training courses for staff in charge of labor affairs of industries/offices, the general assembly and meetings of women and religious groups, etc., can be utilized to impart the necessary activities, responses and preventive measures for disaster and emergency. It is necessary for government to promote organization and reinforce voluntary groups. Through the

coordination meeting of the groups, knowledge of disaster should be disseminated and enlightened in order to increase awareness of cooperation in case of disaster.

C. Drill and training

Major drills and training can be conducted in form of:

- Evacuation,
- Fire fighting at the early stage,
- First aid, and
- Lifesaving.

The implementation will be done in school, community and region in collaboration with government, voluntary groups, and other emergency-related organizations.

(2) Contents of the information

In line with the above aim, many recognize that community members need to know the following facts in relation to possible disaster impact. Additionally, depending on the characteristics of each group, appropriate contents should be provided. The information to be communicated to the public can be divided into various categories, for example:

A. Information on disaster preparedness

- Basic information and knowledge of disaster (mechanism and disaster occurrence)
- Calculation of risk level of disaster
- Information on the area with high risk of disaster
- Ways of acquisition of disaster information
- Knowledge of preparation of emergency
- Preparation in normal condition such as diagnosis of disaster-proof housing, remodeling, preventive measures of damages, fires and emergency goods
- Knowledge of fire fighting, rescue, relief, first aid, etc.
- Guidance of activities in the house, community and offices for disaster prevention
- Basic information of action guidelines for local people
- The importance of self-reliant groups in region and industries and their cooperation
- Ways of formation of citizens groups for disaster prevention and measures to improve activities in case of disaster
- What the government has planned to assist the community

B. Information on government assistance programs

This might include:

- Community-relevant details of the national disaster management system

- Any necessary information to amplify the foregoing basic community needs. This might include special warning signals, designated shelters of safe havens, evacuation procedures and so on.
- The limitations that are imposed on government assistance by factors such as the need for survey and the time takes, logistical problems in providing relief supplies and the necessity to establish priorities for various relief measures
- Any other information, which is applicable to particular circumstances
- Countermeasures prescribed in regulations/rules

C. Information on emergency responses

- What will the disaster do
- The best immediate action to take, personally, by families and other groups
- How best to help other members of the community
- How to participate effectively in the disaster communication and warning process
- How to improvise shelter and sustenance until assistance is available
- Emergency measures in case of sudden occurrence including action guidelines
- Information on refuge, evacuation route, and other evacuation measures

If considered appropriate, various themes can be utilized in implementing public awareness programs. These, which can be changed and/or given particular emphasis from time to time, might include the following;

- Disasters are not discriminative. Certainly they affect individuals, families and communities. However, they also affect the infrastructure, the economy and the efforts of government in improving regional development and the living standards of the people.
- The community and the government are interdependent in coping with disaster. They must work together to overcome the problems that arise and to restore things to normal.
- The community is better equipped to cope with disaster if it is able to undertake certain basic measures for preparedness, self-reliance and self-help, and if they accurately understand the aims, scope and limitations of government assistance programs.

(3) Points of awareness programs to be considered

Responsibility for public awareness programs needs to be clearly defined. It is probably best in most cases to place responsibility with the authorities that also cover training. In other words, overall responsibility should rest with the Regional and District Education Committee, with day-to-day matters being delegated to Secretariat of Education.

The following main aspects of public awareness programs need to be clearly established.

- The information that needs to be communicated to the public;
- The format in which the information is to be communicated;

- The medium or channel which is to be used to convey the information to the public; and
- The community responsibility for taking action on receipt of this information, where required.

In establishing these main program aspects, it is beneficial to consider to what extent government/community factors, can and should be reflected in the programs themselves. Other factors, which need to be taken into account, are:

- Community experience of disaster, and
- Expectancy and dependency factors, which may have led communities to become over-dependent on government assistance, thus eroding community and individual self-reliance.

In organizing public awareness programs it is usually advisable to seek advice from information specialists (e.g. the government information service). Use can also be made of any systems, which may be applicable to local circumstances. Radio is widely utilized for disseminating government information programs. These radio links can similarly be used for passing training information down to community level.

(4) Monitoring and evaluation of the programs

It is important to check, where possible, the effectiveness of public awareness programs. This particularly applies to the ability of programs to gain and maintain the interest of the people who are being targeted. It is also advisable to check periodically that the public in its intended sense is receiving the information being imparted by programs. The maintenance of adequate awareness levels needs to be continuously monitored. Otherwise, it is likely that programs will become stale and public interest will fade. It is recommended that a definite program, or series of programs, should be established to assist in maintaining the viability of plans. This kind of approach probably provides the most effective basis for maintaining awareness levels. However, it is also suggested that a watch should be maintained for any innovative ideas, which may help to renew or refresh awareness interest. Some of these ideas, whilst basically simple, can be very effective. For instance, manufacturers and distributors of everyday household goods can often be persuaded (in their own as well as the community's interest) to use some promotional gimmick, which will have strong public appeal. Overall, however, watchfulness by the responsible disaster management authority is the best insurance for maintaining public interest.

4) Role of Community in Disaster Prevention and Emergency Responses

(1) Background

Following a major disaster, first responders who provide firefighting and medical services will not be able to meet the demand for these services. Factors such as number of victims, communication failures, and road blockages will prevent people from accessing emergency

services they have come to expect at a moment's notice. People will have to rely on each other for help in order to meet their immediate life saving and life sustaining needs. One also expects that under these kinds of conditions, family members, fellow employees, and neighbors will spontaneously try to help each other. This was the case following many earthquakes where untrained, spontaneous volunteers saved many people.

If we can predict that emergency services will not meet immediate needs following a major disaster, especially if there is no warning as in an earthquake, and people will spontaneously volunteer, what can government do to prepare citizens for this eventuality? First, present citizens the facts about what to expect following a major disaster in terms of immediate services. Second, give the message about their responsibility for mitigation and preparedness. Third, train them in needed life saving skills with emphasis on decision making skills, rescuer safety, and doing the greatest good for the greatest number. Fourth, organize immediate help to victims until firefighting and medical services arrive. There is evidence that public participation can heighten awareness, which in turn can lead to basic mitigation measures being taken at the community level. In order to prevent and mitigate the damages, not only government and disaster-related agencies but also citizens should implement disaster prevention activities voluntarily and work in the spirit of cooperation in the region. These activities can be expected to produce more effective results if the citizens act as a body and systematically.

(2) Approaches

A. Formation of community self-reliant disaster prevention groups and reinforcement of the existing community groups/NGOs involving activities of disaster prevention

The appropriate and prompt actions by citizen groups formed by local people are the nucleus of power of regional disaster prevention. For this purpose, firstly, the existing community groups can be utilized for disaster prevention and responses. Also, among many groups consisting of members with same interest and benefit, such as groups of youth, women, mothers, the elderly, welfare, patrol for security, etc. can be considered. The retired staff of disaster-related organizations such as fire department and police department who are members of the community can be utilized as leaders for the purpose of disaster management. However, they should be flexible and loosely networked from the viewpoint of disaster. Their relationship with each other can be reinforced through the daily activities including disaster prevention and once in case of disaster, there can be mutual cooperation. They share the awareness of protecting the area but each group is independent. If the organization is fixed with a tight structure, the staff and equipment will be useless in normal condition. Further, voluntary NGOs working in the community can be involved for the disaster activities. They should cooperate with private sector (industries, business offices, companies, etc.) to receive financial and technical support. If there is no such group in the community, forming new self-reliant groups for disaster prevention should

be considered. The group activities can be strengthened through formation and distribution of guidebook including manuals for fire fighting, training of leaders, workshops, discussion-meetings, film showing, technical guidance of various drills, etc.

a) The points to be considered in case of formation of the groups

- Basically the existing local community groups are utilized. If these groups are large as a unit of disaster activities, they can be divided into smaller groups (especially, in urban area, self-governing association in apartments and condominiums should participate)
- Considering the population structure in day and night times in the region, the groups should be organized not to disturb the activities even in day and night times and holidays and working days.
- Based on the discussion with businesses in the region, the disaster groups in the business sector should be positioned as self-reliant groups and cooperation with them should be promoted.
- Participation of women is one of the important factors. Some communities have many men folk working outside and only women, children and the elderly are left in the daytime. In this case, the groups can be consisted of women and other inhabitants who stay at home. It is likely that women know the community and families well and can contribute to secure the area.
- Countermeasures considering local conditions should be prepared and provided.
- Partial with strong locality and excessive utilization of experts and experienced should be avoided.

Disaster prevention alone cannot be used as motivation; it is necessary to encourage the people to create a region with comfortable and safe communities that they themselves created through their activities. Disaster prevention should be a part of the daily community activities. The government should not force the formation of the groups. The groups should be created and operated through many discussions among the local people. The groups are not necessarily uniform or standardized but original/unique in each locality based on its characteristics.

b) Activities of the groups

Participants of the groups should prepare their own rules and disaster action plan and implement the activities based on the discussion with local government.

An example of contents of the disaster action plan

- Structure of the group and the assignments of each section
- Dissemination of disaster knowledge
- Disaster drills
- Information collection and conveyance

- Fire prevention and fire fighting at early stage
- Rescue and relief
- Guide of evacuation and refuge life
- Preparation of food and water supply
- Preparation and maintenance of equipment and tools for disaster
- Preparation of safety map and action programs based on the map

Table 5.6.2 Roles of Self-reliant Groups for Disaster Prevention

Normal Condition	- Dissemination and increase of disaster-related knowledge and prevention of fire - Implementation of drills on fire fighting at early stage, evacuation, rescue, first aid - Accumulation and maintenance of equipment for fire fighting, first aid kits, other tools - Understanding of the disaster-weak(infants, disabled, elderly) in the region - Understanding the dangerous area and points in the region - Clarification of role of the groups and formation of information system - Confirmation of evacuation and medical relief facilities places - Communication with disaster-related agencies and neighboring self-reliant groups
Emergency	- Implementation of fire fighting at early stage - Implementation and cooperation of rescue and relief - Collection of information on damages in the region, communication to the inhabitants on evacuation, report and request to the disaster-related agencies - Security of the disaster-weak - Implementation of collective evacuation - Supply of food relief and cooperation with distribution of relief goods

Preparation of community safety file/map

In leadership of the self-reliant groups, regional groups and others concerned should check, diagnose and understand their substances and issues. This information should be maintained and utilized for emergency response and its preparation, etc.

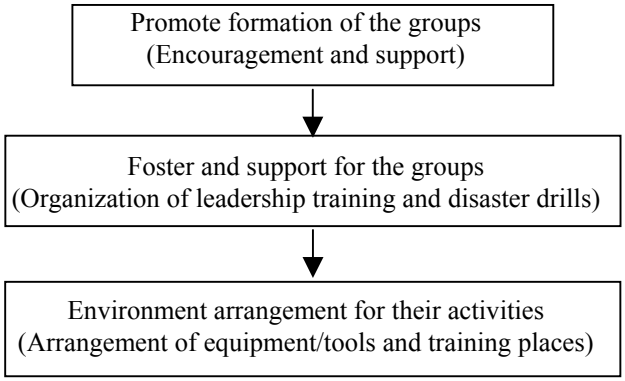
(Items to be covered in the file)

- Groups and activities related to safety and relief
- Human resources, facilities and equipment, etc. related to safety and relief
- The disaster weak and dangerous places, etc.

Based on the above file/map, concrete and detailed measures should be compiled and formed as action program to realize a safe community.

c) Role of the government in formulation and improvement of the groups

Government in each locality should play the roles depicted below.



Local government should try to establish a cooperation system with related agencies and financial support for new groups in order to promote self-reliant disaster groups. Local government should conduct the following activities:

- Establishment of committee on promotion of the group formation
- Preparation of self-reliant group formation plan
- Establishment of model groups
- Preparation and distribution of materials for enlightenment
- Training for core leaders and other leaders of the group
- Organization of various workshops, lectures, round-table conference, etc.
- Individual guidance and advise to each community
- Drills and training for each community
- Award of best self-reliant groups and leaders
- Financial support for equipment and tools

Additionally, the general public should be enlightened on the importance and roles of the groups in order to increase the number of groups and their members. In the formation of the groups, following areas should be focused:

- High-populated area
- Disaster-prone areas with high rate of inhabitants affected
- Concentrated area of fragile houses and dangerous facilities
- Area lacking fire fighting and water control facilities and activities
- Area with disaster experience of large damages

B. Foster leaders for disaster prevention

In order to make the community and self-reliant groups act vividly and function effectively for disaster, leaders are necessary to direct and conduct the people. Leaders will encourage inhabitants in the community and be at the head of prompt and appropriate action in case of disaster. Leaders should be a member of the community and provided with basic information and skill for disaster. Appropriate persons for leaders should be found among the participants to various training, seminar and workshops related to disaster prevention and trained as local leaders.

The local government should organize courses for disaster leaders. The candidates will learn the necessity of regional disaster prevention, basic fire fighting, rescue and relief and lifesaving procedures as well as formation of personal network. Leaders should be liaised with CLE, voluntary groups and other governmental offices, and private sector.

C. Formation of network for mutual help and public help

Figure in Appendix 5.6.1 shows the ideal relationship among the concerned parties for disaster prevention. Soon after the disaster occurrence, such case can be predicted that systematic emergency responses by related agencies are difficult. Also, there are many disaster weak such as the elderly, disabled and infants who need support and assistance. In this condition, cooperation among local people and businesses in the region is strongly needed. In order to promote this kind of cooperation in the big city, the traditional network should be disclosed and inhabitants, neighborhood association, citizen groups, industries, schools, volunteers, NGOs and other various groups should work together. For this purpose, Cundinamarca government prefecture and Bogotá city are appropriate organizations and which can take initiative. They should consider the coordination and cooperation for regional disaster prevention and formulate basic guideline for promotion of the cooperation. In accordance with this basic guideline, each lower level should establish a mutual support system based on the local condition following an agreement, for example.

- In conjunction with the foregoing cooperation of the concerned parties, there are several factors, which affect good understanding and cooperation between governments and communities. These include the following:
- In addition to knowing what government planned to do to assist it in time of disaster, the community should also have at least a broad understanding of the scope and limitations of government responsibility.
- The government and the community must act together to overcome the crisis, which arise from disaster, and to ensure a rapid return to normal conditions.
- The community needs to understand and be able to implement certain measures of self-preparedness when required to do so.
- Similarly, it is important for the community to understand the government's problems in providing post-impact relief, especially the difficulties in accurately establishing immediate needs.
- It is usually in the community's own interests to cooperate, to the maximum extent possible, with the government in disaster management programs.
- For its part, the government needs to understand and take into account the fact that, under disaster conditions, the public is usually affected by shock, loss and other trauma, and needs treating accordingly.

5.6.2 Education Plan

1) Objectives

It is widely accepted that the broad objectives of training are to teach people to carry out specific tasks based upon accepted methodology. Education, on the other hand, is more concerned with the development of mental capacity and thus with people's attitudes. Basic aim of disaster education is to promote disaster prevention literacy. From a disaster management viewpoint, therefore, there is benefit in contributing to public education, as far as possible, in support of training programs. This contribution could also be seen as furthering public awareness. It is suggested, therefore, that national and local authorities concerned with disaster management training, and associated public education, should take advantage of media and other opportunities to apprise the public of current and proposed disaster-related activities. Assistance in educating the public to understand the benefits of long-term mitigation should be regarded as a valid and productive objective for disaster management. In this regard, program of disaster education in schools, in society (community) and for the government staff in charge of disaster management can obviously play an important part. The following plan suggests and guides the appropriate direction and measures for disaster education in Bogotá City Area.

2) Education for Disaster-related Staff

(1) Education for government staff

A. Necessities of government staff in charge of disaster management

In order to secure the smooth and effective implementation of countermeasures for emergency, the governmental staff should be trained and educated. The staff should conduct activities for enlightening measures to be implemented by the citizens. However, there are only a few who can understand the systematic disaster measures well as a whole and deliver them to the local people in plain and appropriate language. Therefore, the government staff themselves should increase grounding for disaster prevention.

There are 2 problems pertaining to government staff for disaster management. One, the number of the government staff in charge of disaster prevention and emergency responses is not enough at all levels. In order to overcome this problem, existing staff should be trained to increase awareness and enable them to become experts. Additionally, the promising experts should be produced through education in university and vocational/technical schools. And two, the existing staff in charge of disaster prevention have insufficient technical skill and fail to recognize their responsibility. They should be trained in order to increase their skill and awareness.

The academic knowledge obtained from the academic research and scientific investigation conducted by consultants, researchers and experts, in universities and institutes, should be

returned to the government and the general public in order to use for mitigation of disaster. Public lectures on this topic in university can be considered.

For governmental staff to carry out their work, they should be trained to promote countermeasures for disaster and emergency and disaster management activities in the region, and to acquire the necessary knowledge and attitudes through various ways. The specific requirements of the staff are:

- Basic information and knowledge on different kinds of disaster
- Information of possible disasters and estimated damages and level of crisis
- Regulations and plans related to disaster
- Activities to be conducted in case of disaster
- Role of staff (System of gathering and assignment)
- Existence of a warning declaration and the following measures and provision of information
- Countermeasures to be taken in each family and community, and formation and enforcement of self-reliant groups for disaster prevention
- Issue and other necessary items in disaster prevention measures

The above-mentioned requirements depend on position and responsibilities. However, they cannot be implemented only by technical knowledge of engineering, sociology, science, etc. in schools and fragmentary experiences in the field. In the existing education system, special courses in universities can cover research and technique, and skill can be acquired in specific colleges and technical schools, etc. However, there is no facility and course that can provide cross-sectoral technique and skills in Bogotá. Therefore, the coordination and cooperation of all disaster-related organizations and facilities is desirable, where interdisciplinary research, technique and skills can be acquired and trained.

In order to achieve these training fields, the following categorized staff should be produced.

Table 5.6.3 Necessary Staff to be Developed

Field for Human Resource Development	Necessary Staff
1. Operation and management of information system on disaster information	GIS engineer Information engineer Risk analyst
2. Engineering of each kind of disaster management	- Engineers in charge of flood, landslide, earthquake, chemical, lifeline, etc.
3. Administration for disaster management - Planning, monitoring and evaluation of the plan and programs	Planner Administrator
4. Education, training and public relations - Formation of community groups, coordination with NGOs and volunteers - Advise for formation and revision of disaster management plan in office and region and training	Specialists for training, education and enlightenment Specialists in charge of community development Public information coordinators
5. Emergency responses	- Red Cross, Civil Defense, Health Department, Police Department, Fire Department, etc.

B. Measures

- Training and education on each specific field
- Seminar, workshop, forum on the topics
- Simulation, drills
- Publications (manual, guide, etc.)

a) Contents of Training and Workshops

Disaster management training

Training for existing or potential managers in order to equip them for disaster-related tasks as specialists, and to orient them on various aspects of crisis management.

Skills training

Training for those persons who may be required to undergo duties in:

- Emergency operations,
- Rescue,
- First aid,
- Emergency feeding and welfare,
- Communications,
- Needs and damages assessment.

In some cases, they may need to be trained as auxiliaries to support existing emergency services (e.g. for auxiliary rescue teams acting in support of the police and fire authorities).

Coordination training

Training for coordinated disaster management action is likely to be required for all key persons in emergency services, and government departments and agencies. As an adjunct to this training,

the services and the organizations themselves need periodic practice in coordinated action, usually in the form of combined exercises.

Workshops and seminars

These will cover:

- Specialized subjects such as prevention and mitigation measures,
- Special briefings of technical and academic studies,
- Annual preparedness reviews.

b) Points for training programs

Responsibility

The implementation of training programs is obviously influenced by the availability of suitable institutional facilities/equipment, materials and staff. On this respect, it is usually worth considering the following factors:

- It is advocated that responsibility for training must be clearly defined within the overall training policy. It is probably best to place this responsibility with the Regional and District Education Committees. The disaster management sections in Cundinamarca and Bogotá governments should be given the responsibility for overseeing day-to-day training matters.
- Members of the committees and sections should receive training at a suitable disaster management establishment. If such training could include institutional techniques, this is advantageous.
- Local disaster-experienced officials and the resources of government sections in charge of training should be utilized to assist in formulating and implementing training programs. Also, there is a good deal of instructional expertise within Police, Civil Defense, academic, Red Cross, religious, welfare and similar resources, and the utilization of this expertise is not only invaluable from a purely training viewpoint, but also from a disaster management coordination aspect. Full use of these local personnel resources can go a good way to offsetting the shortage of suitable trainers. For instance, the graduates of a series of disaster management courses for government officials formed themselves into an association of trainers.

Monitoring and Review

Whilst the four types of training requirements mentioned above are likely to comprise the core activities, other possibilities should not be overlooked. In practice, training requirements tend to fluctuate considerably, the emphasis on some activities fades, whilst the need for other activities increases. Thus training programs need careful monitoring, with adjustment being applied as necessary. It is therefore advisable to review the contents of training programs on a regular basis.

Depending on the size and nature of such programs, this might be done annually or biennially. If a training program is being introduced for the first time, it is useful to run it over a pilot period, after which it should be evaluated as a guide for the future.

The following ways should be initialized for disaster education.

C. Distribution of manual for disaster

This manual will be prepared and distributed by Cundinamarca and Bogotá governments to their staff, so that they can understand what actions are required in disaster response. The points to be included in the manual are as follows:

- Gathering in early stage
- Information collection during the staff gathering
- Rescue and first aid
- Fire fighting in early stage
- Guidance of evacuation
- Establishment and operation of refugee camps/shelters
- Compilation of information on disasters
- Public relations activities
- Other necessary matters

D. Implementation of drills and simulation on the spot, field survey and observation

Toward the local staff in charge of disaster, the drills and simulation on the spot, and supposed emergency activities should be conducted individually and collectively by agencies. Regional and District Operation Committees shall take initiative for this activity, which includes:

- Disaster prevention measures in each related organization and their assigned tasks;
- Mobilization of the staff and confirmation of their roles in case of disaster;
- Communication system among related agencies and information activities;
- Application of related laws and regulations; and
- Damage estimation and evacuation ways (routes and refuge).

E. Training sessions, lectures, workshops, seminars, etc.

Researchers and experts, and staff in the disaster-related agencies will be invited, as lecturers or leaders, and training and lecture sessions shall be organized. The items to be included are:

- Kinds and characteristics of disasters;
- Forecast of disaster and weather conditions;
- Contents of laws and regulations related to disaster;
- Know-how, measures and rules in case of disaster;
- Contents of the disaster plan;
- Past disaster cases and issues on disaster measures;

- Knowledge of living security in case of rehabilitation; and
- Results of academic and technical studies and researches.

F. Courses for specialists of disaster management

Between researchers and the field staff of the government, between the government and the local people, there are still gaps to be overcome. Therefore, it is suggested that the Cundinamarca governments and Bogotá should coordinate to open the courses for governmental staff in charge of disaster in order to enhance the capacity of utilization of academic and scientific researches and studies for practical disaster management, and make them disaster specialists. The aims of the courses are as follows:

- To consider how to interface the researches of disaster with disaster prevention and damage mitigation;
- To review how the existing researches contribute to disaster prevention;
- To be informed how the field side can judge the opinions and comments by scientists;
- To consider how to take countermeasures from the information supplied to local government; and
- To contemplate a system that translates the results of researches into understandable and usable format and feed this information to the general public through publication, workshops and drills, etc.

G. Education for other related agencies

The disaster-related agencies such as Fire Department, Police Department, Health Department, etc. should conduct in-house training for their respective staff in cooperation with Red Cross, Civil Defense and private sector.

(2) Education for educational staff

A. Training of teachers and school staff

It is essential that school teachers and staff should be trained. They are not only those who are in charge of disaster prevention in school but also those who teach subjects that can be related to disaster. Additionally, some schools have possibilities to be used as refuge in the event of a disaster. Since, in this case, the roles of schoolteachers and staff will become very important, they should be prepared for this situation.

a) Appropriate means

- To continue and improve training courses already provided by DPAE
- To provide opportunities for participation to various training courses offered by other agencies such as Civil Defense, Red Cross, Fire Department, etc.
- To distribute pamphlets, leaflets, posters, manual, guide on the topics

- To show videos on the related topics
- To organize workshops, seminars, symposium, lectures, discussion meetings, drills, etc.

b) Contents to be provided

- General knowledge of disasters
- Countermeasures in case of emergency
- Information on the area with high risk and possibilities in the region
- Knowledge of fire fighting, rescue, relief and first aid
- Ways of acquisition of disaster information
- Information on refuge, evacuation route, and other evacuation measures
- Security of students and communication with their families
- Mental care of the students after a disaster

B. Activation and utilization of regional and district education committees, board of education and teachers' union

The Education Committee in coordination with Secretariat of Education should be activated for the following tasks. In addition to this, it is proposed that the Board of Education and teachers' unions and associations should be vitalized for disaster education in cooperation with Education Committees. The tasks they have to carry out are as follows:

- Definition of the concept of disaster education
- Formation of disaster education program
- Action plans by each Committee member in short, medium and long terms
- Recognition and reinforcement of roles and advantages of each member agency
- Increase of awareness among the members
- Centralization and unification of the related information
- Evaluation and utilization of teaching aids, manuals and guides already published and formation of guidelines for educational materials by newly set up evaluation committee
- Preparation of new educational materials based on the guideline
- Preparation of school disaster manual to become a basis of school emergency plan and annual teaching plan for disaster education

School disaster manual can have the following structure:

- Activities to be prepared for disaster
- Responses in case of disaster
- Reopening of educational activities after disaster
- Responses as refuge in case of disaster

In order to implement these, the members also should participate in training, workshop, seminars and other available ways.

3) School Education

(1) Concept of school education for disaster prevention

The ability of the children should be harnessed and increased through education, which will enable them to understand the mechanism of natural disaster, natural environment and disaster experiences in the region and the system of disaster prevention and emergency responses. It will also help them recognize well the crisis in case of emergency, prepare for the disaster daily and act spontaneously for their own security following their appropriate judgment.

The aims of the education for disaster in general are:

- To recognize possibilities of disaster, to make daily preparedness, and to act timely and in an effective manner for their own security based on their appropriate judgment in accordance with the conditions,
- To help actively in securing the other people, groups and region during and after the disaster, and
- To understand not only the mechanism of natural disaster occurrence but also the basic and necessary information of regional natural environment, disaster and its prevention.

In order to achieve the above 3 aims, education for disaster should be implemented through a whole package of educational activities in school systematically with a definite plan, in conformity with the conditions of each school and local society in the region, development level and experience of the students, clearing the contents with priority in the curriculum.

(2) Curriculum

Disaster education curriculum in schools should be established. The Education Committee should determine the program and contents. Nine (9) subjects in the National Education System in Prevention of Emergency and Disaster should be utilized with some teaching aids. Additionally, it is proposed that model schools should be assigned in order to experiment with the proposed curriculum as a pilot project.

(3) Extracurricular activities

In order to supplement the curriculum, activities outside the curriculum are necessary. Example activities to be considered are as follows:

- Visit and experience work and activities in fire stations, Red Cross, Civil Defense, etc.
- Voluntary activities in the region where the school and students' houses locate
- Drills of evacuation, fire fighting, rescue and first aid
- Presentation of the learning and study results to the community in the region
- Participation to activities in Disaster Prevention Day
- Formation of school brigade of disaster prevention and its action plan

The school children from 7 to 12 years old have been targeted by DPAE through summer vacation activities. This program should be continued and expanded to the children over 12 years old. A potential group that has not been accessed and operated yet for disaster education is parents and teachers associations. Considering that most of the schools, whether they are public or private, have this kind of organization, some coordinated activities should be promoted including workshops and joint drills of students, their parents and teachers.

(4) Preparation of annual teaching plan in school

Each school will promote disaster education, preparing a teaching plan to clarify the disaster education in the annual teaching schedule. The plan can contain the following items but the characteristics of each school should be considered:

- Time schedule
- Target classes and achievement
- Subjects to be utilized and approaches
- Kind and method of teaching aids used and other education materials

(5) Preparation of school disaster management plan by school

Defining the responsibilities and available services which can be expected during times of emergency will help protect the lives of students and staff and permit prompt measures to safeguard property and maintain educational activities. The disaster management plan incorporates the above goals by:

- Prescribing authority, responsibility, functions, and operations of the school disaster management committee,
- Coordinating emergency operations with those of other agencies,
- Developing mutual aid and other support agreements with appropriate local agencies,
- Developing procedures to ensure a reasonable state of disaster preparedness, and
- Developing disaster-proof structure for school facilities and equipment.
- There is need for continued review and upgrading of the plan to reflect changes in the school environment. The school principal should develop the school disaster management plan including preparedness and emergency responses. Also, a committee on disaster management should be established in school, a sample structure of which is shown in Table 5.6.4 below. Committee members will have specific roles in response and recovery activities.

Table 5.6.4 Structure of Disaster Management in School

Condition	Organization (Chief)	Major Role	Member
Normal	Committee on Disaster Management (Principal)	- Discussion and planning of disaster prevention system - Annual plan of disaster prevention - Survey and guidance for security - Communication and coordination with external agencies, Parents Association and local self-reliant group of disaster prevention - Education plan for disaster prevention - Coordination and discussion for operation of refuge - Assignment of educational staff to gather in case of emergency - Emergency plan for educational staff to gather in case of emergency	- Vice-principal - Head of school affairs - Head of disaster prevention - Teacher in charge of curriculum - Teachers consultant - Teacher in charge of health - Head of each grade - Dietician, etc.
Emergency	Task Force on Emergency Responses (Principal)	- Establishment of task force on emergency responses and command and unification - Information analysis and response decisions - Plan of 24-hour mobilization of operative educational staff - Confirmation of roles of all educational staff - Supplement of absent staff - Organization of voluntary students - Security check of facilities and equipment for prevention of the secondary disaster - Measure of operation of refuge - Measures for reopening of classes	

(6) Courses of disaster management in university

In order to create specialists of disaster management who will work in government and private sectors, special courses related to disaster management should be established in universities. The program should be prepared by Education Committee and applied to some model universities as a pilot project. Courses should be multidisciplinary and practical, which aims at increasing awareness of disaster prevention and technical knowledge and skills including on-the-job training in the disaster related organizations. Therefore, not only young students but also governmental staff and private employees in active service can attend the courses.

4) Social Education

(1) Concept of social education for disaster prevention

Leadership at community or local level is a very significant factor in disaster management. Since the general public is composed of various kinds of people, it is difficult to carry out education and enlightenment for awareness of disaster if the public is considered as being all of equal level. Where the frequency of disaster is low and the practical opportunities for disaster activities are

few, people's awareness is low and the role of education and training is very important. The present training, drill and courses for volunteer leaders are likely to focus on activities soon after the disaster, however the most important stage in need of citizen power is the promotion of measures preventing and mitigating the future disaster. In order to utilize the citizen's power, more training and education should be arranged for the whole stages from prevention to the recovery. Based on the concept "protect you own life", the disaster-related organizations should disseminate thoroughly the idea of self-reliance in case of disaster, such as promotion and encouragement of actively dealing with disaster in the region, home and work places, etc. even in normal condition. The general public, i.e., those in the offices, industries and homes, should be provided with knowledge of disaster prevention in cooperation with related agencies and groups at any time appropriate opportunities present themselves.

The aims of social education are:

- To disseminate knowledge of disaster,
- To increase awareness of disaster,
- To increase ideas and skill of disaster management, and
- To establish a local disaster prevention system.

If the administrative leadership/guidance is too strong, however, the communities will decrease their voluntary activities and increase dependency on the government. The effective approaches to encourage community interest and participation should be considered carefully. Additionally, the delicate leadership and instruction by the government should be required in order to continue inhabitants' daily activities for disaster prevention especially in time of rare disasters.

(2) Contents of the disaster knowledge to be conveyed

The disaster knowledge should cover prevention, emergency measures and rehabilitation. For example:

- Disaster countermeasures in the area
- Knowledge of disaster and past disasters
- Daily exercise of prudence and preparedness for disaster
- Disaster risks and possibilities in the area
- Check of houses and furniture, etc
- Communication system among family members
- Prevention of fire
- First aid
- Evacuation ways (routes and refuge)
- Stock of food, water, and goods for 3 days after disaster
- Confirmation of goods to be taken out in case of emergency (valuables, portable radio, flashlight, clothes, first aid kits, foods, etc.)

- Formation of self-reliant groups
- Consideration of the disaster-weak
- Participation in voluntary activities
- Knowledge in case of emergency
- Action to be taken in disaster
- Prevention of fire and fire fighting at the early stage
- Understanding of damage conditions around the houses and the region
- Rescue activities
- Information collection by television and radio
- Necessary measures in evacuation
- Behaviors in refugee camps/shelters
- Activities by self-reliant groups
- Attitudes during driving and traveling

(3) Approaches

A. Processes to be educated

There can be three categories of the participation level of the local people to the activities for disaster prevention. They are as follows:

a) Step 1: Recognition Level

For the general public, the target should be set and guided in a way that they can always check their own town from the safety aspect and evaluate through education and enlightenment.

b) Step 2: Daily activities level

There is disaster prevention in family, acquisition of technique of disaster prevention, and participation to the creation of a safe community. However, in order to maintain and increase the participation rate to the training and drills, the daily life and disaster prevention should be connected closely and effectively.

c) Step 3: Activities in case of emergency

The appropriate information collection system should be established. The citizens should be trained as information and assistance supply sources. The citizens should be organized as self-reliant groups for disaster prevention. In future, voluntary activities should be systematized in order to be ready to gather for necessary activities.

B. Target groups

Target groups for social education can be local inhabitants in the region. Sometimes governmental staff, employers and employees in private sector, educational staff, and journalists

can be included as members of society. The community organization is the tail end of information resource channel from government to the inhabitants and can be used as self-reliant group for disaster prevention. The level of relationship and local activities among the inhabitants and leadership can produce a different level of emergency responses. Therefore at the beginning of the formation of the groups, the best way is the utilization of the existing community groups with strong leadership. There might be possibilities in groups of women, mothers, self-patrol, etc. JAC and JAL can be also considered with support of CLE at locality level. Local active leaders such as local government staff, grass-roots voluntary groups with close relationship with the region, and local private industries should be involved.

C. Means for education

In order to disseminate appropriate information and knowledge related to disaster, the most effective and practical media should be utilized. They include the following:

- Newspaper, television, radio, etc.
- Public relations paper, pamphlet (poster, leaflet, handbill, etc.) and other publications
- Movie, slide, video
- Standing sign board, banner
- Lecture session, training, workshop, seminar, symposium, forum, etc.
- Competition of slogans, paintings, compositions, posters, etc. among school children, students and the general public
- Utilization of Day of Disaster Prevention and Attention (campaign and drills)
- Formation of community safety map
- Formation of self-reliant groups of disaster prevention by community

The community safety map showing danger and risks and facilities and resources necessary in case of disaster in the region might be prepared and presented or distributed to each household in order to make easier formation of an accurate disaster plan. Also, it can make the individual activities of disaster prevention quick and appropriate.

In order to motivate and mobilize the people for constructing a self-reliant, safe community, a competition could be launched to award the best in the three categories given below. The organizers might be members of the Education Committee with support from the Cundinamarca and Bogotá government.

- Objects: Facilities in the community taking into consideration the viewpoint of disaster management, such as road, park, building, trees, etc.
- Activities: Increase of disaster awareness, enlightenment, such as formation of safety map, self-reliant organization of disaster prevention in the region

- Persons: Leaders who take initiative of disaster drills, practical educational training, workshops, courses, seminars to increase people's awareness and capacity for disaster prevention

The self-reliant groups for disaster prevention should be formed using existing community groups with the following expected activities. The leaders and members should be trained to implement their activities effectively.

Table 5.6.5 Expected Activities for Self-reliant Groups of Disaster Prevention

Normal Condition	Enforcement of organization Dissemination of information and knowledge regarding disaster Formation of activity manual Equipment of necessary tools
Emergency Case	Collection and distribution of information Prevention of fire and fire fighting at early stage Rescue and relief of the injured Guidance of evacuation of the inhabitants Provision of food and water

Table 5.6.6 Training of Self-reliant Groups

Name of Training	Implementation Agency	Target	Objectives
Leaders Training	Governments of Cundinamarca and Bogotá	Core leaders of the groups	- To increase knowledge and skills of disaster prevention - To activate the groups - To exchange information of activities - To foster regional leaders with broad views
Members Training	Governments of Cundinamarca and Bogotá	Main members of the groups	- To acquire knowledge and skills of disaster prevention - To enlighten and enforce awareness and measures among groups and local people

(4) Formulation of disaster prevention plan by community

In order for inhabitants to protect their own community, the community disaster prevention plan should be prepared. The preparation work should be conducted led by self-reliant groups and/or community groups. Points to be considered are as follows:

- Plan should be utilized for practical work for disaster countermeasures and preparation itself is not the purpose.
- The geographical condition of the region, and estimated damages should be taken into consideration. In this case, experts in civil engineering and architecture should be consulted.
- The characteristics of the community (advantages, disadvantages, uniqueness, constraints, etc.) should be understood and the system to cover and supplement these points should be established. In addition, at all stages from the disaster occurrence to relief activities in the refuge (fire fighting, life-saving, relief, rescue), role of players should be defined.

- Especially, it should be recognized that communities implement activities during the time soon after the occurrence until the arrival of fire fighting and medical services.
- The information on disaster should be delivered to the inhabitants appropriately and promptly.

The structure and items to be included into the community disaster prevention plan can be as follows:

- Introduction
- Outline and Characteristics of the Region
  a) Natural Conditions
  b) Social Conditions
- Disaster Prevention Plan (for Earthquake)
  a) Earthquake force
  b) Estimated Damage
  c) Groundings and Directions for Disaster Prevention
  d) System of Disaster Prevention in Normal Condition
  e) System of Disaster Responses in Case of Emergency
  f) Security in Case of Emergency
- Disaster Prevention Plan (for Flood, if necessary)
- Disaster Prevention Plan (for Industrial Disaster, if necessary)
- Disaster Prevention Plan (for Landslide, if necessary)
- Storage Plan
- Issue for Future
- Conclusion

5.7 Disaster Management Information System

5.7.1 General

"Disaster Management Information System (DMIS)" is the system to support the functions of DMA (Disaster Management Agency), and the one of the most effective tool in decreasing the damage of disasters by giving the necessary information in time.

DMIS will be composed five independent systems with the functions mentioned as follows:

1) Information Collection and Transmission System (CTS)

Collecting hydrological and meteorological information and transmitting to DMA

Collecting and transmitting disaster (damage) information to DMA

2) Database System (DB)

Storing information related to disasters as a database using GIS

3) Information Processing System (PS)

Processing information for decision-support in case of disaster, research and study, formulation of disaster mitigation plan, etc.

4) Decision-support System (DSS)

Supporting decision by automated alert using pre-set criteria

5) Information Distribution System (IDS)

Distributing the monitored and processed information, announcement, etc. to public and/or related agencies.

To set up DMIS, the followings have been taken into account:

- Kinds of disaster
- Emergency situation
- Information to be handled
- System to be constructed
- Organization

5.7.2 Disasters to be Correspond

The system should correspond to any kinds of disasters; however, the system proposed in this study will correspond to the following disasters, because the present study not includes other disasters.

- Earthquake
- Landslide/slope failure

- Flood
- Industrial disasters

The characteristics of each disaster from the viewpoint of construction of DMIS will be described in the following sub-sections.

1) Earthquake

The damage of earthquake will be widely spread and various types of damage will happen. Moreover, other disasters (e.g. landslide, slope failure, industrial disasters) will also have a possibility of happening caused by the earthquake. On the other hand, since it is difficult to predict the occurrence of an earthquake, the system will be mainly used after the disaster happened.

Therefore, the system for the earthquake should have a capability of handling the various kinds and the large amounts of information in the short period, and should resist against the large earthquake.

2) Landslide/slope Failure

Although the hazardous areas of landslide/slope failure spread widely in the Study Area, the landslide/slope failure will not occur in the same time except the event of heavy rainfall or earthquake. Thus, the extent of damage will usually be limited. In addition, it is possible to predict the occurrence of these kinds of disasters, especially landslide, with appropriate monitoring system.

3) Flood

The flood is mainly caused by heavy rainfall and it is possible to predict an event and to prepare a response plan before occurrence of the event using weather forecast and hydrological and hydraulic simulation system.

Since hazardous areas of flood are extended widely in the low-laying areas along the river, to mitigate the damage of flooding, the sub-system, especially CTS and IDS, should cover the whole possible inundation area.

4) Industrial Disasters

There are two causes of happening the industrial disasters. One is a failure of operation and the other is a natural disaster such as earthquake, landslide and flooding. Among these natural disasters, an earthquake is the most critical one because it is impossible to prevent the hitting of earthquake.

On the other hand the materials handling and/or storing, location, weather, etc will vary the extension of hazardous area, and the kinds of damage will also be varied. However, the extent of

hazardous area and damage can be assumed because the locations of factory/storage and kinds of materials to be handled and stored have been identified.

Because of the difficulty of prediction of the happening, the system should be constructed with the consideration of the situation after the event happening.

5.7.3 Emergency Situation

As for the disaster management, following three situations should be considered.

- Normal
- Pre-emergency
- Emergency

Since, DMIS should be corresponded to each situation appropriately, the system has three (N: Normal, P: Pre-emergency, E: Emergency) information flows (see Figure 5.7.1).

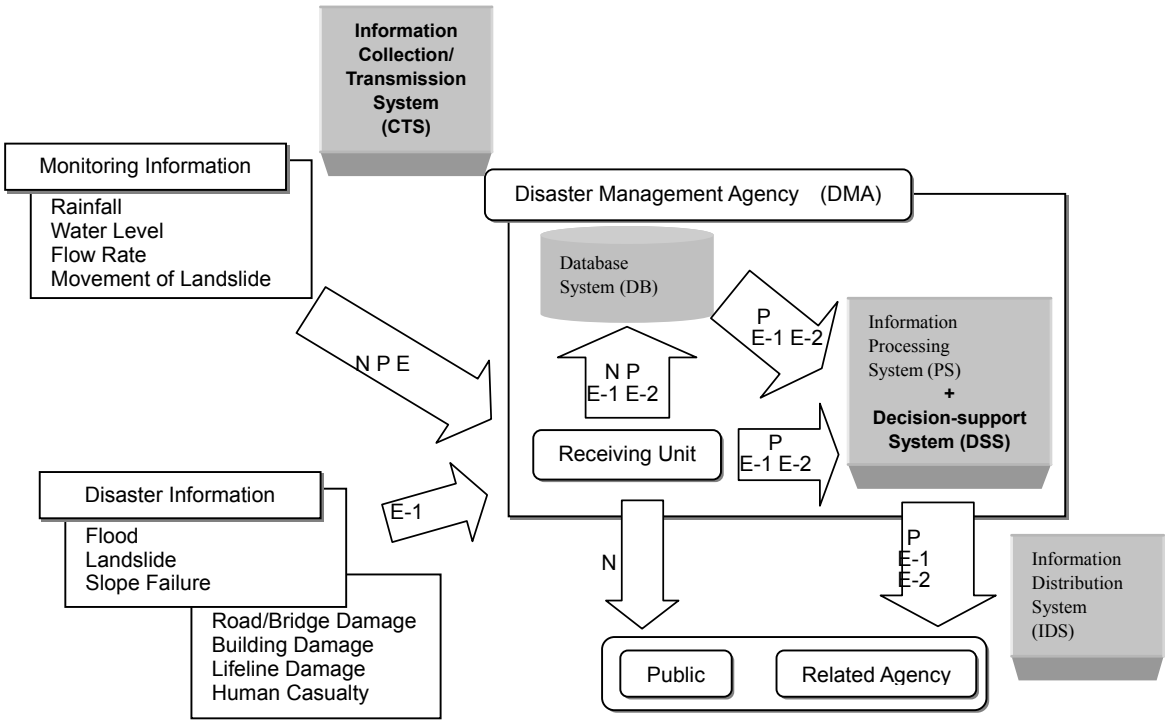


Figure 5.7.1 Flow of Information

1) Normal Situation

In the Normal Situation, the main functions of DMIS are collecting/monitoring the information related to the disasters (e.g. seismic wave, hydrological data, movement of landslide, etc.) and storing of collected information to the database.

Collected information by CTS is stored to DB (arrow with "NPE" in Figure 5.7.1). PS also processes the collected information as soon as the information reached to DMA. DMIS will

inform the officials if the monitored or processed figure extends the pre-set standards (e.g. rainfall amount, amount of movement of landslide, etc.).

2) Pre-emergency Situation

This situation is the situation that happening of disaster is predicted in near future (e.g. expecting a flood, a new movement of landslide due to the heavy rainfall, etc.). DMA should prepare appropriate corresponding plan to the disaster, and publish the warning about disasters. Therefore, the system should provide the useful information to the officials for prompt action.

In this situation, the collected information should be monitored by the officials in the real time and stored to DB as well. The information is processed by PS and is provided to the officials through DSS. Official announcements and monitored/processed information are distributed through IDS (arrow with "P" in Figure 5.7.1).

3) Emergency Situation

"Emergency" is a situation, which the disaster happens. To act promptly and properly against the disaster, it is important to unify the information and to share the same and correct one among the agencies related to emergency response.

The emergency situation can be classified into two phases of just after the event happening (Phase E-1) and the situation after a while (E-2).

In the phase E-1, the main activities of DMA are collection of information and confirmation of damage distribution. It is, therefore, CTS, and PS (arrow with "E-1" in Figure 5.7.1) will be assigned as a main function of DMIS. Using the information collected, the information stored in DB, PS and DSS, the officials prepare the information for emergency response.

In the situation of "E-2", the main activities of DMA are analyzing the information, deciding a measures which correspond to the disaster and announcement of directions to local office(s)/damaged site(s)/public through IDS (arrow "E-2" in Figure 5.7.1).

IDS includes a direct inform distribution system to public, therefore, IDS to public should have continuous distribution system using various interfaces such as mass media (e.g. TV, Radio), Internet, wireless communication, etc.

Figure 5.7.2 shows characteristics of information flow from the local office(s)/disaster site(s) to DMA and DMA to local office(s)/disaster site(s).

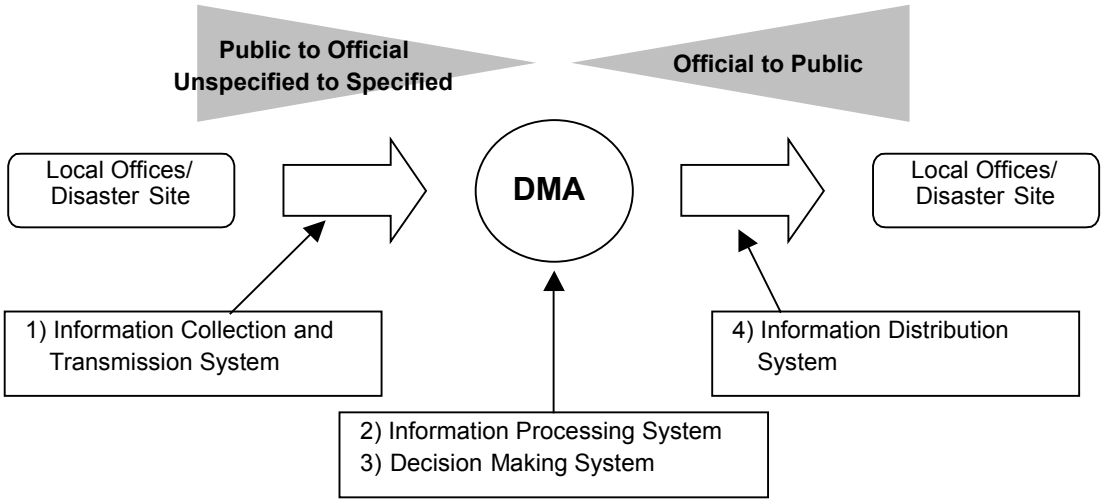


Figure 5.7.2 Characteristics of Information Flow

As shown in the figure, in the emergency situation, public (various kinds of source and way) will transmit the information to DMA. Therefore, the system should have a capability to handle large amount and various kinds of information with same format.

5.7.4 Information to be Handled

The system should handle many kinds of information, e.g. seismic wave, hydrological data, disaster information by telephone, radio (voice), digital photo/movie at site through Internet, etc. The information to be handled will change the kinds of disasters and disaster situation. The interval of acquisition and transmission of information are also changed by the type of disaster and situation. It is therefore necessary to select the suitable data transmission method by the types of information and disasters.

Table 5.7.1 shows the information to be handled on DMIS, and the interval and method suit for collection and transmission of information.

Table 5.7.1 Information to be Handled

Collection and Transmission System				
Kinds of Disaster	*Information*	*Transmission Method*	*Situation*	*Frequency*
Earthquake	Seismic wave	Telemeter (radio)	Normal	Continuous Event monitoring
Landslide	Movement of landslide mass	Telemeter	Normal	10 min. Event monitoring
			Pre-emergency	???
	Rainfall	Telemeter	Normal	10 min. Event monitoring
			Pre-emergency	10 min.
	Groundwater level	Telemeter	Normal	2 times/day
			Pre-emergency	???
Flood	Rainfall	Telemeter	Normal	10 min. Event monitoring
			Pre-emergency	1 min.
			Emergency	1 min.
	Water level	Telemeter	Normal	2 times/day
			Pre-emergency	30 min.
			Emergency	10 min.
Industrial Disaster	Accident Information	Telephone Radio	Emergency	
Common	Damage on Human	Telephone Fax Radio Internet	Emergency	
	Damage on Building			
	Damage on Infrastructure			
	Damage on Lifeline			
Distribution System				
Information	*Target Person*	*Transmission Method*	*Situation*	*Frequency*
Warning	Public	Radio Internet	Pre-emergency Emergency	
Direction	Official	Telephone Internet	Pre-emergency Emergency	
Actual Situation	Public/Official	Mass Media Board Internet	Emergency	Continuous

5.7.5 Systems to be Constructed

As described in 5.7.1, the systems to be constructed are as follows:

- Information Collection and Transmission System (CTS)
- Database System (DB)
- Information Processing (PS) / Decision-support System (DSS)
- Information Distribution System (IDS)

The sub-systems will be set up according to the purpose and disaster situation. The summary of sub-systems is shown in Table 5.7.2

Table 5.7.2 Summary of Sub-systems

Name of system	Name of Sub-system	Handling Information	Method	Situation to be Considered
Information Collection System	Monitoring System	Seismic wave Movement of Landslide Groundwater Level Rainfall Water Level Etc.	Telemeter	Normal Pre-emergency Emergency
	Damage Information System	Human Building Infrastructure Lifeline	Telephone Fax Radio Internet	Emergency
Database System	Risk Database	Risk Map on Earthquake Landslide Flooding Industrial Disaster	GIS/Relational Database	
	Damage Database	Damages on Human Building Infrastructure Lifeline	Relational Database	
	Resource Database	Resources on Firefighting Doctor/Hospital Facilities Location Etc.	GIS/Relational Database	
Information Processing System	Earthquake	Seismic Wave Earthquake Risk Database Damage Database Damage Formula		Normal Pre-emergency Emergency
	Landslide	Movement of Landslide Rainfall Groundwater Level Landslide Risk Database Damage Database		
	Flood	Rainfall Water Level Flood run-off Simulation Program Flood Risk Database Damage Database		
	Industrial Disaster	Weather Information Industrial Disaster Risk Database Damage Database		
Decision-Making System	Sub-system for Earthquake Landslide Flood Industrial Disaster			Pre-emergency Emergency
Information Distribution System	Center to sub-center	Warning Direction Etc.	Telephone Fax Radio Internet	Normal Pre-emergency Emergency
	Center to related agency	Information		
	Center to public	Warning Etc.		
	Sub-center to public			

These sub-systems are independently constructed but the sub-systems are related and should be functioned as an integrated system.

5.7.6 Proposed Disaster Management Information System

1) Basic Concept

The proposed DMIS will be constructed with the basic concepts as follows:

The system should:

- be a disaster proof,
- be a system ensuring the collection and unifying the information,
- be able to transfer the information rapidly without any error,
- provide useful information to decision maker(s) as quick as possible, and
- be a system which can be utilize the experience of administration on past disasters.

2) Proposed DMIS

It is proposed that Main system of DMIS will be installed in the office of Bogotá City and managed by DMA. To share and exchange the latest information, the main system should be accessed from other related agencies by satellite system of DMIS through Internet.

The image of proposed DMIS is shown in Figures 5.7.3.

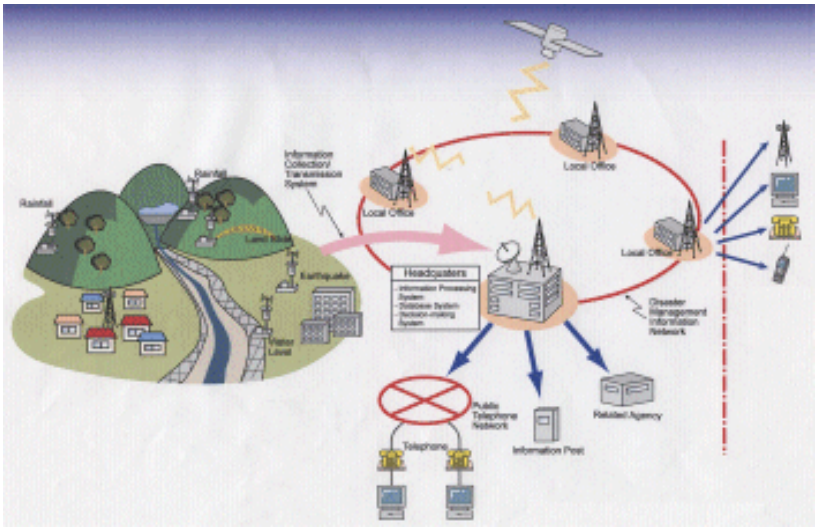


Figure 5.7.3 Image of DMIS

3) Necessary Activities

Necessary Activities to set up DMIS is as follows:

- To establish the main and sub systems of DMIS
  Including setting up simulation model, threshold, database, etc.
- To install the necessary monitoring station
- To install DMIS to related entities
- To link related entities by optical fiber network

5.8 Implementation Schedule

5.8.1 Implementation Period

The projects are planned to be implemented by 2010 considering the target year of the existing Territorial Ordering Plan (POT) and the period is planned to be divided into three terms due to the Mayor's term of the city of Bogotá as follows:

1. Short term: 2002 - 2004
2. Mid-term: 2005 - 2007
3. Long-term: 2008 - 2010

5.8.2 Implementation Schedule of Projects

Major tasks and projects of each term are planned and summarized as follows:

1) Short-term (2002 - 2004)

(1) Arrangement of government entities

- To arrange the government entities related to the Bogotá City Area, i.e. the government of Bogotá City, the Cundinamarca Government and the National government, dully to their responsibilities, and prepare their action programs for disaster prevention and emergency responses based on the Basic Plan,
- To prepare 1st Action program for the Bogotá City Area.

(2) Strengthening the urban area by improvement or strengthening strategic buildings and facilities

- To strengthen the urban areas of the Bogotá City Area by conducting seismic diagnosis studies on the strategic buildings, infrastructure and lifeline structures identifies in the Study. The strategic buildings are including emergency response centers, government buildings, hospitals, police buildings, fire-fighting stations, Civil defense buildings, Red cross buildings, school buildings. The infrastructure is consisting of bridge facilities along the major roads and the lifeline facilities include water supply, gas, electricity and Tele-communication facilities.
- To conduct the improvement or rehabilitation works of the 1st priority facilities,
- To promote strengthening or improvement of private buildings.
- To conduct preliminary design on strategic facilities like water supply tanks and open spaces required for emergency responses.
- To conduct study on infrastructure of the vulnerable areas.

(3) Enhancement of public education

- Enhancement of public awareness for seismic disaster
- Promotion of cooperation system of support inter-region.

(4) Arrangement of emergency response system

- To establish executing agencies of each emergency response functions and prepare an emergency action plan.
- To improve disaster management information system before and in a disaster.
- To study on recovery and rebuild after a disaster.
- To arrange and strengthen cooperation system.
- To prepare monitoring systems for landslide hazard areas.
- To prepare flood warning system.

(5) Implementation of landslide protection works

- Preparation of landslide protection works of 1st priority,
- Implementation of landslide protection works of 1st priority.
- Preparation of monitoring systems.

(6) Implementation of flood control works

- Preparation of river improvement works for the Rio Bogotá.
- Implementation of river improvement works for the Rio Bogotá.
- Preparation of warning systems.

(7) Conduct development studies

- To conduct a development study on the selected pilot area, conducting and preparation preliminary studies and design of major facilities, in order to promote smooth implementation of the Basic Plan.
- To prepare for other basic studies.

2) Mid-term (2005 - 2007)

(1) Arrangement of government entities

- To improve and update the executing entities.
- To review the previous plan and prepare the 2nd action program.

(2) Strengthening the urban area by improvement or strengthening strategic buildings and facilities

- To improve or strengthen strategic buildings and infrastructures of 2nd priority.
- To promote strengthening or improvement of private buildings.
- To construct strategic facilities like water supply tanks and open spaces required of 1st priority for emergency responses.
- To implement infrastructure of the vulnerable areas of 1st priority.

(3) Enhancement of public education

- To update and enhance public awareness for seismic disaster
- To strengthen the cooperation system of support inter-region

(4) Arrangement of emergency response system

- To strengthen the executing agencies of each emergency response functions and update emergency actions plan.
- To strengthen the disaster management information system before and in a disaster.
- To review and update the recovery and rebuild plan.
- To strengthen and update the cooperation system.
- To install monitoring equipment for landslide hazard areas,
- To establishment a flood warning system.

(5) Implementation of landslide protection works

- To prepare for landslide protection works of 1st priority area.
- To implement landslide works of 1st priority area.

(6) Implementation of flood control works

- To implement of river improvement works for the Rio Bogotá.
- To prepare river improvement works for tributaries.

(7) Conduct development studies

- To conduct the detailed design of the projects proposed in the pilot study.
- To prepare for other basic studies.

3) Long term (2008 - 2010)

(1) Arrangement of government entities

- To improve and update the executing entities.
- To review the previous plan and prepare the 3rd action program.

(2) Strengthening the urban area by improvement or strengthening strategic buildings and facilities

- To improve or strengthen strategic buildings and infrastructures of 3rd priority.
- To promote strengthening or improvement of private buildings.
- To construct strategic facilities like water supply tanks and open spaces required of 2nd priority for emergency responses.
- To implement infrastructure of the vulnerable areas of 2nd priority.

(3) Enhancement of public education

- To update and enhance public awareness for disasters.
- To update and strengthen the cooperation system of support inter-region.

(4) Arrangement of emergency response system

- To strengthen and update the executing agencies of each emergency response functions and update the emergency actions plan.

- To strengthen and update the disaster management information system before and in a disaster.
- To review and update the previous recovery and rebuild plan.
- To strengthen and update the cooperation system.

(5) Implementation of landslide protection works

- Implementation of landslide protection works for 2nd priority.

(6) Implementation of flood control works

- Implementation of river improvement works for the Rio Bogotá.
- Implementation of improvement of flood control structures for the Rio Tunjuero.

(7) Conduct development studies

- To implement the projects proposed in the pilot study.
- To prepare for other basic studies.

5.8.3 Implementation Agencies

The implementation agencies for the projects are different depending on the facilities. The responsible agencies are divided into the government sectors; Bogotá City, Cundinamarca Prefecture and national, privatized or private lifeline sectors; EAAB, CODENSA, EMGESA, ETB, CAPITEL, and private individuals.

In order to implement the Basic Plan it is indispensable for the Bogotá City Area to have a well-organized cooperation among the related entities and a strong leading coordinating organization.

5.8.4 Program Implementation Schedule

Study team identified proposed programs and projects for the disaster management system in the study areas. The cost of each project has estimated based on the information of existing on-going projects as well as hiring from the governmental agencies, yet some of the projects are not enough information for the cost estimation. The estimated total cost of the project is about 1,671,676 million pesos or US$ 730.3 million over the next nine years. In the short period it is expected to use 22 % of the total cost, while medium term it is to use 51.5 % of the total cost. The details of the cost flow are shown in Table 5.8.1. The project implementation schedule is summarized in Table 5.8.2.

The details of implementation plans are shown in Appendix 5.8.1.

Table 5.8.1 Cost Distribution of the Projects

Items	Cost Distribution									Total
	Short			Medium			Long			
Year	2002	2003	2004	2005	2006	2007	2008	2009	2010	
Seismic Diagnosis Study of Important Buildings	927	926	30	625	626	52	1,001	1,002	152	5,340
Strengthen Important Buildings	9,232	18,316	18,342	24,713	31,229	22,118	45,363	45,364	49,627	264,303
Seismic Reinforcement of Vehicle and Ped. Bridge	6,825	6,825	57,700	57,700	57,700	57,700	57,700	-	-	302,150
Water Supply	4,805	4,805	88,420	101,580	101,580	101,380	99,680	12,200	12,450	526,900
Gas Supply system	775	575	1,110	1,110	1,130	1,130	200	200	200	6,430
Electronic Supply Systems	780	780	1,320	3,320	3,370	3,820	3,820	3,300	1,250	21,760
Telecommunication Systems	410	410	1,250	1,750	1,750	1,750	700	800	800	9,620
Urban Development	8,658	8,658	8,660	66,391	66,391	66,397	-	-	-	225,155
Earthquake Engineering	-	-	-	-	-	-	-	-	-	-
Landslide Program	830	2,471	2,471	2,364	2,364	2,375	579	580	-	14,034
Flooding Program	27,028	27,028	27,030	19,078	19,078	19,079	38,150	38,150	38,150	252,771
Industrial facility	-	-	-	-	-	-	-	-	-	-
Health Program	4,216	4,226	4,246	4,136	4,136	4,196	2,716	2,716	2,848	33,436
Education Program	-	-	-	-	-	-	-	-	-	-
Information System	1,603	1,603	1,603	1,603	1,603	1,605	-	-	-	9,620
Monitoring Program	70	66	3	3	3	3	3	3	3	157
Total	66,158	76,689	212,185	284,373	290,960	281,605	249,912	104,315	105,480	1,671,676
Toal (Time span)			355,032			856,937			459,707	

Source: Study Team

Table 5.8.2 Summary of Project Implementation

Program		Project Name	Implementation Agency	Cost (Million Pesos)	Implementation Schedule								
					Short			Medium			Long		
					2002	2003	2004	2005	2006	2007	2008	2009	2010
1	Improvement of Important Buildings	1-1 Seismic Diagnosis of Important Buildings	Each Governmental Organization	5,340									
		1-2 Strengthening of Important Buildings	Each Governmental Organization	264,301									
2	Improvement of Bridges	2-1 Seismic Diagnosis of Vehicular and Pedestrian Bridges	Bogota City	13,650									
		2-2 Seismic Reinforcement of Vehicular and Pedestrian Bridges	Bogota City	288,500									
3.1	Seismic Reinforcement of Water Supply Facilities	3-1 Seismic Reinforcement of Water Supply Facilities	EAAB	447,140									
		3-1-2 Provision of Emergency Water Supply Tanks	EAAB	79,760									
3.2	Seismic Reinforcement of Gas Supply Facilities	3-2-1 Seismic Diagnostic Study of Gas Supply Facilities	Natural Gas Company	770									
		3-2-2 Seismic Reinforcement of Gas Supply Facilities	Natural Gas Company	5,660									
3.3	Seismic Reinforcement of Electronic Supply Facilities	3-3 Seismic Diagnostic Study of Electronic Supply Facilities	CODENSA/EMGESA	1,160									
		3-4 Seismic Reinforcement of Electronic Supply Facilities	CODENSA/EMGESA	20,600									
3.4	Improvement of Telephone Facilities	3-3-1 Seismic Diagnostic Study for Telephone Facilities	ETB/CAPITEL	420									
		3-3-2 Seismic Reinforcement of Telephone Facilities	ETB/CAPITEL	9,200									
4	Urban Redevelopment of Priority Area	4-1 Urban Redevelopment of Priority Area	Bogota City	87,913									
		4-2 Road Development	Bogota City	109,862									
		4-3 Open Space Development	Bogota City	27,380									
5	Earthquake Engineering	5-1 Geophysical Study of Subsurface Structure	DPAE/ INGEOMINAS	-									
		5-2 Geotechnical Study for Site Response and Liquefaction Evaluation	DPAE/ INGEOMINAS	-									
6	Landslide	6-1 Landslide Protection Works	DPAE	14,030									
7	Flooding	7-1 Structural Measures	EAAB/ Cundinamarca	251,790									
		7-2 Non-structural Measures	EAAB/ Cundinamarca	982									
8	Industrial Facility	8-1 Handling of Hazardous Materials	DAMA/CAR	-									
9	Health Sector	9-1 Health Sector Improvement	Bogota/ Cundinamarca	33,430									
10	Education Sector	10-1 Education Program	Bogota/ Cundinamarca	-									
11	Disaster Management Information System	11-1 Establishment of Disaster Management Information System	Bogota/ Cundinamarca	9,620									
12	Monitoring Program	12-1 Establishment of Monitoring Program	DPAE	151									

Source: Study Team

5.9 Evaluation

The proposed programs in the basic plan for disaster prevention of the Bogotá Metropolitan Area are evaluated in technological, social, environmental and economic terms. The programs are evaluated from A to C based on the impact by each program.

The followings show the details of the evaluation criteria.

5.9.1 Evaluation Criteria

1) Technology Aspect

The supposed reduction of the damages by the programs is evaluated as a part of the impact from technological aspects. The seismic damages to building, infrastructure and lifeline structures estimated are as follows:

(1) Building damage

Number of heavily damaged buildings would be 421,989 (heavily damaged building in case 2) and the proposed program would reduce numbers of the damaged buildings.

(2) Infrastructure (bridge)

Number of collapsed bridges: would be 58 (high-risk bridges in case 2) and numbers of the damaged bridge would be reduced by the program.

(3) Lifeline structures

Lifeline structures of water and gas supply pipelines, electric power supply and telephone cables, would be also widely damaged and proposed to be reinforced by related public service entities.

2) Social Aspect

The expected earthquake damage includes casualty and injured personnel. Those damages are linked with the building damage. The building damage ratio is comparatively high at low estrato, which is characterized in low-income community. Therefore, human casualty and injured personnel has strong linkage to socially vulnerable population. The proposed program is assessed by reduction of casualty and injured personnel.

3) Environmental Aspect

There are many vulnerable localities from disaster prevention aspects, lacking of open spaces and proper road networks at community level. Proposed program would reduce the vulnerability and the social environmental conditions of the Study Area. Therefore, proposed program is evaluated by improvement of vulnerable urban area. as well as reduction of debris in a disaster.

4) Economic Aspect

The proposed programs have been assessed by reduction of damage costs. By reduction of the damage total damage cost would be decreased.

Table 5.9.1 Evaluation of Programs

No	Program	Expected Impacts	Evaluation Items			
			Technology	Social	Environment	Economy
1-1	Seismic diagnosis study of important buildings	Reduction of weak building for the governments and emergency response organization as well as private housings. The number of improved building is more than 400,000 in total.	A	C	C	C
1-2	Strengthen important building facilities		A	A	A	A
1-3	Improvement of Private Housing		A	A	A	A
2-1	Seismic diagnosis study of vehicular and pedestrian Bridges	Improvement of existing vehicle bridges and pedestrian bridges are required. The number of improved bridges is 58 in total.	A	C	C	C
2.2	Seismic reinforcement of vehicular and pedestrian bridges		A	B	A	A
3-1-1	Seismic reinforcement of water supply facilities	The seismic reinforcement of the water supply facilities is 13 stations.	A	C	A	C
3-1-2	Provision of emergency water supply facilities	Emergency water supply system is required in 110,800m3 in total.	A	C	A	A
3-2	Seismic reinforcement gas supply facilities	Improvements of existing gas supply facilities.	A	C	B	B
3-3	Seismic reinforcement of electronic supply facilities	Improvement of existing electronic supply facilities	A	C	B	B
3-4-1	Seismic diagnosis study for telephone facilities	Improvement of existing telephone facilities.	A	C	C	C
3-4-2	Seismic reinforcement of telephone facilities		A	C	B	B
4-1	Urban redevelopment of priority area	Improvement of vulnerable urban area. Total area is more than 7,000 ha in the study area.	B	A	A	B
4-2	Road development		B	A	B	B
4-3	Open space development		B	A	A	C
4-4	Education and enlightenment Program	Technology Improvement Secondary damage	-	-	-	-
5-1	Geophysical study of subsurface structure	Provision of more accurate information for seismic reinforcement for infrastructure and buildings.	A	C	C	C
5-2	Geotechnical study for site response and liquefaction evaluation		A	C	C	C
6	Landslide protection works	Five locations are identified for priority area.	B	A	C	C
7-1	Flooding (Structural Measures)	The proposed development includes five rivers in the study area.	A	B	C	A
7-2	Flooding (Non-structural Measures)	Warring system installation and preparation of flood map/	A	B	C	C
8	Handling of hazardous materials	Establishment of inspection system	A	B	A	C
9	Health sector improvement program	Improve health sector capacity and improvement of emergency response capacity.	C	A	C	C
10	Education program	Disaster management education for all level	-	-	-	-
11	Establishment of disaster management information system	Establishment of information system in the study area	B	A	C	B
12	Establishment of monitoring program	Establishment of warning system	B	A	C	B

Note: A: High impact
B: Medium impact
C: Low impact

Chapter 6

Conclusion and Recommendation

CHAPTER 6 CONCLUSION AND RECOMMENDATION

6.1 Conclusion and Recommendation

For disaster prevention of the Bogotá Metropolitan Area, the National government, the city of Bogotá and the prefecture of Cundinamarca are related. The existing disaster prevention systems have been effective for landslide and floods, but for earthquakes. The related government entities are required to prepare against earthquakes. It is necessary for the related three governments to arrange the responsible entities for preparation of preparedness for disaster prevention and also emergency responses in order to cope with a seismic disaster.

Due to the results of seismic damage analyses buildings, infrastructure and lifeline structures are vulnerable to the seismic disaster, among them the vulnerability of the building structures are most urgent to meet.

The vulnerable buildings are widely distributed in the Bogotá Metropolitan Area due to the informal building construction and housing development. The Basic Plan has proposed to reduce the numbers of the weak buildings by strengthening by phased expansion till 2010. The vulnerable Localities and Municipalities in the Bogotá Metropolitan Area have been selected as a priority area for a pilot study to reduce the vulnerability of the area by developing.

The Basic Plan proposed for disaster prevention and mitigation for the Bogotá Metropolitan Area is effective in technical, economic, financial, social and environmental terms. By implementation of the proposed projects, the vulnerability of the area will be reduced.

It is concluded and recommended for the related governments of the Bogotá Metropolitan Area to take immediate actions for implementation of the following:

1) Arrangement of government organizations is necessary for preparation of the preparedness for disaster prevention of the Bogotá Metropolitan Area, and for preparation of the emergency responses before, in and after a seismic disaster, it is necessary for the city government of Bogotá, the government of Cundinamarca and the National government to take immediate actions to arrange the government entities to implement the preparedness for disaster prevention and prepare the emergency responses before, in and after a seismic disaster.

   For the purposes the coordinate agencies of Bogotá D.C. (DPAE-FOPAE), Cundinamarca (OPAD) and the National (DGPAD) shall take their responsibilities to coordinate the necessary arrangements through the District Committee, the Regional Committee and the National Committee for prevention and attention of disasters respectively.

   Also the coordinate agencies are necessary to arrange the government entities to participate in preparation of the preparedness for disaster prevention and emergency responses before,

in and after a seismic disaster, and establish a leading coordination organization for the Bogotá Metropolitan Area. Each coordinate agency is to take necessary actions to develop the human resources in order to strengthen the related organizations.

Also it is necessary for the three Governments to arrange a cooperation and support system with other Prefectures and City governments and private entities.

2) The database, information and disaster management information systems for the Bogotá Metropolitan Area are to be held in common among Bogotá D.C. (DPAE-FOPAE), Cundinamarca (OPAD) and the National (DGPAD). It is recommended for the related agencies to hold the database in common and maintained properly because the database development in the Study is a basic tool for disaster management.

3) For alleviation of the seismic damage it is most important for the Bogotá Metropolitan area to reduce numbers of weak buildings or no seismic resistant buildings by strengthening (seismic retrofitting) and also it is important to reduce numbers of informal building constructions by enhancement of public awareness. The CURADURIA is responsible to give approval of construction of new buildings in Bogotá. It is recommended for the CURADURIA to expand the capacity to meet the demand of new building constructions and also to extend the responsibility to the seismic retrofitting or strengthening projects. Also it is recommended for the government of Bogotá and Cundinamarca to introduce an authorized inspection system of the Locality office for inspection of construction works after getting the approval of the design from the CURADURIA.

4) Seismic design and construction standard for masonry buildings shall be reviewed duly based on the actual conditions. In the Bogotá Metropolitan Area there exist about 950,000 buildings, of which more than 80%are masonry buildings. In the 1999 Quindio earthquake many of the masonry buildings were collapsed. It is recommended for the Bogotá metropolitan Area to review the seismic design and construction standard for masonry buildings duly considering the building damages estimated and the assessment of the building damages in the 1999 Quindio earthquake.

5) A Disaster Management Information System (DMIS) is necessary to be developed for the Bogotá Metropolitan Area to collect disaster information, processing data, making decision and disseminating disaster information in a disaster as a management tool. It is recommended for the Bogotá Metropolitan Area to review the existing information or communication systems and to promote the development of a Disaster management Information System as a basic management tool for disaster prevention and emergency responses of the Bogotá Metropolitan Area.

6) Infrastructure and lifeline structures will be affected in a seismic disaster. It is recommended for public or service entities to prepare their emergency response plans, which consists preparedness for disaster prevention, strengthening the facilities like water

supply tanks for emergency response in a disaster due to their seismic diagnosis study based on the damages estimated, and for restoration of the damaged facilities after a disaster, including materials and equipment.

7) Public education for disaster prevention is necessary for the government staff to strengthen the government organizations and for communities to enhance the public awareness. The government organizations are recommended to be strengthened due to their responsibilities in preparedness for disaster prevention and also responsibilities in emergency responses. Also the inhabitants and communities are recommended to be enhanced of public awareness to follow the regulations related to disaster prevention in general, and for the necessity of seismic design and strengthening the building structures, though generally they do not have any penalty cords in building construction, land development and housing development. As for seismic design

8) Early execution of a pilot study is necessary to promote the Basic Plan for disaster prevention of the Bogotá Metropolitan Area. It is recommended for the pilot study on disaster prevention to include organization of local communities, emergency response facilities and restoration plan and for the pilot area to be selected from the vulnerable localities and municipalities selected from disaster prevention aspects in Bogotá and Cundinamarca. They are localities of Santa Fe, San Cristobal, Usme, Bosa, Kennedy, Suba, Rafael Uribe and Ciudad Bolivar, and municipalities of Cota and Soacha.

9) For further study the existing conditions of the Bogotá Metropolitan Area, studies required to be conducted are listed as follows:

- Development study on disaster prevention for pilot areas in the Bogotá Metropolitan Area,
- Geophysical study on Cundinamarca,
- Geotechnical study on Cundinamarca,
- Study on Water Resources and Environmental Management for the Upper Rio Bogotá,

10) This basic plan for disaster prevention shows the direction of the prevention and attention of disasters. It is recommended to promote the basic plan as follows:

- The disaster prevention organizations for the Bogotá Metropolitan Area are necessary to be arranged through each committee for prevention and attention of disaster, the city of Bogotá, the prefecture of Cundinamarca and National levels. The responsible and supporting agencies assigned by the committee are necessary to implement the disaster prevention plans and prepare for the emergency responses. Also it is necessary to arrange coordination agreements with other cities and prefectures and international agencies.
- It is indispensable to decide a leading coordination agency for the Bogotá Metropolitan Area in order to coordinate the agencies related and the implementation of projects.

- It is important for the city of Bogotá to assign DPAE as an Administrative Department considering the required coordination among the administrative organizations for planning the disaster prevention measures before, in and after a disaster, especially seismic disaster.
- It is necessary for the agencies, which are responsible for infrastructure and lifeline facilities, to conduct diagnostic studies on the proposed projects and reinforce them due to the study.
- It is necessary for the Localities of Bogotá and the 8 municipalities of Cundinamarca to prepare their disaster prevention plans and emergency responses.