2.2 Earthquake Damage and Urban Vulnerability

2.2.1 Summary of Earthquake Damage

Summary of earthquake damage for Model08, 13, 18 are shown in Table 2.2.1.

Table 2.2.1 Summary of Earthquake Damage

Scenario Earthquake		Model			Model 08	Model 13	Model 18
		Magnitude			7.2	7.9	6.5
		Fault Mechanism			Inland Fault	Subduction	Unknown
Residential Building 1,325,896		Damage		Heavily	168,300 (12.7%)	1,900 (0.1%)	14,200 (1.1%)
				Partly	339,800 (25.6%)	6,600 (0.5%)	52,700 (4.0%)
Population 9,932,560		Casualty		Dead	33,500 (0.3%)	100 (0.0%)	3,100 (0.0%)
				Injured	113,600 (1.1%)	300 (0.0%)	9,500 (0.1%)
Fire	Outbreak				500	-	-
	Burnt area and building	Wind Speed 3m/s			798 ha 42,100 buildings	-	-
		Wind Speed 8m/s			1,710 ha 97,800 buildings		
	Casualty	Wind Speed 3m/s			7,900 (0.1%)		
		Wind Speed 8m/s			18,300 (0.2%)	-	-
Bridge 213 (with detail inventory and stability analysis 189) Flyover 80 (with detail inventory and stability analysis 38)		Large possibility of falling-off		Bridge	7	0	0
				Flyover	0	0	0
		Moderate possibility of falling-off		Bridge	2	0	2
				Flyover	0	0	0
Water Supply Distribution Pipes Total 4,615km				Break of pipes or joints	4000 points	0 points	200 points
Electric Power Transmission and Distribution Line Total 4,862km				Cut of cables	30 km	0 km	4 km
PLDT Telephone Aerial Cable 9,445 km Underground Cable 3,906 km				Cut of cables	95 km	0 km	11 km
Public Purpose Buildings (Hospital 177, School 1412, Fire Fighting 124, Police 43, MMDCC Organizations and 17 LGU City and Municipal Halls 53)				Heavily Damaged	8 - 10 %	0 - 0.2 %	0 – 1 %
				Partly Damaged	20 – 25 %	0 - 0.3 %	2 - 3 %
Mid-rise and High-rise Buildings	10-30 stories building	981		Heavily Damaged	11 %	0.3 %	2.3 %
				Partly Damaged	27 %	2.8%	9.2 %
	30-60 stories building	119		Heavily Damaged	2 %	0 %	0%
				Partly Damaged	12 %	0.1%	0.5%

Source: Study Team

2.2.2 Earthquake Damage Scenario During One Week from Occurrence of Earthquake

Earthquake damage scenario for Model 08 is shown in Table 2.2.2.

Basic Condition

Scenario earthquake: Model 08 (West Valley Fault, Magnitude 7.2)

Occurrence of earthquake: 7PM, wind speed 8m/sec.

Damage amount and situation are presented Section 2.1 and 2.2. These are translated into a script for better understanding. Lynn Paladio-Melosantos of PHIVOLCS, based upon damage data, developed the script. Script contents were discussed with the Study Team before being finalized.

Table 2.2.2 Earthquake Damage Scenario

Basic Condition		**-Scenario earthquake: Model 08 (West Valley Fault, Magnitude 7.2) -Occurrence of earthquake: 7PM, wind speed 8m/sec.**				
Items		**0-1 hour**	**1-24 hours**	**1-3 days**	**3-7days**	**7days after**
Buildings	Residential houses	• 170,000 heavily damaged or collapsed (13% of total buildings) • 340,000 moderately damaged (26% of total buildings) • 10,000 Liquefaction affected building alongside of Manila Bay • Damage ratio of concrete-made buildings is 9%, wooden-made buildings is 16% • Damage ratio in squatter building is 27%. • These figures include damaged caused by aftershocks	• Aftershock causes further building damage • 1,260,000 people lost their residential house (people living in collapsed or heavily damaged residential buildings)			• Debris removal
	Hospital, school, fire fighting, police, government	• 8 – 10% heavily damaged or collapsed • 20-25% moderately damaged	• Residents begin to evacuate to slightly damaged public buildings • Official function severely limited	• Public buildings are occupied with refugees • Staffs can not reach to the Buildings • Official function severely limited		• Temporary repairs initiated • Debris removal
	Mid-rise and High-rise	• 11% heavily damaged or collapsed, 27% moderately damaged for total of 1000 10-30 stories building • 2% heavily damaged or collapsed, 12% moderately damaged for total of 100 30-60 stories building	• Many people are trapped in elevators by electric power failure • Damage expands by aftershocks	• Collapse of moderately damaged buildings by series of aftershocks • No power and water supply in not severely damaged buildings • Habitation impossible in high-rise residences		
Casualties	Dead	• 34,000 dead, 90% of dead from pressure of collapsed building • This figure includes trapped persons who are not rescued from collapsed buildings and die. • Number of dead is small in squatter area	• 20,000 trapped in damaged building burnt to death • Burnt to death in squatter area occurs • Building Collapse by aftershocks make further dead people		• Persons trapped in the collapsed building are all dead. • Some dead bodies are dug out • Absolute limitation of burial • Death of heavily injured persons as to limitation of appropriate medical treatment	• More dead bodies are dug out
	Injured	• 110,000 people with non-life-threatening injuries • Trauma, fracture of a bone, visceral cleft caused by collapsed building and falling furniture • Non structural elements fall from mid-rise and high-rise buildings	• Non structural elements fall from mid-rise and high-rise buildings	• Many crush syndromes occur to the rescued from collapsed building	• Limitation of clean water • Patients increasing by contamination, unsanitary living conditions, especially in infants • Wounds become infected	

Items		0-1 hour	1-24 hours	1-3 days	3-7days	7days after
Fire	Outbreak of Fire	• Total 500 fire outbreak by electricity short circuit • 70 in Manila, 60 Quezon, 50 in Pasig • Fire from Factories, Hospitals, Residential Kitchens • Petroleum leakage from storage tank • LPG leakage from storage tank	• Explosion of LPG and petroleum and tanks by spreading of fire around • Magnification of fire spreading		• New fire outbreaks occur by short circuit of resuming of power supply	
	Spread of Fire	• Not occurred yet	• Fire hydrants incapable • Fire engine unreachable to the fire areas because of congested or debris-blocked roads • Fire fighting system incapable • 100,000 (7%) residential building in 1,700 hector area burned out • Heavy smoke causes respiratory illnesses		•	• Fire almost extinguished
Lifelines	Water Supply	• Failure of water supply caused by damage to water supply pipe at 4,000 points	• Failure of water supply over the whole city		• Damages to Angat reservoir and water purification plant causes stopping of water supply for long term	
	Electricity Supply	• Electric transmission facilities, electric transformer substation on the fault is damaged • Total 30km snapping of cables • Many snapping of cables caused by building collapse	• Power failure over the whole city • Damaged area expands by spread of fire	• Partially recovering in area of building damage is not severe	• Damages to transformer substation is not recovered • Power failure continues over the whole city	
	Telephone	• Total 100km snapping of cables • Many snapping of cables caused by building collapse • Cellular phone broken off as results of damages to base transceiver station • Telephone and cellular phone service is congested and out of use	• Telephone services suspended over the whole city • Suspended area expands by spread of fire	• Partially recovering applying emergency backup generators • Limitation of available fuel for the generator • Limited time of telephone		
Transportation	Airports	• Runway slightly damaged • Some loss of function in airport facilities	• Closure of runway • Only helicopter available • Poor visibility by fire haze	• Runway reopening • Incapable Instrumental landing system by electricity problem • Only daytime visual flight		
	Ports and Harbors	• Wharfs in Northport, Southport and Container terminal are damaged and tilted by liquefaction • Damages to cargo-handling machine	• General shipping impossible to come alongside the pier • Incapable loading and unloading			
	Roads and Bridges	• Total of 9 bridges damaged • One in Pasig River, One in Marikina River, One in Manggahan Floodway	• Fire occurs from vehicles left on roads	• Almost all roads are occupied with vehicles • Almost all roads are disabled • Many people having difficulty in returning to their residence		
Central Government		• Residential buildings around the Maracanang Palace, the Upper House are severely damaged • Liquefaction around The Lower House area • MMDA building severely damaged	• Danger to fire spreading to the Maracanang Palace	• Public buildings are occupied with refugees • Staffs can not reach to the Buildings • Official function stopped		

1) Day 1

Evening. August 26, 2003 is a typical Tuesday, the traffic, the crowd, the sunset at 6:14 as announced by PAGASA. Except that today you are not coming home from work, but from the WORKSHOP at Shangrila Hotel. You are almost home, looking forward to a simple *tinolang manok* that you know is stewing in your kitchen.

You get off from the bus and navigate your village road. As you are walking the last few meters to your gate, you feel a sudden jolt. It sort of pushes you forward. At first you don't know what it is. But the ground continues shaking, up and down, sideways, getting stronger every second. You fall to the ground, unable to keep standing. You hear a booming sound. You hear screams from people inside their homes. You hear breaking glasses. Telephone and power poles sway violently. Then the power goes off. In front of you, the village road is heaving, as if you are riding waves. The strong ground shaking goes on for 50 seconds. It is the longest 50 seconds of your life.

The ground shaking has stopped but you remain on the ground, still feeling dizzy. You try to get up, your knees shake under you. People start pouring out of their homes. Panic and confusion are everywhere. Occasional cries and wails add to the confusion. Around you are toppled poles and fences, collapsed houses, cracked roads, broken water pipes.

You go home as quickly as you can. You recognize your family amongst the crowd on the village street. They are all home, shaken but unhurt. You let out a sigh of relief and say a prayer of thanks. But your family refuses to enter your home. A barangay leader gives instructions to you and your neighbors to move to the basketball court to keep away from objects that may fall or topple.

You move your family as instructed. You try to make a call to other relatives but your mobile phone has no signal. Still you dialed a number. It didn't work. You finally walked back to check your home. But home is something you barely recognize. Everything seems to be piled up on the floor – appliances, shelves, books, lighting fixtures, family portraits, clothes, your prized Jollibee collectibles, even the *tinola* dinner.

Among the pile of mess on the floor, you pick up the old battery-operated transistor radio that your mother-in-law refuses to part with. You turn it on. At first you only get static. You play with the dials and catch this piece of news: PHIVOLCS issued a bulletin that says a devastating earthquake, with magnitude 7.2 generated by the nearby West Valley Fault, hit Metropolitan Manila. The ground shaking was felt at PEIS VIII in Metropolitan Manila. Weak to strong aftershocks are expected.

You rummage for blankets and go back to the basketball court. You try to think happy thoughts knowing this would be a very long night. You stay tuned in to the radio. News trickles in.

- There is a major power outage in Metropolitan Manila as well as in the neighboring provinces in Luzon.
- Telephone lines, including cellular networks, are down.
- Many residential houses are heavily damaged and collapsed
- Some school buildings collapsed.
- A few hospitals are heavily damaged, ICU patients need to be transferred, and other patients need to be evacuated.
- Fires broke out in several residential clusters, chemical plants, and few other factories and hospitals.
- Hundreds, if not thousands, are estimated trapped dead or injured from collapsed or burning houses, buildings and factories.
- Abandoned cars, some damaged by falling objects, littered the streets of Metropolitan Manila.

Within the next few hours after the earthquake, the National Disaster Coordinating Council convened. Not all the member agencies have representatives immediately available.

2) Day 2-3

You are one of the more fortunate. No one is injured in your household. But your house is damaged and you are not sure if it will survive the next strong aftershock. Also, food and drinking water are becoming scarce. The barangay leaders and community members work together to provide for everyone.

Overnight you felt several moderate to weak after shocks. There is still no electricity, telephone communication, and water. Haze from burning buildings darkens the horizon. Fires still spread unabated.

News reports give more dismal picture of the extent of damage brought by the earthquake:

The President declares a state of calamity. She mobilizes the Armed Forces of the Philippines for rescue, clearing of debris, and construction of temporary shelters. She suspends schools and offices.

Philippine flags fly at half-mast.

PHIVOLCS confirms movement of the West Valley Fault after it conducted an aerial survey over Metropolitan Manila.

Volunteer rescue groups from Olongapo and Baguio City coordinate with the NDCC.

Back-up power generators are available only in critical public and private offices.

There are more reports of collapsed houses, now numbering in the thousands, mid- to high-rise buildings, and major bridges

Many roads are impassable.

The LRT and MRT railways remain standing but not operational.

Reports of casualties continue to rise to several thousands.

Several thousand families have lost their homes and begin to occupy open spaces.

People rescued from collapsed buildings show crush syndromes and given medical attention on site in temporary medical shelters. They cannot be transferred immediately to hospitals because ambulances cannot get through the roads littered with debris and cars.

The police contain random acts of looting.

3) Day 4-7

You continue to occupy the basketball court. There is still no power, communication and water supply.

In the tent clusters that sprouted in parks and other open spaces, the lack of clean water supply makes the outbreak of infectious diseases a threat.

In hospitals, injured patients are lined up even along corridors. Again, the lack of clean water is a major problem.

Many people, especially children, suffer from shock, traumatized by the strong ground shaking, the sight of destruction, or being temporarily trapped.

Bodies exhumed from rubbles are lined up along the streets. The air has the distinct smell of decay.

International volunteer rescue teams coordinate with the NDCC. Rescue will continue in the next few days.

Clearing of debris will continue for several weeks to months. Bodies will continue to be recovered among building debris.

Relief goods are distributed in evacuation centers. Some evacuation centers receive more relief goods than others.

Neighboring Asian countries pledge and extend technical, medical and other forms of support.

The Government appeals to those with capabilities to join forces in responding to the disaster. Recovery and rehabilitation will take years and years.

2.3 Regional Urban Vulnerability

2.3.1 Approach

Understanding the urban earthquake vulnerability correctly together with urban structure is important in order to come up with appropriate measures for reducing level of vulnerability. In relation to this, regional vulnerability evaluation aims to achieve the following:

1) An index for planning an earthquake prepared city
2) A reference for selecting the regions for establishing projects on earthquake measures, and
3) A tool of understanding the urban earthquake vulnerability for the community members, to raise awareness

Among the earthquake scenario prepared for this study, Model 08, the West Valley Fault model, will cause the most damages Metropolitan Manila. Once the urban structure is being prepared for the impact of the Model 08 earthquake, it will also be prepared for less destructive earthquake scenarios. Therefore, Model 08 was applied for consideration.

Three indices, building collapse, flammability, and evacuation difficulty, were used for determining the existing vulnerabilities for earthquakes in the region. Lastly, an evaluation on the comprehensive regional vulnerability is also added to understand the foremost vulnerable areas within Metropolitan Manila. Simplified flow of this analysis is shown in Figure 2.3.1.

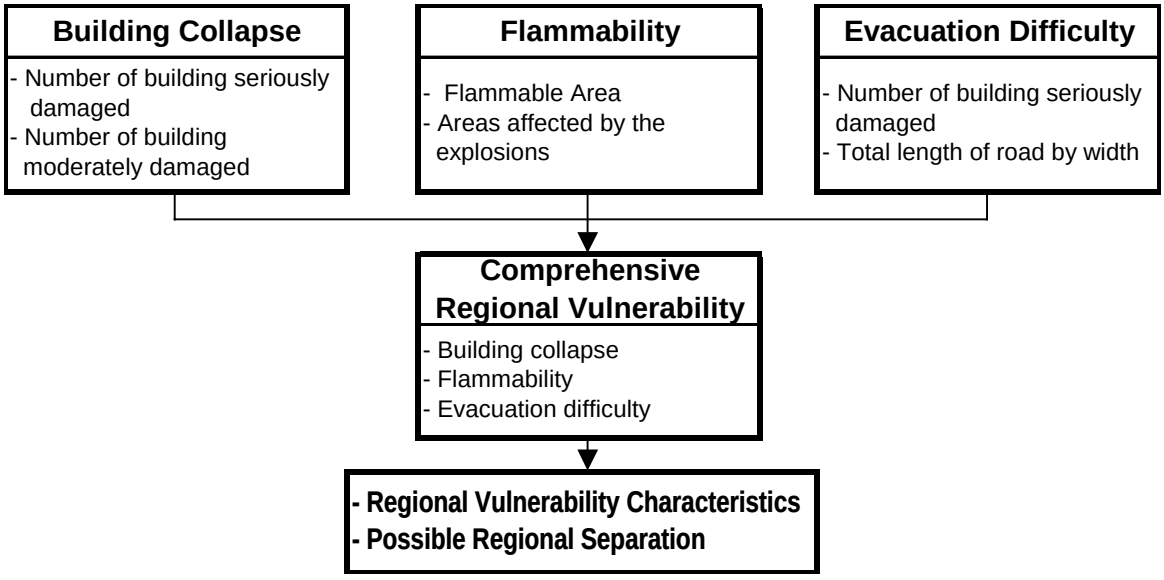

Figure 2.3.1 Flow of the Regional Vulnerability Evaluation

2.3.2 Comprehensive Regional Vulnerability and its Characteristics

Comprehensive regional vulnerability evaluation was done to show the areas with high vulnerability for all three kinds of vulnerabilities - building collapse, flammability, and, evacuation difficulty.

The comprehensive evaluation gives an idea which areas of Metropolitan Manila have the highest vulnerability during earthquake occurrences. This is important for administrative and planning purposes, and for the awareness of community members of their living environment. Areas with high vulnerability are priority areas for consideration in plans to reduce the earthquake impacts.

The characteristics of the comprehensive regional vulnerability are also expressed by integrating the result of three vulnerabilities. The figure of regional vulnerability characteristics (Figure 2.3.2 and Figure 2.3.3) are the simplified expression of the region, for people to understand easily the characteristics of the vulnerabilities facing the area.

The three indices were accumulated and re-classified by equal intervals to indicate the degree of vulnerability. For the creation of regional vulnerability characteristics, areas with high vulnerability, for (ranks 4 and 5), for all indices on building collapse, flammability, evacuation difficulty, and comprehensive regional vulnerability were taken into account.

Comprehensive Regional Vulnerability

Figure 2.3.2 shows the comprehensive regional vulnerability. Warmer colored area shows higher vulnerable rank. This figure indicates that there are 9 areas to pay most attention to among the Metropolitan Manila as for the comprehensive regional vulnerability. Those areas are summarized in Table 2.3.1.

Table 2.3.1 Area of High Vulnerability

1) Navotas Bay Area	6) Western Marikina City Area
2) Manila North Port Area	7) Eastern Pasig City Area
3) South Eastern Manila City Area	8) Muntinlupa Laguna Bay Area
4) Central Manila Bay Area	9) Mandaluyong - Makati City Border Area
5) North Eastern Quezon City Area	

Regional Vulnerability Characteristics

Figure 2.3.3 shows the regional vulnerability characteristics. Metropolitan Manila has vulnerability characteristics as described in Table 2.3.2.

Table 2.3.2 High Vulnerable Area by Type

Type of Vulnerability	Area	
Flammability and Evacuation Difficulty	1) Navotas Bay Area 2) Manila North Port Area	3) South Eastern Manila City Area 4) Central Manila Bay Area
Building Collapse and Evacuation Difficulty	1) North Eastern Quezon City Area 2) Western Marikina City Area 3) Eastern Pasig City Area	4) Muntinlupa Laguna Bay Area 5) Mandaluyong Makati City Border Area
Flammability	1) Valenzuela-Kalookan South-Quezon west intersection	
Evacuation Difficulty	1) Metropolitan Manila Fringes - Northern Fringe	- Taguig Fringe - Las Pinas Fringe

2.3.3 Possible Regional Separation

The proposed emergency road network was overlain onto the comprehensive regional vulnerability map to determine the possible separation of areas in Metropolitan Manila because of earthquake impact. Results are shown in Figure 2.3.4. Obviously, roads crossing or passing through the high vulnerable areas are with a high probability of becoming impassable. Overall, by analyzing passable and impassible roads, it can be deduced that Metropolitan Manila will possibly be separated into four regions by the earthquake impact. Reasons for regional separation are summarized below.

MM West

Western part of Metropolitan Manila will be isolated from other part of Metropolitan Manila by fire and building collapse

MM North, and MM South

Northern and Southern part of Metropolitan Manila will be separated by the building collapse and the geographical condition. The area between Mandaluyong and Makati has a high possibility of building collapse; Moreover, Pasig River is running east-west which is naturally disadvantageous in terms of separation.

MM East

All road networks running east-west, which are on the fault will be broken due to the movement. Other roads running north-south near in fault areas will be difficult to use, due to the high number of building collapse.

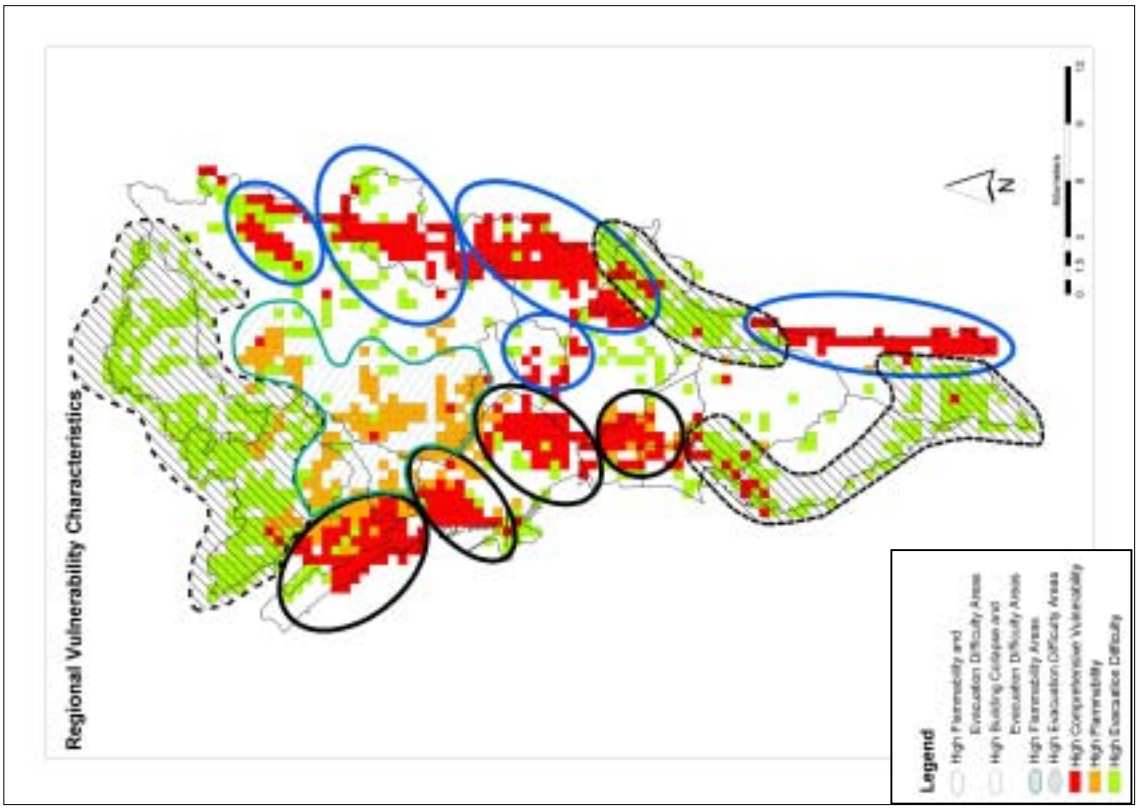

Figure 2.3.3 Regional Vulnerability Characteristics

Source: JICA Study Team

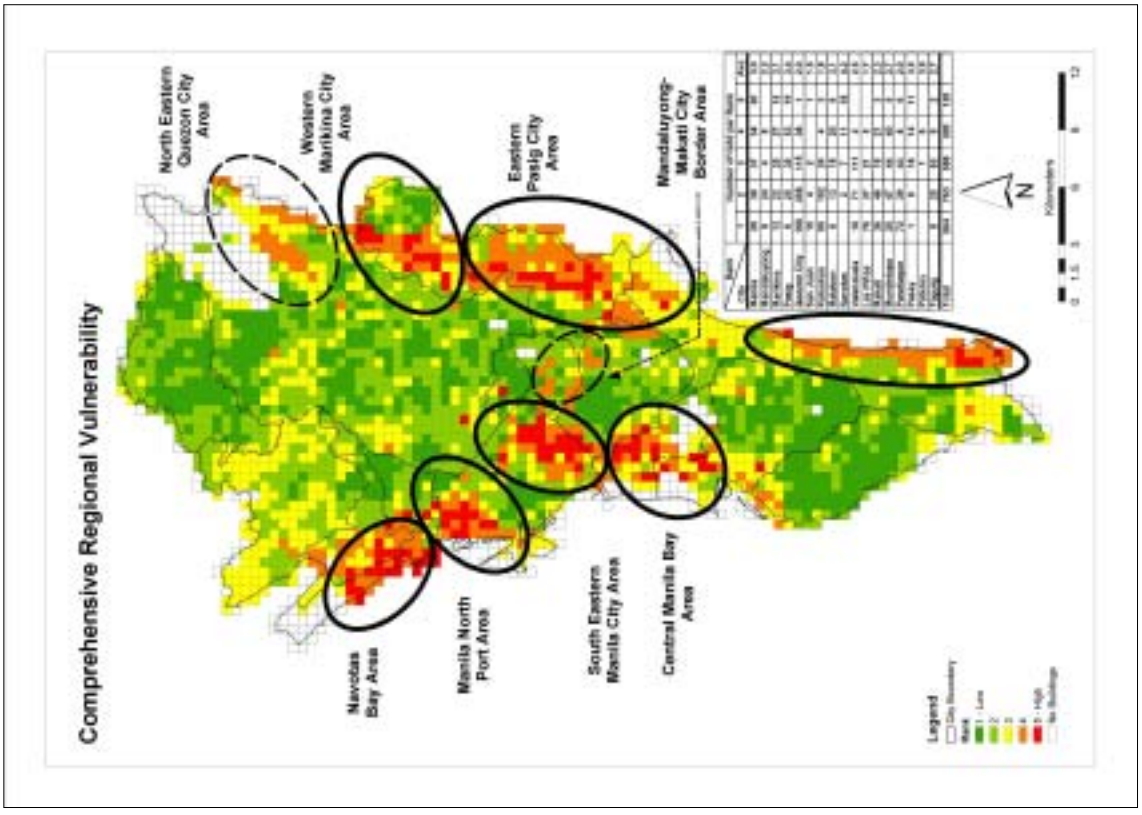

Figure 2.3.2 Comprehensive Regional Vulnerability

Source: JICA Study Team

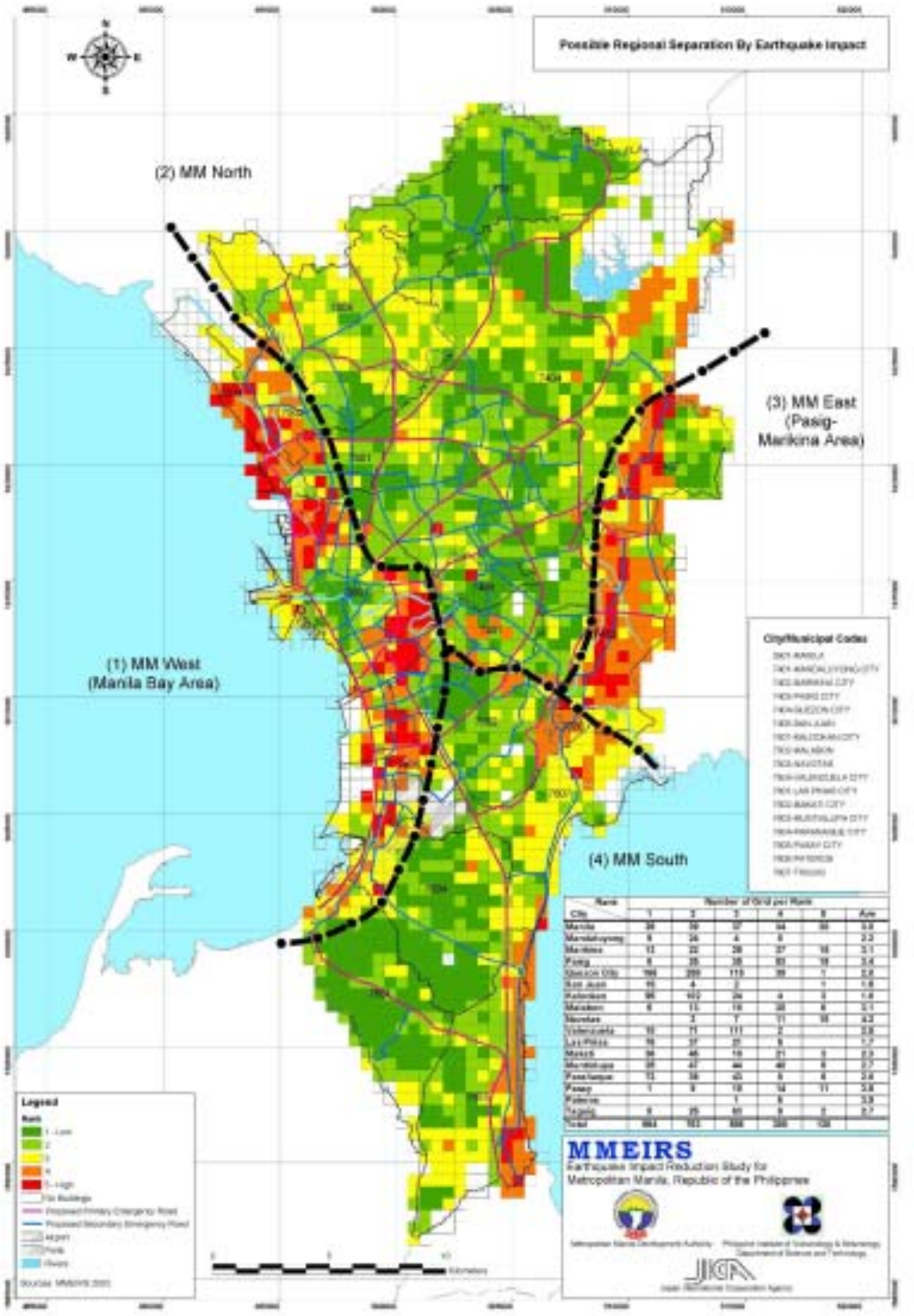

Figure 2.3.4 Possible Regional Separation by Earthquake Impact

Source: JICA Study Team

2.4 Facts and Damage Estimation by LGUs

1) Social Condition (Population & Land Use Condition) of LGU

City/ Municipality	Population		Population Growth 95-00	Total Land Area (GIS)	Residential				Commercial Area		Industrial Area		Open Area (Parks, Open Spaces)		Subdivision	
					Residential		Informally Occupied Area									
	1995	2000			Area (Ha)	Ratio (%)	Area (Ha)	Ratio (%)	Area (Ha)	Ratio (%)	Area (Ha)	Ratio (%)	Area (Ha)	Ratio (%)	Area (Ha)	Ratio (%)
Manila	1,654,761	1,581,082	-0.91	4,128	1,526	37.0	89	2.2	574	0.04	353	8.5	247	6.0	224	5.4
Mandaluyong	286,870	278,474	-0.59	1,107	468	42.3	18	1.6	150	0.05	196	17.7	125	11.3	245	22.2
Marikina	357,231	391,170	1.83	2,265	1,466	64.7	0.5	0.0	63	0.02	214	9.4	177	7.8	916	40.5
Pasig	471,075	505,058	1.40	3,188	1,477	46.3	13	0.4	317	0.06	631	19.8	403	12.6	581	18.2
Quezon	1,989,419	2,173,831	1.79	16,533	7,864	47.6	1,211	7.3	1,027	0.05	852	5.2	666	4.0	4,792	29.0
San Juan	124,187	117,680	-1.07	588	426	72.4	6	1.0	63	0.05	24	4.2	11	1.8	140	23.8
Valenzuela	437,165	485,433	2.12	4,452	3,547	79.7	54	1.2	216	0.04	409	9.2	696	15.6	1,496	33.6
Kalookan	1,023,159	1,177,604	2.85	5,312	746	14.0	44	0.8	45	0.00	260	4.9	116	2.2	161	3.0
Malabon	347,484	338,855	-0.50	1,596	278	17.4	38	2.4	4	0.00	140	8.8	2	0.2	34	2.1
Navotas	229,039	230,403	0.12	1,095	1,572	143.5	28	2.5	86	0.04	1,061	96.9	1,008	92.1	378	34.6
Las Pinas	413,086	472,780	2.74	3,227	2,040	63.2	-	0.0	252	0.05	190	5.9	667	20.7	1,576	48.8
Makati	484,176	444,867	-1.68	3,196	1,633	51.1	6	0.2	579	0.13	66	2.1	189	5.9	784	24.5
Muntinlupa	399,846	379,310	-1.05	3,813	1,917	50.3	12	0.3	377	0.10	303	7.9	926	24.3	1,255	32.9
Paranaque	391,296	449,811	2.83	4,561	2,796	61.3	12	0.3	315	0.07	327	7.2	593	13.0	1,524	33.4
Pasay	408,610	354,908	-2.78	1,778	569	32.0	10	0.6	154	0.04	26	1.5	353	19.9	11	0.6
Pateros	55,286	57,407	0.76	195	153	78.5	-	0.0	6	0.01	1	0.4	4	1.8	4	2.0
Taguig	381,350	467,375	4.15	2,752	1,163	42.3	18	0.6	13	0.00	342	12.4	158	5.8	181	6.6
Total	9,454,040	9,906,048	0.94	59,786	29,642	49.6	1,559	2.6	4,241	0.04	5,396	9.0	6,341	10.6	14,301	23.9

Source: JICA Study Team

Note: 1) Population 1995, 2000 Philippine Year Book; Population 2000 is based on the data provided by NSO, 2) Land area is calculated based on the GIS, 3) Subdivision map was provided by ALMEC 1996, 4) Land use area is calculated by the 2003 Landuse Map

2) Building Distribution of LGU

City / Municipality	Total Building Numbers	Classification of Buildings				Construction Year				
		CB	CW	W	S	Earlier than 1960	1961-1970	1971-1980	1981-1990	1991-2000
Manila	168,528	45,830	66,741	32,428	23,529	32,651	20,061	25,156	33,269	32,507
Mandaluyong	32,942	9,778	13,195	5,102	4,868	2,959	3,471	5,175	7,627	9,809
Marikina	53,422	30,298	13,473	6,552	3,100	2,632	4,249	8,562	15,065	18,314
Pasig	72,143	32,487	19,194	14,648	5,814	3,147	4,700	10,290	18,756	27,283
Quezon	302,818	141,287	88,738	35,797	36,995	15,709	18,636	41,915	82,085	109,616
San Juan	11,793	4,480	3,930	2,145	1,238	2,672	1,652	1,642	1,659	1,931
Valenzuela	62,778	33,781	15,148	8,357	5,492	7,702	8,356	14,865	51,013	71,864
Kalookan	168,480	87,830	44,065	18,295	18,290	4,162	4,713	8,260	13,960	15,119
Malabon	51,694	16,160	14,884	13,268	7,382	2,726	2,317	6,326	9,995	11,293
Navotas	35,124	9,145	10,037	9,244	6,698	2,290	3,703	8,920	16,880	23,176
Las Pinas	73,919	40,028	13,194	13,149	7,549	1,072	2,852	11,451	23,351	29,925
Makati	50,381	23,862	15,169	6,529	4,821	5,764	6,070	7,235	11,813	12,406
Muntinlupa	55,522	25,152	13,749	8,983	7,638	1,506	2,485	8,290	18,522	19,979
Paranaque	72,230	34,099	17,253	14,037	6,842	2,935	3,522	9,242	21,432	28,051
Pasay	39,968	13,225	14,895	6,931	4,917	4,693	4,567	7,114	9,894	8,089
Pateros	8,726	3,650	2,540	1,641	895	912	1,124	1,756	2,071	2,242
Taguig	65,428	34,859	14,548	9,797	6,224	1,485	2,193	7,855	19,439	29,508
Total	1,325,896	585,952	380,751	206,904	152,292	95,017	94,671	184,054	356,831	451,112

Source: JICA Study Team

Note: 1) CB: Concrete/Brick/Stone, 2) CW: Half concrete/brick/stone/and half wood, 3) W: Wood, 4)S: Galvanized iron, Makeshift/Salvaged

3) Road Distribution by LGU

City/ Municipality	Road length (km)				Road ratio (%)		
	0-6m	6-12m	12m+	Total	Narrow (0-6m)	Moderate (6-12m)	Wide (12m+)
Manila	44	579	26	650	6.8	89.1	4.1
Mandaluyong	1	432	29	462	0.1	93.5	6.4
Marikina	1	439	73	513	0.2	85.5	14.3
Pasig	12	151	7	170	6.8	89.0	4.2
Quezon	2	124	18	145	1.4	86.0	12.6
San Juan	36	569	142	747	4.8	76.2	19.0
Valenzuela	3	336	11	351	0.9	95.8	3.3
Kalookan	8	341	47	396	2.0	86.0	12.0
Malabon	14	72	6	92	15.3	78.3	6.4
Navotas	2	540	52	594	0.4	90.9	8.7
Las Pinas	2	149	44	196	1.1	76.3	22.6
Makati	2	365	32	400	0.6	91.4	8.0
Muntinlupa	1	17	2	19	5.1	86.7	8.2
Paranaque	59	1,654	190	1,903	3.1	86.9	10.0
Pasay	0	93	9	103	0.0	91.0	9.0
Pateros	1	249	10	260	0.4	95.6	4.0
Taguig	31	287	15	333	9.2	86.4	4.4
Total	219	6,398	715	7,331	3.0	87.3	9.7

Source: JICA Study Team

4) Land Damage Area of LGU (Earthquake Scenario Model 08)

City/ Municipality	Land Areas		Damage Affected Areas									
	Published Area (sq. km.)	GIS Calculated Area (sq.km.)	Rate of Area by MMI (%)			Rate of Area by PGA (gal)			Rate of Area by Liquefaction Potential (%)			
			8+	9+	10+	300 - 600	600 - 1000	1000 - 1600	Low	Rela-tively Low	Rela-tively High	High
Manila	38.3	41.3	16.2	83.8	0.0	51.2	48.8	-	37.9	2.4	29.1	28.6
Mandaluyong	26.0	11.1	0.0	100.0	0.0	78.8	20.5	0.7	18.6	0.0	0.8	4.6
Marikina	38.9	22.6	0.0	53.8	46.2	6.9	43.1	50.0	46.8	0.0	0.1	13.0
Pasig	13.0	31.9	0.0	44.9	55.1	20.7	53.9	25.4	33.7	0.0	17.8	30.3
Quezon	166.2	165.3	33.3	65.5	1.2	82.5	13.2	4.3	4.1	0.0	0.3	2.0
San Juan	10.4	5.9	0.0	100.0	0.0	100.0	-	-	0.0	0.0	0.0	11.6
Valenzuela	47.0	44.5	81.2	18.8	0.0	86.5	13.5	-	15.7	0.0	13.5	10.7
Kalookan	55.8	53.1	86.7	13.3	0.0	98.4	1.6	-	14.2	0.0	1.9	0.0
Malabon	23.4	16.0	42.9	57.1	0.0	62.5	37.5	-	45.4	3.1	21.1	7.3
Navotas	2.6	10.9	2.5	97.6	0.0	47.3	52.7	-	72.2	0.0	27.8	0.0
Las Pinas	41.5	32.3	34.0	66.0	0.0	92.9	7.1	-	1.5	2.1	3.2	0.9
Makati	29.9	32.0	0.0	98.4	1.6	48.8	50.3	0.9	18.5	0.9	1.8	4.6
Muntinlupa	46.7	38.1	0.0	85.9	14.1	38.1	54.3	7.6	26.8	0.2	1.6	0.0
Paranaque	38.3	45.6	0.0	100.0	0.0	60.8	39.2	0.0	0.6	0.0	16.9	8.5
Pasay	13.9	17.8	0.0	100.0	0.0	44.1	55.9	-	16.6	0.0	46.7	6.2
Pateros	10.4	2.0	0.0	100.0	0.0	98.8	1.2	-	0.0	0.0	37.9	60.9
Taguig	33.7	27.5	0.0	97.7	2.3	61.0	37.6	1.5	1.8	0.0	25.8	37.4
Total	636.0	597.8	-	-	-	-	-	-	-	-	-	-

Source: JICA Study Team

5) Building Damage and Casualty (Earthquake Scenario Model 08)

City/ Municipality	Population	Total Building Number	Building Damage				Casualty			
			Number (x 1,000)		Ratio		Number (x 1,000)		Ratio	
			Heavily	Partly	Heavily	Partly	Dead	Injured	Dead	Injured
Manila	1,581,082	168,528	24.6	50.1	14.6%	29.8%	6.0	19.8	0.4%	1.3%
Mandaluyong	278,474	32,942	4.3	9.6	12.9%	29.2%	1.0	3.4	0.4%	1.2%
Marikina	391,170	53,422	15.0	18.8	28.1%	35.1%	2.6	8.7	0.7%	2.2%
Pasig	505,058	72,143	22.8	25.6	31.5%	35.5%	3.4	11.8	0.7%	2.3%
Quezon	2,173,831	302,818	25.8	69.6	8.5%	23.0%	5.5	18.7	0.3%	0.9%
San Juan	117,680	11,793	1.2	3.1	9.8%	26.4%	0.4	1.1	0.3%	1.0%
Valenzuela	485,433	62,778	2.1	7.3	3.3%	11.6%	0.5	1.4	0.1%	0.3%
Kalookan	1,177,604	168,480	6.5	23.4	3.9%	13.9%	1.5	4.9	0.1%	0.4%
Malabon	338,855	51,694	4.3	11.7	8.2%	22.7%	0.8	2.8	0.2%	0.8%
Navotas	230,403	35,124	5.1	10.9	14.6%	31.0%	0.8	3.2	0.4%	1.4%
Las Pinas	472,780	73,919	5.9	16.7	8.0%	22.6%	1.2	4.0	0.3%	0.8%
Makati	471,379	50,381	8.9	16.4	17.7%	32.5%	2.3	7.5	0.5%	1.6%
Muntinlupa	379,310	55,522	13.3	19.0	24.0%	34.1%	2.0	7.5	0.5%	2.0%
Paranaque	449,811	72,230	9.0	20.9	12.4%	28.9%	1.7	5.6	0.4%	1.2%
Pasay	354,908	39,968	6.8	12.8	17.0%	32.1%	1.6	5.3	0.4%	1.5%
Pateros	57,407	8,726	1.6	2.9	18.8%	33.0%	0.3	0.9	0.5%	1.5%
Taguig	467,375	65,428	11.2	21.0	17.1%	32.2%	2.1	7.0	0.4%	1.5%
Total	9,932,560	1,325,896	168.3	339.8	-	-	33.5	113.6	-	-

Source: JICA Study Team

6) Fire Damage and Casualty (Earthquake Scenario Model 08)

City/ Municipality	Maximum Possible Burnout Area (ha)		Maximum Possible Burnout Building				Maximum Possible Fire Casualty Damage			
			Number (x 1,000)		Ratio		Number (x 1,000)		Ratio	
	Wind speed		Wind speed		Wind speed		Wind speed		Wind speed	
	3m/sec	8m/sec	3m/sec	8m/sec	3m/sec	8m/sec	3m/sec	8m/sec	3m/sec	8m/sec
Manila	216	450	13.7	31.0	8.1%	18.4%	3.0	6.8	0.2%	0.4%
Mandaluyong	33	70	1.7	4.0	5.1%	12.2%	0.3	0.7	0.1%	0.2%
Marikina	4	9	0.1	0.4	0.3%	0.8%	0.0	0.1	0.0%	0.0%
Pasig	35	74	2.2	5.0	3.1%	6.9%	0.7	1.6	0.1%	0.3%
Quezon	115	259	4.9	12.3	1.6%	4.1%	0.6	1.4	0.0%	0.1%
San Juan	21	43	0.5	1.3	4.6%	10.8%	0.1	0.2	0.1%	0.2%
Valenzuela	8	22	0.2	0.7	0.3%	1.1%	0.0	0.0	0.0%	0.0%
Kalookan	56	120	3.5	8.2	2.1%	4.8%	0.3	0.6	0.0%	0.1%
Malabon	54	114	3.2	7.3	6.1%	14.1%	0.3	0.7	0.1%	0.2%
Navotas	48	97	3.9	8.6	11.2%	24.4%	0.6	1.4	0.3%	0.6%
Las Pinas	18	38	0.8	1.7	1.0%	2.3%	0.1	0.2	0.0%	0.0%
Makati	53	116	2.0	4.9	4.0%	9.7%	0.7	1.6	0.1%	0.3%
Muntinlupa	35	78	0.8	2.0	1.4%	3.6%	0.2	0.6	0.1%	0.2%
Paranaque	39	82	1.5	3.5	2.1%	4.8%	0.2	0.6	0.1%	0.1%
Pasay	50	103	2.5	5.8	6.4%	14.4%	0.7	1.5	0.2%	0.4%
Pateros	3	7	0.2	0.5	1.8%	5.4%	0.0	0.1	0.1%	0.2%
Taguig	12	28	0.3	0.8	0.5%	1.3%	0.1	0.2	0.0%	0.0%
Total	798	1,710	42.1	97.8	-	-	7.9	18.3	-	-

Source: JICA Study Team