JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
NATIONAL ECONOMIC AND DEVELOPMENT AUTHORITY (NEDA)

# ROADMAP FOR TRANSPORT INFRASTRUCTURE DEVELOPMENT FOR METRO MANILA AND ITS SURROUNDING AREAS (REGION III & REGION IV-A)

## FINAL REPORT

## TECHNICAL REPORT NO. 1
## ENVIRONMENT AND HAZARD RISK REDUCTION ANALYSIS

March 2014

ALMEC CORPORATION

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# ABBREVIATIONS

| | |
|---|---|
| ADB | Asian Development Bank |
| AFCS | automated fare collection system |
| ASBU | Anti-Smoke Belching Units |
| ATI | Asian Terminals Inc. |
| BCDA | Bases Conversion and Development Authority |
| BMDS | bus management and dispatch facilities |
| BOT | build–operate–transfer |
| BPO | business process outsourcing |
| BRT | bus rapid transit |
| BURs | biennial update reports |
| CALA | Cavite Laguna |
| CALABARZON | Cavite, Laguna, Batangas, Rizal and Quezon |
| CAMANAVA | Caloocan, Malabon, Navotas and Valenzuela |
| CBD | central business district |
| CBU | completely built unit |
| CCW | center/cluster-corridor-wedge |
| CIAC | Clark International Airport |
| CLUP | comprehensive land use plans |
| CME | coconut methyl ester |
| CNG | compressed natural gas |
| COP | Conference of Parties |
| DBM | Department of Budget and Management |
| DBP | Development Bank of the Philippines |
| DMIA | Diosdado Macapagal International Airport |
| DOF | Department of Finance |
| DOST | Department of Science and Technology |
| DOTC | Department of Transportation and Communications |
| RTPD | Road Transport Planning Division |
| DPWH | Department of Public Works and Highways |
| ECC | environmental compliance certificate |
| EDSA | Epifanio de los Santos Avenue |
| ESSO | Environmental and Social Services Office |
| FTI | Food Terminal, Inc. |
| GCR | Greater Capital Region |
| GDP | gross domestic product |
| GRDP | gross regional domestic product |
| HCPTI | Harbour Centre Port Terminal Inc. |
| HLURB | Housing and Land Use Regulatory Board |
| HUDCC | Housing and Urban Development Coordinating Council |
| ICTSI | International Container Terminal Service, Inc. |
| Infracom | Infrastructure Committee |
| IRR | internal rate of return |
| ISSMFE | International Society of Soil Mechanics and Foundation Engineering |
| ITS | integrated transport system |
| JBIC | Japan Bank for International Cooperation |
| JICA | Japan International Cooperation Agency |
| LGU | local government unit |
| LRT | Light Rail Transit |
| LRTA | Light Rail Transit Authority |
| LTFRB | Land Transportation Franchising & Regulatory Board |

| | |
|---|---|
| LDV | Low Duty Vehicle |
| METI | Ministry of Economy, Trade and Industry |
| MIAA | Manila International Airport Authority |
| MICT | Manila International Container Terminal |
| MMDA | Metro Manila Development Authority |
| MMEIRS | Earthquake Impact Reduction Study for Metro Manila |
| MMPTS | Mega Manila Public Transport Study |
| MMUTIS | Metro Manila Urban Transportation Integration Study |
| MNL | Manila North Line |
| MNTC | Manila North Tollways Corporation |
| MNHPI | Manila North Harbour Port Inc. |
| MPDTC | Metro Pacific Tollways Development Corp. |
| MPPA | million passengers per annum |
| MRO | maintenance, repair and overhaul |
| MRT | Metro Rail Transit |
| MRV | measurable, reportable and verifiable |
| MSL | Manila South Line |
| MTDP | medium-term development plan |
| MVIS | Motor Vehicle Inspection System |
| NAAQGV | National Ambient Air Quality Guideline Values |
| NAIA | Ninoy Aquino International Airport |
| NFSCC | National Framework Strategy on Climate Change |
| NCR | National Capital Region |
| NGVPPT | Natural Gas Vehicle Program for Public transport |
| NEDA | National Economic and Development Authority |
| ICC | Investment Coordination Committee |
| NCTS | National Center for Transportation Studies |
| NLEX | North Luzon Expressway |
| NSCB | National Statistical Coordination Board |
| NSO | National Statistics Office |
| OAP | outdoor air pollution |
| O&M | operation and maintenance |
| ODA | official development assistance |
| OTCA | Overseas Technical Cooperation Agency |
| PDP | Philippine Development Plan |
| PEZA | Philippine Economic Zone Authority |
| PHIVOLCS | Philippine Institute of Volcanology and Seismology |
| PIBAS | provincial integrated bus axis system |
| PMO | project management office |
| PNCC | Philippine National Construction Corporation |
| PNR | Philippine National Railways |
| PNRI | Philippine Nuclear Research Institute |
| PPA | Philippine Port Authority |
| PPP | public-private-partnership |
| PUB | public utility bus |
| PUJ | public utility jeepney |
| Php | Philippine peso |
| R&D | research and development |
| RDA | regional development agenda |
| RET | rapid exit taxiways |
| ROW | right of way |
| SBF | Subic Bay Freeport Zone |
| SBPDP | Subic Bay Port Development Project |

| | |
|---|---|
| SCMB | Subic-Clark-Manila- Batangas |
| SCTEX | Subic-Clark-Tarlac Expressway |
| SLEX | South Luzon Expressway |
| SLTC | South Luzon Tollway Corporation |
| SOE | state-owned enterprise |
| STAR | Southern Tagalog Arterial Road |
| TDM | Transportation Demand Management |
| TEAM | traffic engineering and management |
| TEU | twenty-foot equivalent units |
| UP VRTL | University of the Philippines Vehicle Research and Testing Laboratory |
| USAID | United States Agency for International Development |
| USD | US dollar |
| UV | utility vehicle |
| UVVRP | Unified Vehicular Volume Reduction Program |
| VFR | visual flight rules |
| VECP | Report on Vehicular Emission Control Planning |
| WB | World Bank |
| WHO | World Health Organization |

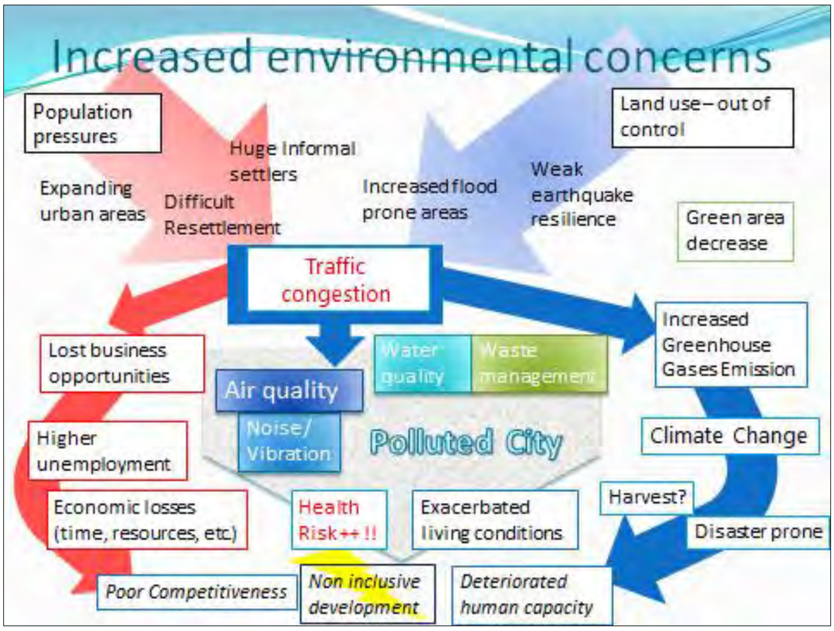
# 1 BACKGROUND

## 1.1 Objectives

1.1 The Transport Sector Roadmap for the sustainable development of the Greater Capital Region addresses urban development issues, vision, and spatial development direction, as well as highlights pivotal transport issues for further discussion towards implementation. The objective of this section is to discuss key environmental policy challenges and disaster concerns to substantiate the roadmap towards sustainable transport strategy in the study area and to identify specific implementation plans.

## 1.2 Current Environmental Situation of Metro Manila

1.2 Metro Manila, like many other mega-cities in the neighboring developing Asian countries, experiences rapid economic growth, which brings about traffic congestion with severe air pollution, noise and vibration, and more serious traffic accidents. Metro Manila has been suffering from chronic environmental concerns caused by population pressures, increased disaster prone areas and expanded urban areas caused by weak land use management, insufficient transportation service, etc. (see Figure 1.2.1). The expansion and congestion of urban areas have been contributing to environmental degradation and to immense ecological burdens.




Source: JICA Study Team.

**Figure 1.2.1 Environmental Issues of Metro Manila**

1.3 The average time for one person trip (the time required from origin to destination) in Metro Manila, according to the JICA Study Team, is already at a critical level of 1.17 hours per person trip. It is expected to further deteriorate to 1.33 hours per person trip by 2030, assuming that there are no significant transport interventions such as investing in railways and roads, and transport demand management policies. However, the JICA Study Team also projects that if all the priority projects it recommends would be implemented, the average time for a trip per person would decrease to 0.52 hour by 2030, which is only 43% of the current average time. Such a large reduction of travel time in Manila would significantly contribute to economic and social development.

1.4 Efficient and reliable transport is essential for social and economic activities. On the other hand, it has become one of the major causes of environmental problems such as air pollution, noise, vibration, and emission of greenhouse gases (GHG). Residents perceive traffic congestion as their number one problem, followed by air pollution, flood control and the need for security. Congestion and air pollution are serious problems caused by the transport sector.

1.5 However, a mega city such as Metro Manila can also be a model of environmental efficiency, since increased density and better management reduce the cost of service delivery, promote innovation, and enable prosperity through economic development. Sustainable cities are the best option to provide a quality of life while reducing net pollution such as GHG emissions. At the political level, cities are credible laboratories of social change with sufficient scale to bring about meaningful actions. The problems of traffic congestion, air pollution, contaminated surface water, and increasing waste, etc. are not only prevalent in Metro Manila but in many other regional centers in the Philippines. The outcomes of Metro Manila's efforts to improve the environment will be able to expand in the adjacent regions as well as other major cities which share the same challenges.

# 2 ENVIRONMENTAL CONCERNS IN METRO MANILA

## 2.1 Air Pollution

### 1) Prime Significance of Pollution in Metro Manila

#### (1) Comparison with Other Asian Cities

2.1 The air quality of the major Asian cities has deteriorated with the rapid growth in motorization. The air quality of Manila has been seen slightly better than Beijing's, but worse than those of other major capitals of the ASEAN members in the early 2000s (see Table 2.1.1).

**Table 2.1.1 Air Pollution Status of Major Cities in Asia**

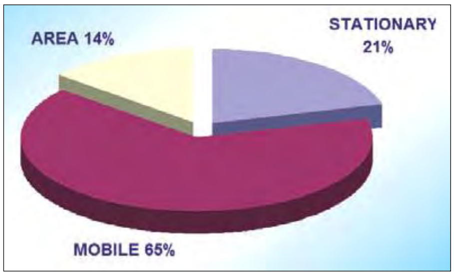
| City | Country/Area | PM | $SO_2$ | CO | $NO_2$ | $O_3$ | Pb |
|---|---|---|---|---|---|---|---|
| Tokyo | Japan | B | A | A | B | B | A |
| Beijing | China | E | D | D | D | C | B |
| Seoul | South Korea | D | B | A | C | B | A |
| Taipei | Taiwan | D | B | B | B | B | B |
| Bangkok | Thailand | E | B | B | B | B | C |
| Kuala Lumpur | Malaysia | B | B | C | C | C | C |
| Jakarta | Indonesia | E | C | C | B | C | D |
| Manila | Philippines | E | B | C | D | D | C |

Source: N. Hayashi (2004) http://mee.k.u-tokyo.ac.jp/siee/eeip/2004fy/20041025hayashiC.pdf (in Japanese)
Concentration level of respective materials in the atmosphere is:
A: Very low pollution: Less than half of the WHO guideline value
B: Low pollution: Within the level of WHO guideline value
C: Moderate pollution: Exceeded WHO guideline value by less than two-fold
D: Heavy pollution: Exceeded WHO guideline value by less than three-fold
E: Serious pollution: Exceeded WHO guideline value by more than three-fold
Note: PM: Particulate Matter, $SO_2$: Sulphur Dioxide, CO: Carbon Monoxide, $NO_2$: Nitrogen Dioxide, $O_3$: Ozone, Pb: Lead

2.2 The Philippine Clean Air Act of 1999 defines air pollution as “any alteration of the physical, chemical and biological properties of the atmospheric air, or any discharge thereto of any liquid, gaseous or solid substances that will or is likely to create or render the air resources of the country harmful, detrimental, or injurious to public health, safety or welfare or which will adversely affect their utilization for domestic, commercial, industrial, agricultural, recreational, or other legitimate purposes.” By this definition, air pollution is unmistakably an environmental risk to human health.

#### (2) Sources of Air Pollution in the Philippines

2.3 The sources of air pollution are classified as stationary, mobile and area sources. In this Study, air pollution focuses on the mobile sources, which pertains to vehicles on the Metro Manila road network. The Philippine National Emission Inventory in 2008 showed that 65% of the total emission comes from mobile sources, followed by stationary sources at 21%, and 14% coming from area sources (see Figure 2.1.1 and Table 2.1.2).




Source: EMB, National Air Quality Status Report (2005–2007)

**Figure 2.1.1 National Emission Inventory of the Philippines, 2008**

**Table 2.1.2 National Emissions Inventory in 2006**

| Source | PM (μg/NcM) | $SO_x$ (μg/NcM) | $NO_x$ (μg/NcM) | CO (μg/NcM) | VOC | Total | % |
|---|---|---|---|---|---|---|---|
| Stationary | 110,023 | 598,634 | 326,219 | 360,620 | 67,859 | 1,463,385 | 20.9 |
| Mobile | 244,764 | 14,309 | 405,033 | 2,988,616 | 914,996 | 4,567,719 | 65.1 |
| Area | 423,615 | 1,963 | 327,261 | 165,647 | 63,855 | 982,340 | 14.0 |
| Total | 778,402 | 614,937 | 1,058,514 | 3,514,883 | 1,046,710 | 7,013,444 | 100.0 |

Source: EMB, National Air Quality Status Report (2005–2007)
VOC: volatile organic compounds ug/NcM= micrograms/m3

2.4 Emissions from mobile sources contribute significantly to total emissions of particulate matters (PM), volatile organic compounds (VOC), carbon monoxide (CO), and nitrogen oxides (NOx). Motor vehicles are the dominant source of air pollutants in the urban area. According to the EMB-DENR, the share of mobile sources to the total amount of VOC, CO, NOx, and PM10 in Metro Manila are 95.6%, 99.4%, 89% and 17%, respectively. Table 2.1.3 shows that UVs such as jeepneys, most of which are old diesel vehicles, and motorcycles and tricycles (MC/TC) are the major sources of PM. Other pollutants from jeepneys, such as NOx and SOx, also show a high share of the total mobile source emissions. Rapid motorization may have great potential impacts to deteriorate the air quality in urban areas of Metro Manila.

2.5 The urban rail transport does not emit air pollutants from the train cars because of the electrification. On the contrary, the regional rail transport emit air pollutants such as PM and SOx because PNR uses diesel train cars. Although maritime transport and air transport are the typical sources to emit air pollutants such as PM and SOx, they have not been quantified so far in the Philippines, and no evident and significant air pollution contribution from the sector is recorded.

**Table 2.1.3 Motor Vehicle Emissions by Vehicle Type in Metro Manila in 2008 and 2010 (tons/year)**

| Vehicle Type | Fuel Used | TOG | | CO | | $NO_x$ | | $SO_x$ | | $PM_{10}$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2008 | 2010 | 2008 | 2010 | 2008 | 2010 | 2008 | 2010 | 2008 | 2010 |
| Cars | Gasoline | 32,450 | 32,640 | 267,715 | 269,281 | 14,603 | 14,688 | 647 | 626 | 535 | 538 |
| | Diesel | 312 | 85 | 912 | 247 | 960 | 260 | 64 | 17 | 276 | 75 |
| UV | Gasoline | 68,793 | 63,934 | 515,948 | 479,502 | 25,797 | 23,975 | 411 | 384 | 1,023 | 951 |
| | Diesel | 11,655 | 12,551 | 41,626 | 44,825 | 23,310 | 25,102 | 1,657 | 1,775 | 14,386 | 15,492 |
| Buses | Gasoline | 1,108 | 1,126 | 1,108 | 1,126 | 120 | 122 | 1 | 1 | 1 | 1 |
| | Diesel | 6,122 | 8,027 | 6,122 | 8,027 | 6,172 | 8,091 | 39 | 39 | 217 | 285 |
| Trucks | Gasoline | 435 | 381 | 10,396 | 8,220 | 1,017 | 891 | 7 | 7 | 12 | 11 |
| | Diesel | 11,539 | 13,040 | 38,671 | 43,700 | 38,983 | 44,053 | 248 | 2,806 | 1,372 | 1,551 |
| MC/TC | Gasoline | 107,561 | 124,677 | 150,354 | 174,280 | 1,157 | 1,341 | 830 | 962 | 11,508 | 13,339 |
| | Diesel | | | | | | | | | | |
| Sub-Total | Gasoline | 210,347 | 222,757 | 945,521 | 932,408 | 42,694 | 41,017 | 1,896 | 1,979 | 13,080 | 14,841 |
| | Diesel | 29,628 | 33,702 | 87,331 | 96,799 | 69,425 | 77,507 | 2,009 | 4,638 | 16,252 | 17,402 |
| Total | | 239,975 | 256,459 | 1,032,851 | 1,029,207 | 112,119 | 118,524 | 3,905 | 6,616 | 29,332 | 32,243 |

Source: EMB-DENR, METRO MANILA AIR QUALITY STATUS REPORT 2011
CO= carbon monoxide, NOx= nitrogen oxide, PM= particulate matter, SOx= sulfur oxide, TOG= Total Organic Gases

2.6 Carbon monoxide (CO) emission is relatively caused by the increasing population of gasoline-fed vehicles such as cars and motorcycles and tricycles (MC/TC). Based on numerous medical studies, it is an accepted fact that CO poses danger to human health. However, recent studies conducted by the World Health Organization (WHO) show that particulate matter (PM) can affect more people than any other pollutant.

### (3) National Ambient Air Quality Guideline Values

2.7 The National Ambient Air Quality Guideline Values (NAAQGV) of the Philippines are shown as Table 2.1.4, with a comparison to WHO Guidelines. The NAAQGV are generally more lenient than the WHO Guidelines. However, the former's $O_3$ value is more stringent, while its CO and Pb values are more or less compatible with the WHO Guidelines. These guidelines refer to the safe level of pollutants for a given average time to protect the public from acute health effects. Department of Environment and Natural Resources (DENR) Administrative Order No. 2013–03 (DAO No. 2013–03) established the Guidelines for PM2.5 in March 2013. Within the Metro Manila air shed, there are currently three stations measuring PM2.5 levels in the atmosphere. EMB-DENR plans to expand their air quality monitoring network in Metro Manila and rest of the Philippines.

## 2) Status of Air Quality Monitoring

2.8 The recent report of the Air Quality Monitoring Section (AQMS) of the EMB-DENR shows a decreasing trend in the annual average total suspended particulates (TSP) from 2004 to 2012, setting an average TSP level of 100 micro grams per normal cubic meter (μg/NcM) (see Table 2.1.5). However, this nine-year trend remains above the NAAQGV of 90 ug/NcM, which is the annual mean TSP guideline value over a one-year averaging time period.

2.9 In 2011, EMB-DENR started to monitor PM10 in 27 stations nationwide, which includes 9 stations around the Metro Manila area (see A to I in Table 2.1.6 and Figure 2.1.2). Only 18 stations delivered sound data for the year 2012, five of which stations located in Metro Manila (i.e., National Printing Office, EDSA, Marikina, MRT-Pasay Taft, Valenzuela, and Caloocan) have exceeded the PM10 AQGV of 60 ug/NcM. This indicates that the fine particulate pollution in Metro Manila should be addressed.

### Table 2.1.4 National Ambient Air Quality Guideline Values (NAAQGV) vs. WHO Guidelines (ug/NcM)

| Pollutant | Average Time | NAAQGV | WHO Guidelines |
|---|---|---|---|
| $PM_{10}$ | 24-hour average exposure | 150 | 50 |
| | Annual average exposure | 60 | 20 |
| $PM_{2.5}$ | 24-hour average exposure | 75 | 25 |
| | Annual average exposure | 35 | 10 |
| TSP | 24-hour average exposure | 230 | - |
| | Annual average exposure | 90 | - |
| $NO_2$ | 1-hour average exposure | - | 200 |
| | 24-hour average exposure | 150 | - |
| | Annual average exposure | - | 40 |
| $SO_2$ | 10-minute average exposure | - | 500 |
| | 1-hour average exposure | - | - |
| | 24-hour average exposure | 180 | 20 |
| | Annual average exposure | 80 | - |
| $O_3$ | 1-hour average exposure | 140 | - |
| | 8-hour average exposure | 60 | 100 |
| | 24-hour average exposure | - | - |
| CO | 1-hour average exposure | 35,000 | 30,000 |
| | 8-hour average exposure | 10,000 | 10,000 |
| Lead (Pb) | 3-month average exposure | 1.5 | - |
| | Annual average exposure | 1.0 | 0.5 |

Source: Philippine Air Quality Profile 2010 (Clean Air Asia for Asian Cities).
Note: Guidelines refer to the safe level of a pollutant, for a given average time, to protect the public from acute health effects. µg/m3=micrograms per cubic meter

### Table 2.1.5 Annual TSP Trend by Monitoring Stations, 2004–2012

| Region | | Stations | µg/NcM | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | '04 | '05 | '06 | '07 | '08 | '09 | '10 | '11 | '12 |
| National Capital Region (NCR) | 1 | Makati Bureau of Fire Compound, Ayala Ave., cor. Buendia St., Bel-Air, Makati City | 211 | 183 | 153 | 146 | 134 | 145 | 160 | 128 | 135 |
| | 2 | Valenzuela Municipal Hall, Quezon City | 206 | 152 | 157 | 146 | 156 | 164 | 162 | 121 | 123 |
| | 3 | EDSA East Avenue BFD Compound, East Ave., Q.C. | 170 | 129 | 104 | 102 | 107 | 90 | 105 | 74 | 72 |
| | 4 | NCR-EDSA NPO, Q.C. | 164 | 163 | 138 | 125 | 144 | 89 | 152 | 103 | 96 |
| | 5 | Ateneo de Manila Observatory, Ateneo University | 105 | 87 | 72 | 65 | 74 | 62 | 79 | 58 | 62 |
| | 6 | City Hall, Maycilo Circle, Plainview, Mandaluyong City | 133 | 124 | 121 | 134 | 125 | 104 | 138 | 136 | 148 |
| | 7 | Dept. Health, San Lazaro St., Rizal Avenue | 134 | 138 | 111 | 110 | 103 | 103 | 132 | 101 | 114 |
| | | LLDA Compound Pasig City Hall | 109 | 106 | 90 | 92 | 85 | 126 | | | |
| | 8 | Sports Complex, Sumulong Highway, Sto. Nino, Marikina City | | | | | | | 125 | 125 | 108 |
| | 9 | MRT-Taft Avenue Station, EDSA cor. Taft Avenue, Malibay, Pasay City | 236 | 323 | 316 | 257 | 282 | 283 | 294 | 219 | 213 |
| Region 3 | 1 | Reg 3-San Fernando | | | | | | | | 128 | 243 |
| | 2 | Reg 3-Saluysoy Station | 190 | 309 | 186 | 116 | 106 | 124 | 61 | 21 | 14 |
| | 3 | Reg 3-Intercity Station | | | | | | | | 344 | 277 |
| Region 4A | 1 | Reg 4-A Cavite | | | | | | | | - | - |
| | 2 | Reg 4-A Batangas | 144 | 140 | 46 | 49 | 50 | 19 | 22 | - | - |
| | 3 | Reg 4-A Quezon | | | | | | | | - | - |

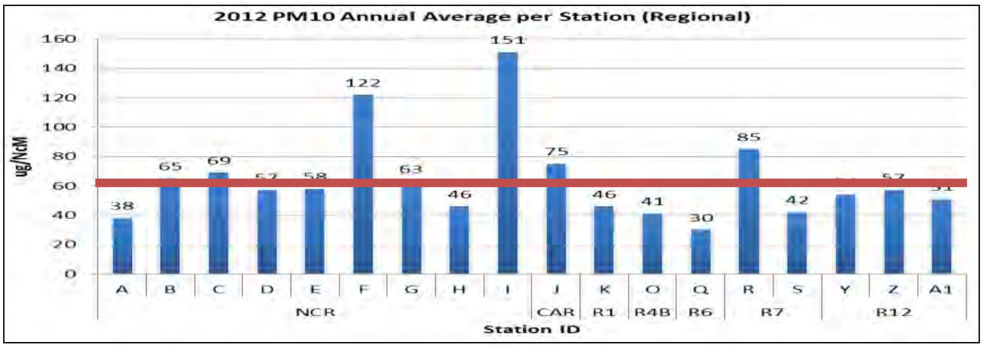
Source: EMB-DENR
Note: There are other stations, but this focuses only on NCR and Regions 3 and 4A - Did not meet sampling criteria

**Table 2.1.6 PM10 Monitoring Results in Metro Manila in 2011 and 2012**

Air Quality Guideline Values (AQGV) of 60 ug/NcM

| Region | Station ID | Location | Year 2011 Annual Arithmetic Mean | Year 2012 Annual Arithmetic Mean |
|---|---|---|---|---|
| NCR | A | Ateneo (RT) | 41 | 38 |
| | B | NPO-EDSA | 78 | 65 |
| | C | Marikina | 70 | 69 |
| | D | DOH-Manila | 57 | 57 |
| | E | MMDA-Guadalupe | 54 | 58 |
| | F | MRT-Pasay Taft | 136 | 122 |
| | G | Valenzuela-Radio ng Bayan (RT) | 55 | 63 |
| | H | NAMRIA (RT) | 50 | 46 |
| | I | Caloocan | 179 | 151 |

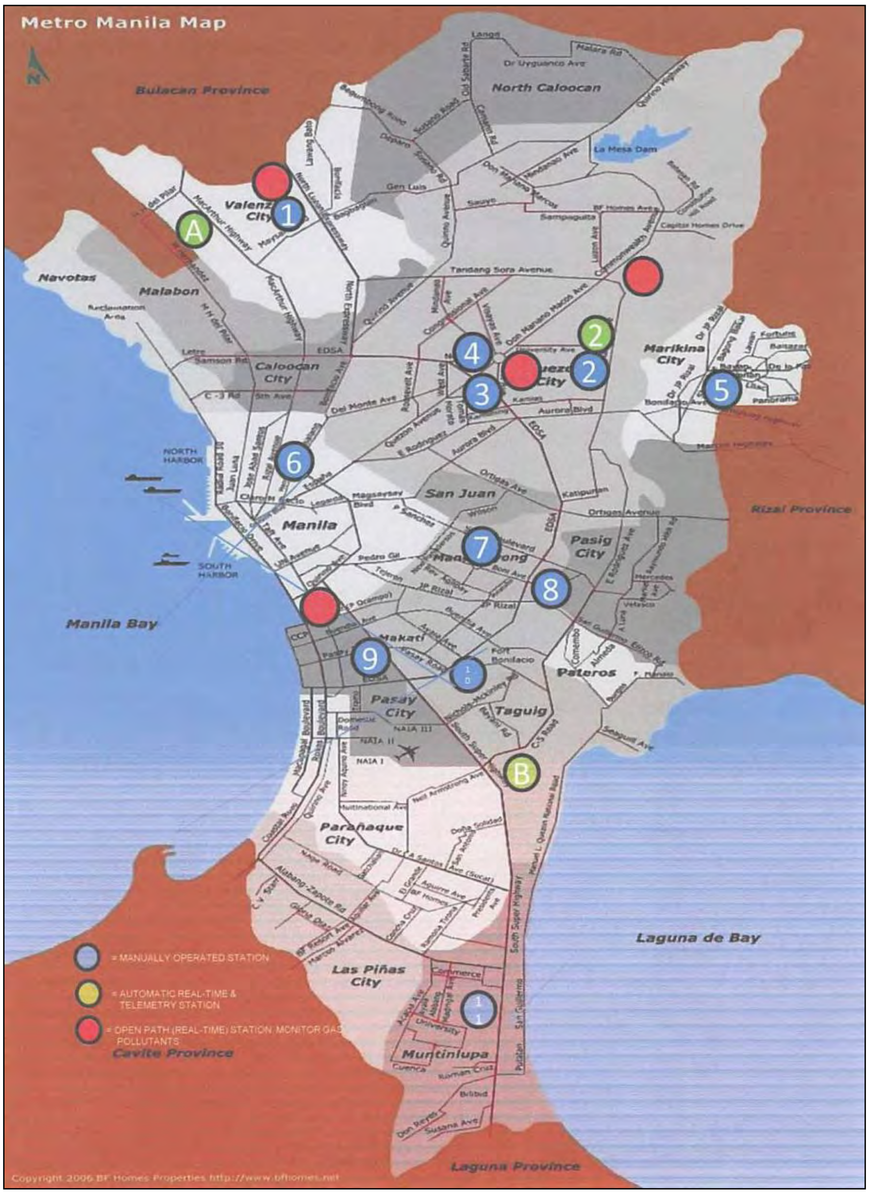
Source: EMB-DENR
Note: Annual arithmetic means are from monthly arithmetic mean results of each station.




Source: EMB-DENR.

**Figure 2.1.2 National PM10 Monitoring Results in 2012**

2.10 $PM_{10}$, $PM_{2.5}$ and TSP were regularly monitored in Metro Manila (NCR) under the EMB-DENR but other pollutants such as NOx, CO originating from vehicle emissions are not monitored even though there is guideline values set as Table 2.1.7. Setting up an air monitoring station requires more or less 10 million PHP for initial investments and 1.5 to 2 million PHP annually for operation and maintenance. The monitoring devices other than TSP and PM are more expensive, which hampers to materialize monitoring NOx, $O_3$, SOx regularly. In the Philippines as a whole, only limited regions have capacity to monitor the air quality besides PM. Under these circumstances, the air monitoring status to analyze the impact on health in Metro Manila is regarded as insufficient.




Source: 2011 Metro Manila Air Quality Status Report (National Capital Region, EMB-DENR) and interviews

**Figure 2.1.3 Ambient Air Quality Monitoring Stations in Metro Manila**

**Table 2.1.7 Summary of the Parameters Monitored in the Philippines (2008)**

| Region | DENR | | | | | Philippine Nuclear Research Institute | | | Manila Observatory | |
|---|---|---|---|---|---|---|---|---|---|---|
| | TSP | $PM_{10}$ | $NO_2$ | $SO_2$ | $O_3$ | CO | $PM_{10}$ | $PM_{2.5}$ | $PM_{10}$ | $PM_{2.5}$ |
| I | √ | | | | | | | | | |
| II | √ | | | | | | | | | |
| **III** | √ | | | | | | | | | |
| **IV** | √ | | | | | | | | | |
| V | √ | | | | | | | | | |
| VI | √ | | | | | | | | | |
| VII | √ | √ | √ | √ | √ | | | | | |
| VIII | √ | √ | | | | | | | | |
| IX | √ | | | | | | | | | |
| X | | | √ | √ | √ | | | | | |
| XI | √ | | √ | √ | √ | | | | | |
| XII | √ | | | | | | | | | |
| XIII | √ | | | | | | | | | |
| CAR | | √ | √ | √ | √ | √ | | | | |
| ARMM | | | | | | | | | | |
| **NCR** | √ | | | | | | √ | √ | | √ |

Source: Philippines: Air Quality Profile - 2010 Edition.

2.11 EMB-DENR is tasked to prepare an annual National Air Quality Status Report, which will be used as basis in formulating the Integrated Air Quality Improvement Framework. The said report will include, but not limited to, the following:

(i) Extent of pollution in the country, per type of pollutant and per type of source, based on reports from the Department's monitoring stations;
(ii) Analysis and evaluation of current state, trends and projections of air pollution;
(iii) Identification of critical areas, activities or projects which will need closer monitoring or regulation;
(iv) Recommendation for necessary executive and legislative action; and
(v) Other pertinent qualitative and quantitative information concerning the extent of pollution and the air quality performance rating of industries in the country.

2.12 The EMB-DENR, in cooperation with the National Statistical Coordination Board (NSCB) is also tasked to design and develop an information network for data storage, retrieval and exchange. DENR serves as the central depository of all data and information related to air quality, but other sources exist in the Philippines; the Philippine Nuclear Research Institute (PNRI), Manila Observatory, National Center for Transport Studies (NCTS), Metro Manila Development Authority (MMDA), University of the Philippines -College of Engineering, De La Salle University's Engineering Department, non-government organizations such as the Clean Air Initiative-Asia, and a number of local government units (LGUs) in the metropolis.

2.13 Only the EMB-DENR is mandated to conduct regular monitoring and the formulation of a status report on air quality. With this mandate, EMB has strategically established monitoring stations in every region of the country. However, in the past decade according to the Air Quality Monitoring Section of EMB, a number of stations were rendered non-operational due to financial or budgetary constraints. AQMS noted that things started to improve in 2011 with the acquisition of 4 state-of-the-art air monitoring equipment with open-pot technology which can provide run-time data on air parameters including PM10 and PM2.5. These equipments are currently stationed and operational in 4 locations in Metro Manila as previously explained. The air monitoring office will be installing 27 more units of the said equipment at the rest of their monitoring stations which may be completed within 2013. Currently the air pollution prediction system is under preparation and will be operated in 2014. With these efforts, air monitoring system is expected to be improved, but not sufficiently able to address the danger of air quality.

### 3) Air Quality in a Planning Perspective

2.14 The Integrated Environmental Strategies-Philippines by the Manila Observatory forecasted traffic demand levels for 2005, 2010 and 2010 utilizing the comprehensive MMUTIS study (1999) in relation with air pollution (PM and $CO_2$) reduction policies aimed to bring the state of air pollution to 2002 level. These policies:

(i) Transportation Demand Management through license plate scheme (TDM);

(ii) Construction of Railway-based Mass Transit System;

(iii) Construction of Bikeways;

(iv) Implementation of the Motor Vehicle Inspection System (MVIS);

(v) Implementation of the Compressed Natural Gas for buses (CNG);

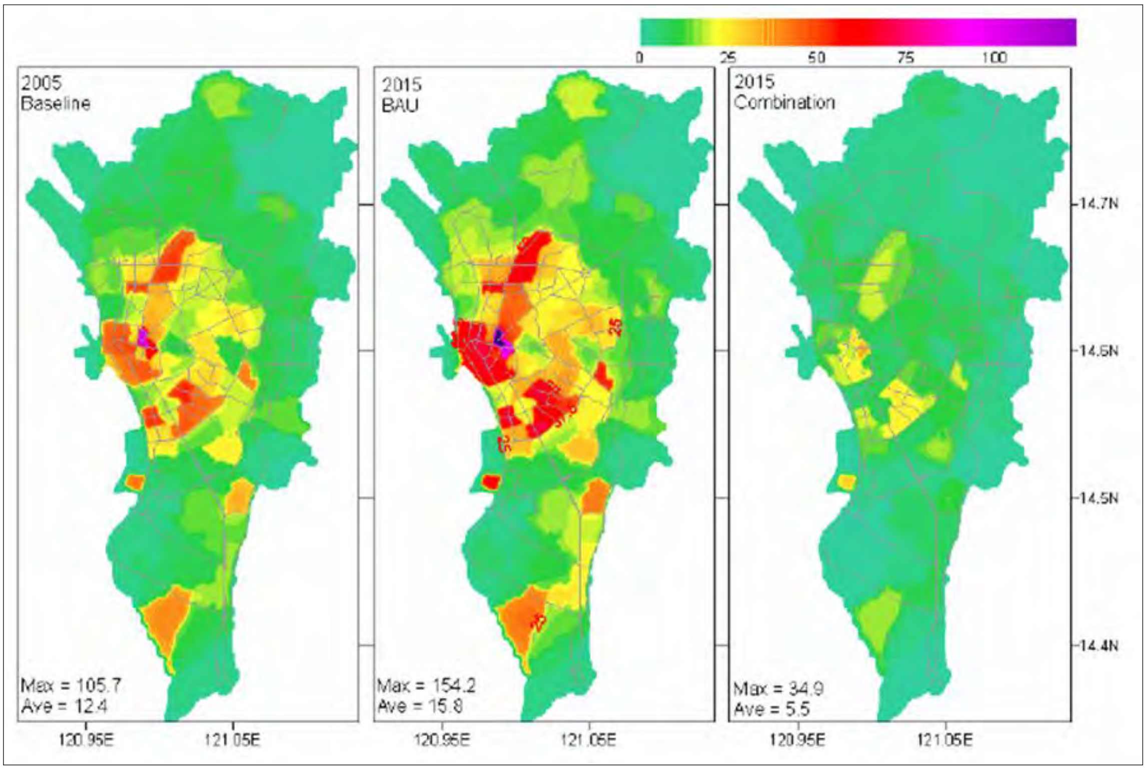
(vi) Introduction of Coco diesel for diesel-fuelled vehicles particularly jeepneys (CME);

(vii) Two-stroke tricycles switching to four-stroke engines;

(viii) Improvement of vehicles by the use of Diesel Traps;

2.15 Traffic in 98 zones in the study area was projected for 2005, 2010 and 2015 in consideration of the period of implementation of policies mentioned above. The total emission from vehicular traffic during these periods was estimated using emission factors assumed from the business-as-usual scenario (BAU). Air quality simulations using isopleth maps show a BAU (worst-case) scenario having a PM range of above 125 ug/NcM in the main business center in the metropolis when no policies would be implemented to reduce air pollution. On the other hand, a 2015 best-case scenario where all policies are assumed to be implemented shows that the level of pollution in Metro Manila would be better than that of the 2005 baseline (see Figure 2.1.4). All exceedances might be able to disappear. While this modeling conducted by the Manila Observatory is not correlated with the traffic demand projection under the JICA study, it is obvious that the adaptation of several strategic policies can result in a dramatic improvement in Metro Manila's air quality.

2.16 As far as the present level of air pollution is concerned, government should establish a present baseline in relation to policies already in place. The exercise would confirm and assess the traffic forecast and emission factors used and work to formulate sustainable air quality control action plan for the next generation. The policies already taking place are actually related to the climate change mitigation policies, and are further elaborated in Section 2.2 on Climate Change Mitigation.




Source: Manila Observatory, et al (2005) "Integrated Environmental Strategies Philippines Project Report Metropolitan Manila Focus on the Transport Sector"

**Figure 2.1.4 Calculated Particulate Concentrations in µg/NcM for the 2005 Baseline (left), 2015 Business-as-Usual (middle), and 2015 Combination of Policies (right)**

### 4) Health Impact of Air Quality

2.17 Particulate matter (PM) is a complex mixture of solid and liquid particles of organic and inorganic substances with major components such as sulphates, nitrates, ammonia, sodium chloride, carbon, mineral dust and water (WHO Fact Sheet, 2011). It is identified according to their aerodynamic diameter as either PM10 (particles with an aerodynamic diameter smaller than 10 µg) or PM2.5 (aerodynamic diameter smaller than 2.5 µg). PM2.5 may prove to be more harmful since, if inhaled, it may reach the peripheral regions of the bronchioles, and interfere with gas exchange inside the lungs.

2.18 There has been a significant rise in incidence of respiratory diseases in the Philippines, yet the epidemiological analysis is limited. Table 2.1.8 presents a record of annual (2003) cases of disease by age group associated with outdoor air pollution[1]. This indicates that the youngest members of society bear the heaviest burden of lower respiratory infections due to outdoor air pollution. Poor air quality hits the potentially productive members of society during their formative stage and may affect the productivity of the future labor force in the Philippines. It should, however, be noted that these estimates do not include cardiovascular disease, chronic bronchitis, and other diseases that predominantly affect the adult population. The calculations show that the number of people who became ill due to exposure to PM totaled more than 1 million in 2003.

[1] Due to data limitations, hospital admissions for respiratory disease only include acute lower respiratory infection (ALRI, including pneumonia) and acute bronchitis, while respiratory symptoms only include ALRI (non-hospitalized cases). Technically, acute bronchitis is included in ALRI. The data from the Department of Health, however, list ALRI and acute bronchitis separately. Under this study, it is consistent in distinguishing between the two.

**Table 2.1.8 Incidence of Outdoor Air Pollution (OAP)-Related Illnesses by Age Group, 2003**

| Age | Acute Lower Respiratory Infection (ALRI ) (including Pneumonia)* | Acute Bronchitis** |
|---|---|---|
| 0 to 4 | 274,112 | 427,711 |
| 5 to 14 | 60,766 | 195,812 |
| 15 to 19 | 8,464 | 10 |
| 20 to 29 | 13,875 | 16 |
| 30 to 64 | 40,374 | 41 |
| 65 and older | 16,844 | 12 |
| Total | 414,437 | 623,602 |

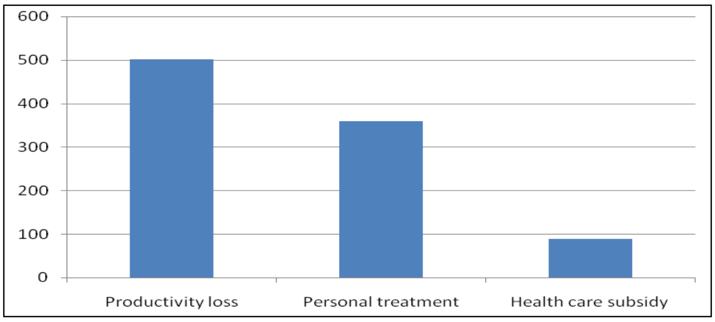
Source: Arcenas, Agustin B. 2009. Environmental Health: Economic Costs of Environmental Damage and Suggested Priority Interventions: A Contribution to the Philippines Country Environmental Analysis. Manila: World Bank.
* Hospitalized and non-hospitalized cases.
** Cases in age group 15+ years are hospitalized cases only.

2.19 OAP-related morbidity in 2003 cost the national economy PHP950 million (in 2007 prices, about USD21 million) (see Table 2.1.9). A closer look at the components of morbidity costs (see Figure 2.1.5) reveals that productivity loss (i.e., income and time loss due to absence from work and household activities) is the largest category (PHP502 million or USD11 million), followed by personal costs for treatment of disease (PHP360 million or USD8 million). Only a minor part of the cost is covered by a governmental subsidy (PHP88 million or USD2 million). Hence, from a fiscal perspective, the savings from lower OAP-related morbidity would be limited but there would be additional tax revenue from higher income. From the economic and social perspectives, urgent intervention such as improving traffic management is required in order to limit PM emissions.

**Table 2.1.9 Annual Cost of Morbidity from Outdoor Air Pollution (2007 prices)**

| Morbidity Source | Annual Cases from OAP | Average Cost per Case (PHP) | Total Annual Cost (PHP million) |
|---|---|---|---|
| Acute bronchitis (children < 15 years) | 623,523 | 486 | 303 |
| Hospital admissions for respiratory disease | | | |
| *Acute bronchitis (15+ years)* | 79 | 11,018 | 0.9 |
| *Other acute lower respiratory infections (all ages)* | 22,179 | 13,427 | 298 |
| Respiratory symptoms (all ages)* | 392,258 | 890 | 349 |
| Total morbidity cost | | 916 | 950 |

Source: World Bank "The Philippines: Country Environmental Analysis" October 2009, based on Arcenas 2009 for year 2003, with costs adjusted to 2007 prices.
* Non-hospitalized cases of acute lower respiratory infections other than acute bronchitis.




Source: Re-calculated from Arcenas 2009.

**Figure 2.1.5 Components of Morbidity Costs (PHP million, 2007 prices)**

## 2.2 Climate Change Mitigation

### 1) Climate Change Policies in the Philippines and its Obligations

2.20 In response to future projection of climate change, which has essentially become a global crisis, the government has enacted the Climate Change Act (Republic Act 9729) that provides the policy framework with which to systematically address the growing threats on community life and its impact on the environment. The Climate Change Commission (CCC) is the lead policy making government body. Recently, the National Framework Strategy on Climate Change and the Philippine Strategy on Climate Change Adaptation (both in 2010), and the National Climate Change Action Plan (2011–2028) were formulated as the bases of policies on climate change.

2.21 Climate change mitigation policies, compared to adaptation policies, in the Philippines are still regarded as passive. The measurable, reportable and verifiable (MRV) GHG mitigation actions and commitments are not yet actively discussed. According to the CCC, the many concerned line departments are in the stage of capacity building on how to bridge the data gaps in reporting GHG emissions comprehensively. Through Nationally Appropriate Mitigation Actions (NAMAs) the Philippines, like many developing countries, can also demonstrate and receive international recognition for their mitigation actions. The Philippines is still preparing the roadmap for the NAMAs but not yet according to the national preferences and priorities, specifically purse projects.

2.22 Meanwhile, the Conference of the Parties (COP), at its 17th Session, decided that non-Annex I Parties, consistent with their capabilities and the level of support provided for reporting, should submit their first biennial update reports (BURs) by December 2014. Therefore, the Philippines needs to prepare the BUR which should cover the following information related to NAMAs and their effects:

(i) Name and description of the mitigation action;
(ii) Information on methodologies and assumptions;
(iii) Objectives of the action and steps taken or envisaged to achieve that action;
(iv) Information on the progress of implementation;
(v) Information on international market mechanisms; and
(vi) A description of domestic measurement, reporting and verification arrangements.

2.23 The proposed programs under the Roadmap will certainly contribute to the specific mitigation actions required for the BURs.

### 2) Growth in Energy Use

2.24 Growth in energy use and the associated GHG have accompanied economic expansion. About 56 % of the Philippines energy demand is met by indigenous resources including coal, natural gas, hydropower and traditional biomass energy. Starting in 2002, there has been increasing use of natural gas for power generation with the commercial operation of the Malampaya gas fields. Under the whole energy balance of the Philippines, as shown in Table 2.2.1, the share of the transport sector of the total energy consumption in 2007 was 42.8%, followed by residential sector at 25.9%, and manufacturing sector at 21.0%. Energy efficiency, especially in the road transport sector, implies substantial reduction of energy consumption in the country.

**Table 2.2.1 Energy Consumption by Sector (2007)**

| Sector | kTOE | % |
|---|---|---|
| Industry | 5,232.7 | 21.5 |
| Manufacturing | 5,103.6 | 20.9 |
| - Energy Intensive Sector | 3,938.6 | 16.2 |
| - Other Manufacturing | 1,165.0 | 4.7 |
| Mining | 42.4 | 0.2 |
| Construction | 86.7 | 0.4 |
| Transport | 10,406.2 | 42.8 |
| - Railway | 9.2 | 0.1 |
| - Road Transport | 7,767.5 | 31.9 |
| - Water Transport | 1,501.1 | 6.2 |
| - Domestic Air Transport | 46.4 | 0.2 |
| - International Civil Aviation | 1,082.0 | 4.4 |
| Residential | 6,293.2 | 25.9 |
| Commercial | 1,991.9 | 8.2 |
| Agriculture | 134.2 | 0.6 |
| Others, Non-Energy Use | 277.4 | 1.1 |
| Net Domestic Consumption | 24,335.6 | 100 |

Source: JICA "Capability Enhancement on Energy Policy and Planning for a More Effective and Comprehensive Philippine Energy Plan (PEP) Formulation," 2008
KTOE: thousand tons of oil equivalents

2.25 Total crude oil imported in 2012 reached 64,941 MB, a drop of 6.7% vis-à-vis 2011's 69,615 MB. In 2012, total oil import bill amounting to USD13,861.2 million was up by 7.9% from 2011's USD12,846.2 million despite the decrease in crude import volume. This is due to high import costs of both crude and finished products during the period as compared to the year-ago level. The transport sector accounts for approximately 66% of total oil consumption in the country. The cost of fuel imports is expected to rise further as the population continues to grow rapidly and urbanization increases.

2.26 Currently, the Department of Energy (DOE) has been working on introducing more CNG and LPG to transport fuels, as well as biofuels. After the Biofuels Act of 2006 was enacted, there were substantial private sector investments in generating biofuels mainly from sugarcane and cassava-base ethanol and coconut methyl ester (CME) for biodiesel. The Biofuels Act mandates that gasoline be blended with 10% ethanol (E10) and 5% biodiesel blend (B5) by 2011. However, due to the fact that the locally produced ethanol made from sugar cane and cassava are more expensive than imported ones mainly from Brazil, first generation biofuels are no longer contributing to fuel security. On the other hand, there are ample CME for biodiesel. The CME blended biodiesel has been utilized for diesel power generation in the region.

2.27 Since more than 56% of all registered vehicles in 2008 were located in Metro Manila and its adjacent regions, which comprises the expanded Greater Capital Region including Central Luzon and CALABARZON regions, strategies targeting vehicles in these regions are expected with high returns on investment. The current estimate of the country's on-road fuel economy is 14 liters/100 km, way below China's rate of 9.5 liters/100 km[2]. It is likely that urban traffic congestion was a major factor for the low values compared to other Asian countries.

2 World Bank (2010) "A Strategic Approach to Climate Change in the Philippines – An Assessment of Low-Carbon Interventions in the Transport and Power Sectors."

## 3) GHG Emissions

### (1) National GHG Inventory

2.28 Under the National Framework Strategy on Climate Change (NFSCC) 2010–2022, low-carbon paths in the transport sector is regarded as a high strategic priority. The transport sector's contribution to GHG emission has increased significantly both in absolute and relative terms since 1990 (see Table 2.2.2). Based on the current motorization growth of about 6%, emission contributions from road transport is projected to increase to 37 and 87 $MtCO_2e$ by 2015 and 2030 respectively, under a business as usual (BAU) scenario. The NFSCC addresses the environmentally sustainable transportation, promotes models to improve the transport sector's efficiency and modal shifts as compressed natural gas (CNG) and liquefied petroleum gas (LPG) becomes the primary fuel of the public transport, and supports the expansion to more efficient mass transport systems such as the metro rail transit (MRT), light rail transit (LRT), and bus rapid transit (BRT).

**Table 2.2.2 Philippine GHG Emissions in 1990, 2000 and 2004 by Sector,**

| Sector | 1990 | | 2000 | | 2004 | | % Change | |
|---|---|---|---|---|---|---|---|---|
| | $MtCO_2$ | % | $MtCO_2$ | % | $MtCO_2$ | % | 1990–2000 | 2000–2004 |
| Land Use Change & Forestry* | 79.4 | 66.9 | 94.9 | 55.9 | N/A | N/A | 20% | N/A |
| Energy | 36 | 30.4 | 68.9 | 40.6 | 72.6 | 91.8 | 91% | 5.37% |
| Electricity & Heat | 14.2 | 11.9 | 26.8 | 15.8 | 28.9 | 36.5 | 89% | 7.84% |
| Manufacturing & Construction | 8.3 | 7 | 9.2 | 5.4 | 11.2 | 14.1 | 11% | 21.74% |
| Transportation | 6.2 | 5.2 | 23.5 | 13.9 | 25.4 | 32.1 | 279% | 8.09% |
| Other Fuel Combustion | 7.4 | 6.2 | 9.4 | 5.5 | 6.8 | 8.6 | 27% | -27.66% |
| Industrial Processes | 3.2 | 2.7 | 6 | 3.5 | 6.5 | 8.2 | 88% | 8.33% |
| Total Energy | 39.2 | | 74.9 | | 79.1 | | 91% | 5.61% |
| Total | 118.6 | | 169.8 | | 79.1 | | 43% | N/A |

Source: A Strategic Approach to Climate Change in the Philippines Final Report, World Bank April 2010, originally from Climate Analysis Indicators Tool (CAIT) Version 6.0. (Washington, DC: World Resources Institute, 2009).
* Land Use Change and Forestry data available every 10 years only. No data for 2004

2.29 The National GHG Inventory shown in Table 2.2.3 elaborates that the GHG emissions from the transport sector are significantly larger, approximately over 30% when land use change is not counted. As the large part of GHG emission from the transport sector originates from Metro Manila and adjacent regions, it is important to address the climate change mitigation impact of the Roadmap presented in this Study.

### (2) GHG Inventory of Metro Manila

2.30 Metro Manila is the 20th largest megacity in the world in terms of population but its GHG emission level is limited, as shown in Table 2.2.4. Its GHG emission per person is almost the same level as Tokyo's while those of other large industrial cities are much higher, such as Jakarta (60% more) and Bangkok (5.4 times more). Metro Manila is seen as a minor emitter in terms of GHG emission.

### Table 2.2.3 Population, GDP, and GHG Emissions for 50 Largest Cities and Urban Areas in the World (excerpt)

| No, | Urban Area Population | Country | Population (Millions) | GDP (USD bn) | Total GHG ($MtCO_{2e}$) | Total GHG ($tCO_{2e}$/cap) | GHG per GDP ($ktCO_{2e}$/USD bn) |
|---|---|---|---|---|---|---|---|
| 1 | Tokyo | Japan | 35.53 | 1191 | 174 | 4.9 | 146 |
| 2 | Mexico City | Mexico | 19.24 | 315 | 55 | 2.8 | 173 |
| 3 | Mumbai | India | 18.84 | 126 | *25(est)* | *1.3(est)* | 198 |
| 4 | New York | USA | 18.65 | 1133 | 196 | 10.5 | 173 |
| 5 | São Paulo | Brazil | 18.61 | 225 | 26 | 1.4 | 116 |
| 6 | Delhi | India | 16 | 93 | 24 | 1.5 | 258 |
| 7 | Calcutta | India | 14.57 | 94 | 16 | 1.1 | 171 |
| 8 | Jakarta | Indonesia | 13.67 | 98 | *24(est)* | *1.8(est)* | 245 |
| 9 | Buenos Aires | Argentina | 13.52 | 245 | 52 | 3.8 | 211 |
| 10 | Dhaka | Bangladesh | 13.09 | 52 | 8 | 0.6 | 159 |
| 11 | Shanghai | China | 12.63 | 139 | 148 | 11.7 | 1063 |
| 12 | Los Angeles | USA | 12.22 | 639 | 159 | 13 | 249 |
| 18 | Beijing | China | 10.85 | 99 | 110 | 10.1 | 1107 |
| 19 | Moscow | Russia | 10.82 | 181 | *167(est)* | *15.4(est)* | 922 |
| **20** | **Metro Manila** | **Philippines** | **10.8** | **108** | ***16(est)*** | ***1.5(est)*** | **147** |
| 21 | Istanbul | Turkey | 10 | 133 | *51(est)* | *5.1(est)* | 384 |
| 22 | Paris | France | 9.89 | 460 | 51 | 5.2 | 112 |
| 23 | Seoul | South Korea | 9.52 | 218 | 39 | 4.1 | 179 |
| 33 | Bangkok | Thailand | 6.65 | 89 | 71 | 10.7 | 799 |
| 49 | Ho Chi Minh City | Vietnam | 5.1 | 38 | *6(est)* | *1.2(est)* | 158 |
| 50 | Chongqing | China | 5.06 | 35 | 19 | 3.7 | 535 |

Source: World Bank, Cities and Climate Change: An Urgent Agenda, 2010
Notes: The 2006 population figures are based on censuses carried out between 2000 and 2005 and adjusted to take account of average annual population changes. Available: www.citymayors.com.
GDP figures are for cities and their surrounding urban areas for the year 2005 based on research conducted by Price Waterhouse Coopers. Available: www.citymayors.com.
GHG per capita values are from the "City GHG Emissions per Capita" table (available: www.worldbank.org/urban). GHG per capita values presented in italics (est) are national values, as city values are unavailable.
The corresponding GHG emissions should be considered GHG indications, not specific city values.

2.31 The top-down Metro Manila GHG inventory was calculated under the Climate Change and Clean Energy Project (CEnergy) funded by USAID with collaboration with DENR, Manila Observatory and the SEED Institute. The inventory used 2010 as the baseline year. The Energy sector was the primary source of emissions representing 89.27% of the overall emissions. The contributions of the industrial, agriculture and land use sectors to Metro Manila GHG emissions are insignificant that these were not included.

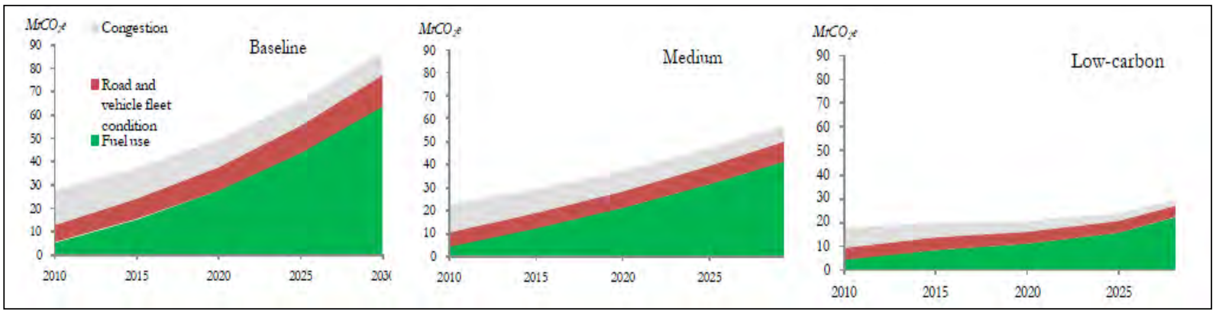
### Table 2.2.4 Combined Energy and Waste Sectors GHG Emissions for Metro Manila

Thousand ton $CO_2$eq ($CO_2$ Equivalent)

| Category | | % | $CO_2$ | $CH_4$ | $N_2O$ | Total |
|---|---|---|---|---|---|---|
| Energy | Mobile source | 38.72 | 7,981.12 | 39.57 | 121.6 | 8,142.30 |
| | Road | | 7,925.32 | 39.57 | 121.68 | 8,086.17 |
| | Railways* | | 55.8 | 0.003 | 0.32 | 56.13 |
| | Stationary source | 61.28 | 12,855.61 | 18.45 | 9.6 | 12,883.67 |
| | Residential /Commercial | | 8,475.28 | 15.41 | 2.77 | 8,493.46 |
| | Industrial | | 4,380.33 | 3.04 | 6.83 | 4,390.21 |
| Total Energy emissions | | | 20,836.73 | 58.03 | 131.21 | 21,025.97 |
| Waste | | | | 2,292.67 | 203.1 | 2,495.89 |
| Gross Emissions | | | 20,866.94 | 2,351.44 | 334.24 | 23,552.63 |

Source: USAID (2010) Annex 2 Climate Change and Clean Energy Project, Metro Manila Greenhouse Gas Inventory
Note: *Breakdown of the Railways are Direct, diesel emission by PNR, indirect: 2.99, electricity consumption by LRT, 53.14

2.32 Recent analytical work by the Asian Development Bank (ADB) and World Bank provided preliminary GHG abatement cost profile for the Philippines. Under a Business As Usual (BAU) scenario (dependence on petroleum for transport), emission from transport will increase from 29 to over 68 $MTCO_2e$/y or about 133% increase. The Study shows that GHG emission under the low carbon scenario would be 62% less compared with the BAU level in 2030 (see Figure 2.2.1). The cost-effective analysis indicates that a package of measures that promote biofuels, low cost vehicle efficiency improvements and transport demand management, including BRT development, urban rail expansion would promote the shift to lower-emitting transport modes. According to the specific abatement costs of respective measures, the highly priority interventions from transport sector are (i) public mass transport system and traffic demand management, (ii) advanced vehicle technology and fuel switching; and (iii) establishment and enforcement of vehicle inspection and emission testing standards. These interventions rely on close coordination among relevant government agencies and active participation of the private sector.




Source: A Strategic Approach to Climate Change in the Philippines Final Report, World Bank April 2010, originally from Climate Analysis Indicators Tool (CAIT) Version 6.0. (Washington, DC: World Resources Institute, 2009).

**Figure 2.2.1 Projected GHG Emission from the Transport Sector, 2010–2030**

2.33 What is the status of countermeasures against pollution caused by transport sector? Many of the measures to help reduce pollution and GHG in the transport sector are already being implemented one way or another in the Philippines. These include switching to biofuel and low carbon fuel like biodiesel, bioethanol, Compression Natural Gas (CNG) and LPG; development of mass rapid transit systems like railway and the planned BRT; measurers to regulate traffic and traffic flow such as dedicated bus lanes, plate number ban (number coding); improvement in vehicle fuel efficiency through technological and behavioral changes such as electric, high (fuel) efficient and, recently, hybrid vehicles (see Table 2.2.5).

2.34 However, there is very little, if any, progress in implementing other measures such as park-and-ride system, road/area pricing, intelligent traffic signals (still being planned), freight mode switch, green management certification, eco-drive, idling stop, fuel cell vehicles, etc. Above all, these policy approaches can be climate mitigation actions to be MRV. Yet, besides the E-trike project to be financed by ADB3 and the LRT projects to be financed by JICA, none of these have quantified their impacts. The following policy approaches are potential measure to reduce air pollution and GHG. Once these can be carefully assessed, they can be potentially reported to the biennial update reports (BURs).

[3] According to the DOE" The E-Trike Project, Market Transformation through Introduction of Energy-Efficient Electric Tricycles", the emission reduction volume of $CO_2$ will be 1,231,655 tons nationally.

### Table 2.2.5 Status in the Philippines of Major Measures or Technologies to Potentially Reduce Pollution and GHG in the Transport Sector

| Categories | | Measures / Technologies | Status in Philippines (Yes/No) |
|---|---|---|---|
| Mass Rapid Transit System | | Railway | Implemented |
| | | BRT | Planned |
| Measures on Traffic Amount/Traffic Flow | | Park & Ride | Planned under the DOE |
| | | Public Transportation Priority System | Y (Bus lane) |
| | | Car Pooling Program | Planned under the DOE |
| | | Road/Area pricing | Y? |
| | | Plate number ban | Y |
| | | Intelligent traffic signals | Planned |
| Measures on Freight | | Freight mode switch | ? |
| | | Logistics freight complex | ? |
| | | Green management certification | ? |
| Improve Fuel Efficiency per vehicle | Vehicle Technologies | Hybrid vehicle | Y (Just started) |
| | | Electric vehicle | Y (Etrike, Ejeepney,) |
| | | Fuel cell vehicle | N ? |
| | | High (fuel) efficiency vehicle | Y ? |
| | | Eco-drive system | Y? |
| | | Idling stop device | N? |
| | Behavioural changes, Improvement of Maintenances | Eco-drive | Y? |
| | | Idling stop | N? |
| | | Vehicle Inspection/ Maintenance Program | Y? |
| Fuel Switching | Biofuel | Biodiesel | Y |
| | | Bioethanol | Y |
| | Low carbon fuel | CNG | Y |
| | | LPG | Y |

Source: DOTC, DOE and the JICA Study Team

## 2.3 Contribution to Emission Reduction of GHG and Air Pollutants under the Roadmap

### 1) Methodology

2.35 The impacts of the overall transport roadmap programs on air quality improvement and climate change mitigation are estimated through the following methodology. There are two approaches for estimating vehicle emission, namely top-down and bottom-up approaches. The top-down approach is a method based on fuel consumption in a target city or region, while the bottom-up approach is a method based on cumulating all the vehicle emission in a target city or region.

2.36 When a program targets specific vehicles such as a fuel switch project, fuel consumption by the vehicle can be identified. Fuel consumption data will be collected as a reliable data. In this case, the top-down approach should be applied.

2.37 When a program includes a set of traffic flow improvement projects in a city or a region, the bottom-up approach should be applied. Since it is rather difficult to identify every vehicle movement in and out a city or a region and fuel consumption data in a city or region will involve uncertainty, the bottom-up approach should be more appropriate to estimate vehicle emissions. Table 2.3.1 shows a summary of both approaches.

**Table 2.3.1 Summary of Top-Down Approach and Bottom-Up Approach**

| | Top-down Approach | Bottom-up Approach |
|---|---|---|
| Method | Estimations with fuel consumption, emission factor by fuel type, etc. | Estimations with emission factor by vehicle type by vehicle speed, traffic volume by link, link length, etc. |
| Applicable projects | Fuel switch project of each vehicle type, etc. | Traffic flow improvement project, etc. |
| Equation (example) | $E_{fuel} = FC_{fuel} \times NCV_{fuel} \times EF_{fuel}$<br>*Where:*<br>*$E_{fuel}$: Emissions by fuel type (tC),*<br>*$FC_{fuel}$: Fuel consumption by fuel type (litre),*<br>*$NCV_{fuel}$: Net calorific value by fuel type (MJ/litre),*<br>*$EF_{fuel}$: Emission factor by fuel type (tC/TJ).* | $E = \sum_k \sum_i (D_k \times T_{k,i} \times EF_{k,i} \times Days)$<br>*Where:*<br>*k: Link number, $D_k$: Link length (km),*<br>*$T_{k,i}$: Traffic volume by vehicle type by link (vehicles/day),*<br>*$EF_{k,i}$: Emission factor by vehicle type by vehicle speed (g/km), and*<br>*Days: the Number of days in year (days).* |

Source: JICA Study Team.

### 2) Emission Reduction of the GHG and Air Pollutants for the Roadmap

#### (1) Methodology

2.38 This study covers a whole transport sector in Mega Manila. In order to evaluate the projects under the roadmap, the bottom-up approach is the appropriate approach. The bottom-up approach of this study is depicted in Figure 2.3.1. The key steps are summarized below.

(i) Traffic demand analysis outputs, vehicle speed and volume by vehicle type by link based on this JICA study;

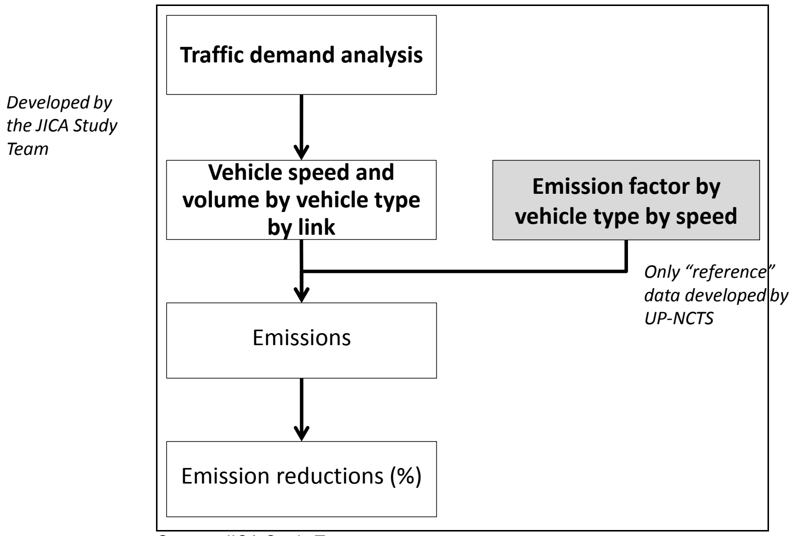
(ii) Emission factor by vehicle type by vehicle speed class in Metro Manila developed under the interpolation using the pattern of JICA-MLIT-Suuri (2011) with the ADB VECP (Report on Vehicular Emission Control Planning in Metro Manila) 1992 emission factor assumed to be at 20 kph;

(iii) Calculation of emissions by vehicle type by link with both outputs of traffic demand analysis and emission factor; and

(iv) Calculation of emission reduction ratio compared with and without project case.

2.39 It can be seen that for emission factors of PM, SOx and NOx, some of the emission factor values become negative at speeds greater than 20 kph. It is proposed that it would follow the emission factor at speed when the EF is still positive. For

nt at 0.1




Source: JICA Study Team.

**Figure 2.3.1 Bottom-up Approach Methodology**

2.40 The equation of emissions is as follows.

$$E = \sum_{k} \sum_{i} \left( D_k \times T_{k,i} \times EF_{k,i} \times Days \right)$$

*Where: k: Link number, $D_k$: Link length (km),*
*$T_{k,i}$: Traffic volume by vehicle type by link (vehicles/day),*
*$EF_{k,i}$: Emission factor by vehicle type by vehicle speed (g/km), and*
*Days: Number of days in year (days).*

2.41 Vehicle emission factor is developed by chassis dynamometer test with real driving conditions based on a driving cycle on both air pollutants (NOx, PM, CO, etc.) and $CO_2$. Air pollutants and $CO_2$ derived from vehicle emissions can be quantitatively evaluated by vehicle emission factors. The driving cycle reflects the real driving conditions of a target city. On the other hand, vehicle emission factor reflects a specific vehicle emission of the city.

2.42 The Philippines introduced the chassis dynamometer testing facility at the UP Vehicle Research and Testing Laboratory (UP-VRTL) in 2008. However, original emission factors developed in 1992 under the ADB study have not been revised yet due to the fact that the facility adapts to Low Duty Vehicle (LDV) only. Jeepneys and buses, which are the main emission sources in Metro Manila, cannot be tested due to the size of the vehicles. The facility required about PHP120 million as an initial cost and 10 to 15% of the initial cost as operating and maintenance cost. Much money will be required to replace the facility.

2.43 In Metro Manila, there are three emission factors used, namely ADB 1992, JICA 1996, and Ministry of Land, Infrastructure, Transportation and Tourism Japan (MLIT) 2011. However, the MLIT study emission factor was not technically reliable due to very limited number of vehicles tested. The estimate for the Philippine emission factors is based on the interpolation using the pattern of JICA-MLIT-Suuri (2011) with the ADB VECP 1992 emission factor assumed to be at 20 kph.

2.44 As shown in Table 2.3.2, emission reduction is determined by traffic volume and emission factor. Under the roadmap study, the ratio of reduction of emission was preliminary calculated for 2016 and 2030 using the same emission factors. The emission factors 1992 utilized for Metro Manila were not differentiated by speed as shown in the Table 2.3.3 and in the same manner, the emission factors 2001 (see Table 2.3.4) could differentiate only three classes of speed. Fuel consumption for vehicles and NOx emission factor were developed for two types of cars by the study supported by MLIT, but the scope is limited (see Table 2.3.5). The Study team, therefore, decided to utilize the “Reference Emission Factors” developed by the UP-NCTS shown in Table 2.3.6. This set of emission factors has sufficient speed classes, which can more accurately calculate the impact of traffic volume reduction. However, these emission factors also have limitations as they were not based on a reliable chassis dynamometer test. These are, therefore, recognized only as a reference. Technical explanations on emission factors are elaborated in Box 2.2.1.

**Table 2.3.2 Vehicle Emission Factors in Metro Manila**

| Project | Donor | Year | Explanation |
|---|---|---|---|
| VECP Project | ADB | 1992 | Emission factors were developed for 6 vehicle types and 6 air pollutant gases. Vehicle speed and vehicle age were not considered and fuel consumption was not included. The first emission factor in Metro Manila was developed with a chassis dynamometer which was set up at the Motor Vehicle Testing Office at the forest park of Quezon City. |
| MMUTIS | JICA | 1999 | JICA revised ADB emission factors in the MMUTIS study. The factors were by vehicle type, by fuel type, and by running speed excluding vehicle age. Running speed was classified in 3 classes: less than 10kph, 10 to 20kph, and greater than 20kph. |
| SUURI | MLIT Japan | 2011 | One PC (model year: 2004) and one bus (model year: 2009) are monitored by on-board measurement system. Running speed is classified in 7 speed classes. Target is limited to NOx which is bus only, fuel consumption of both vehicle types. Though test vehicles were very limited, new vehicles were tested in Metro Manila. |

Source: JICA Study Team.

**Table 2.3.3 Vehicle Emission Factors in Metro Manila (1992)**

| Vehicle Type | g/km | | | | | |
|---|---|---|---|---|---|---|
| | CO | HC | $NO_x$ | $SO_x$ | Pb | PM |
| Gasoline | | | | | | |
| Cars | 49.5 | 6.00 | 2.7 | 0.011 | 0.073 | 0.10 |
| UV | 60.0 | 8.00 | 3.0 | 0.014 | 0.092 | 0.12 |
| MC | 26.0 | 18.60 | 0.2 | 0.004 | 0.028 | 2.00 |
| Diesel | | | | | | |
| Taxi | 1.9 | 0.65 | 2.0 | 0.081 | 0.000 | 0.60 |
| Jeepney | 2.5 | 0.70 | 1.4 | 0.121 | 0.000 | 0.90 |
| UV | 2.5 | 0.70 | 1.4 | 0.115 | 0.000 | 0.90 |
| Bus/Truck | 12.4 | 3.70 | 12.5 | 0.374 | 0.000 | 1.50 |

Source: VECP 1992.
HC: hydrocarbon.

**Table 2.3.4 Vehicle Emission Factors in Metro Manila (2001)**

| | Vehicle Type | V=0 (g/sec) | V<10 kph (g/km) | V=10-20 kph (g/km) | V>20 kph (g/km) |
|---|---|---|---|---|---|
| $CO_2$ | Car | 350 | 200 | 80 | 60 |
| | Truck | 450 | 280 | 120 | 95 |
| | Jeepney | 400 | 230 | 100 | 80 |
| | Bus | 450 | 280 | 120 | 95 |
| CO | Car | 0.0858 | 27.57 | 23.5 | 18.7 |
| | Truck | 0.0781 | 47.58 | 52.2 | 41.14 |
| | Jeepney | 0.0124 | 8.02 | 6.8 | 6.2 |
| | Bus | 0.0214 | 8.12 | 7.11 | 6.5 |
| $NO_x$ | Car | 1.51 | 2.75 | 2.76 | 2.78 |
| | Truck | 1.55 | 4.7 | 3.59 | 3.53 |
| | Jeepney | 9.35 | 8.95 | 7.66 | 7.01 |
| | Bus | 12.6 | 11.24 | 10.59 | 9.22 |
| $SO_x$ | Car | 0.018 | 0.013 | 0.011 | 0.011 |
| | Truck | 1.511 | 4.7 | 3.59 | 3.53 |
| | Jeepney | 0.18 | 0.18 | 0.121 | 0.11 |
| | Bus | 0.22 | 0.2 | 0.15 | 0.1 |
| SPM | Car | 0.1 | 0.07 | 0.05 | 0.05 |
| | Truck | 0.1 | 0.07 | 0.06 | 0.05 |
| | Jeepney | 1.5 | 1.8 | 0.9 | 0.81 |
| | Bus | 1.5 | 2.3 | 1.5 | 0.8 |

Source: UP-NCTS.

**Table 2.3.5 Fuel Consumption for Vehicles and NOx Emission Factors in Metro Manila (2011)**

| Vehicle Type | Speed Classes / Speed of Representative (km/h) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 3 to 5<br>4 | 5 to 10<br>7.5 | 10 to 15<br>12.5 | 15 to 25<br>20 | 25 to 40<br>32.5 | 40 to 60<br>50 | 60 to 80<br>70 |
| Fuel consumption for Bus | 0.809 | 0.681 | 0.602 | 0.532 | 0.455 | 0.383 | 0.337 |
| Fuel consumption for Passenger car | 0.167 | 0.123 | 0.099 | 0.079 | 0.061 | 0.048 | 0.045 |
| $NO_x$ Emission factor for Bus | 22.7 | 16.2 | 12.9 | 10.7 | 8.8 | 7.3 | 6.5 |

Source: MLIT 2011.

**Table 2.3.6 Reference Emission Factors in Metro Manila**

| | Vehicle Type | Speed Classes / Speed of Representative (km/h) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 3 to 5<br>4 | 5 to 10<br>7.5 | 10 to 15<br>12.5 | 15 to 25<br>20 | 25 to 40<br>32.5 | 40 to 60<br>50 | 60 to 80<br>70 |
| $CO_2$ | Gas car | 447.6 | 363.7 | 327.5 | 306.3 | 292.0 | 282.5 | 277.3 |
| | Diesel utility vehicle/ jeepney | 643.7 | 544.6 | 501.8 | 476.7 | 459.9 | 448.7 | 442.5 |
| | Diesel truck/ bus | 1182.9 | 1083.9 | 1041.1 | 1016.0 | 999.1 | 987.9 | 981.7 |
| $NO_x$ | Gas car | 5.512 | 3.656 | 2.998 | 2.700 | 2.546 | 2.462 | 2.424 |
| | Diesel utility vehicle/ jeepney | 4.212 | 2.356 | 1.698 | 1.400 | 1.246 | 1.162 | 1.124 |
| | Diesel truck/ bus | 15.312 | 13.456 | 12.798 | 12.500 | 12.346 | 12.262 | 12.224 |
| PM | Gas car | 2.912 | 1.056 | 0.398 | 0.100 | 0.100 | 0.100 | 0.100 |
| | Diesel utility vehicle/ jeepney | 3.712 | 1.856 | 1.198 | 0.900 | 0.746 | 0.662 | 0.624 |
| | Diesel truck/ bus | 3.712 | 1.856 | 1.198 | 0.900 | 0.746 | 0.662 | 0.624 |
| CO | Gas car | 52.312 | 50.456 | 49.798 | 49.500 | 49.346 | 49.262 | 49.224 |
| | Diesel utility vehicle/ jeepney | 5.312 | 3.456 | 2.798 | 2.500 | 2.346 | 2.262 | 2.224 |
| | Diesel truck/ bus | 15.212 | 13.356 | 12.698 | 12.400 | 12.246 | 12.162 | 12.124 |
| $SO_x$ | Gas car | 2.823 | 0.967 | 0.309 | 0.011 | 0.011 | 0.011 | 0.011 |
| | Diesel utility vehicle/ jeepney | 2.933 | 1.077 | 0.419 | 0.121 | 0.121 | 0.121 | 0.121 |
| | Diesel truck/ bus | 3.186 | 1.330 | 0.672 | 0.374 | 0.220 | 0.136 | 0.098 |
| HC | Gas car | 8.812 | 6.956 | 6.298 | 6.000 | 5.846 | 5.762 | 5.724 |
| | Diesel utility vehicle/ jeepney | 3.512 | 1.656 | 0.998 | 0.700 | 0.546 | 0.462 | 0.424 |
| | Diesel truck/ bus | 6.512 | 4.656 | 3.998 | 3.700 | 3.546 | 3.462 | 3.424 |

Source: JICA Study team
Note: Dr. Karl N. Vergel of UP-NCTS updated existing Manila emission factors (1992, 1996) upon request of study team as a reference.

### (2) Outcomes of the Calculation

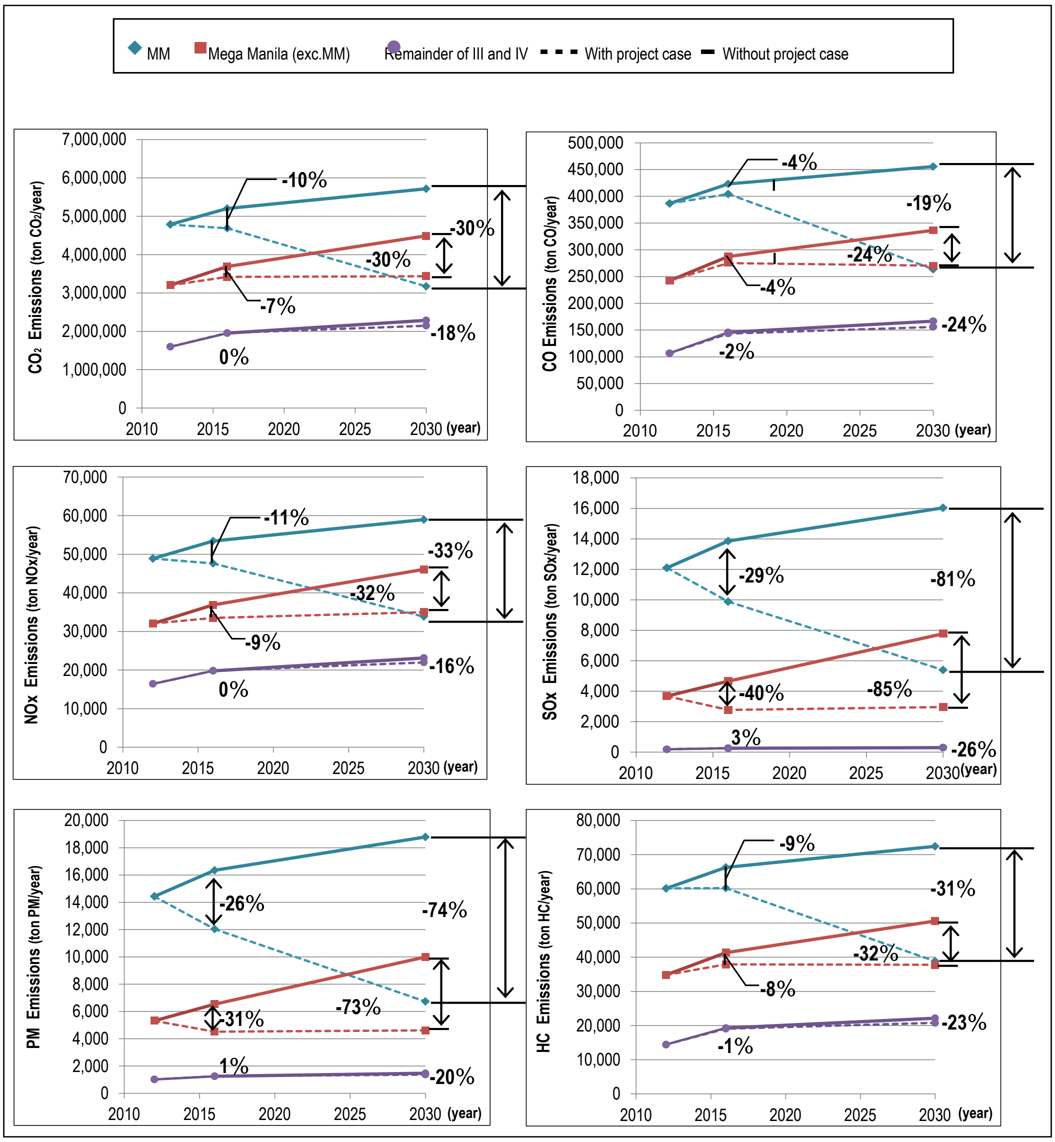
2.45 Vehicle emissions are estimated by both traffic assignment results and revised vehicle emission factors. The results for 2016 and 2030 are summarized in Figure 2.3.2 and Table 2.3.7.

2.46 The amount of emission reductions depends on vehicle emission factors. According to the traffic demand assignment, vehicle speed will increase due to less congestion expected after implementing a set of proposed projects. Since a slope of the emission factor in a low-speed area is steep, the emission reduction ratio will become relatively large. Meanwhile, a modal shift from road transport to rail transport will eventually be realized due to the development of new rail network. The number of both jeepneys and buses will decrease drastically under the "with project" case or the dream plan in 2030 as described in Appendix 4.

2.47 As shown in Figure 2.3.2 in the 2016 case, SOx and PM already show about -30% of emission reduction in comparison to the without-project scenario. Likewise, $CO_2$, NOx, and HC show about -8%. CO is the smallest reduction ratio. In the 2030 case, similar to 2016, SOx and PM show the largest reduction ratio which is about -80% of emission reduction in comparison to the without-project scenario; $CO_2$, NOx, and HC show about -30%, while CO is the smallest reduction ratio.

2.48 The status of air quality of Metro Manila given in Table 2.1.1 shows both PM pollution (Rank E) and NOx pollution (Rank D) are more serious than other neighboring cities. Specific countermeasures should be implemented in order to reduce these air pollutants. Future emissions of these pollutants in Metro Manila and the adjacent provinces of Bulacan, Rizal, Laguna and Cavite (BRLC) based on the traffic demand assignment of this study are summarized in Table 2.3.7. The base year is 2012 and the target year for the long term program is 2030. With regard to "without project" case of 2030, PM emissions will increase 30% and both GHG and NOx will increase approximately 20% compared to the emission of the base year in Metro Manila. In BRLC, PM emissions will increase 88% and both GHG and NOx will increase by about 40% for the same period.

2.49 On the other hand, under the "with project" case or the dream plan, PM emissions will decrease 66% and both GHG and NOx will decrease approximately 20% compared to 2012 in Metro Manila. Similarly, PM emissions will decrease 48% and GHG and NOx will decrease by about 2% in BRLC for the same period. The proposed investment program will significantly improve the status of air pollution in the study area as well as contributed to decreasing GHG emission.




Source: JICA Study Team.

**Figure 2.3.2 Result of Emission Reductions Based on Traffic Demand Assignment**

**Table 2.3.7 Summary of Result of Emission Reductions Based on Traffic Demand Assignment**

| Indicator | | | 2012 | 2030 (without project case) | Change (%) | 2030 (with project case) | Change (%) |
|---|---|---|---|---|---|---|---|
| Transport cost (PHP bil./day) | Metro Manila | | 2.4 | 4.7 | 96 | 1.38 | -43 |
| | BRLC | | 1.0 | 2.4 | 140 | 0.84 | -16 |
| Air quality (mil. Tons/year) | Metro Manila | GHG | 4.79 | 5.72 | 19 | 3.99 | -17 |
| | | PM | 0.014 | 0.019 | 30 | 0.005 | -66 |
| | | NOx | 0.049 | 0.059 | 20 | 0.040 | -18 |
| | BRLC | GHG | 3.20 | 4.49 | 40 | 3.15 | -2 |
| | | PM | 0.005 | 0.010 | 88 | 0.003 | -48 |
| | | NOx | 0.032 | 0.046 | 44 | 0.031 | -3 |

Source: JICA Study Team.

### (3) Comparison between Top-Down and Bottom-Up

2.50 The comparison of $CO_2$ emissions by both approaches are summarized in Table 2.3.8. The $CO_2$ emissions by the top-down approach are based on Metro Manila inventory in 2010. On the other hand, the bottom-up approach shows those of 2012.

2.51 As shown in Table 2.3.8, the difference of both approaches is approximately 40%. This 40% is not a small difference on emission estimations. The difference is caused by following factors:

(i) Target year of each estimation is not the same (Top-down 2010, Bottom-up 2012);

(ii) Bottom-up approach provides the results based on daily traffic demand forecasting and not on an annual basis; and

(iii) Bottom-up approach excludes both motorcycle and tricycle.

**Table 2.3.8 Comparison of $CO_2$ Emissions from Transport Sector in Manila between Top-down Approach and Bottom-up Approach**

| | $CO_2$ Emissions (Thousand Ton ) | Ratio (Top-down / Bottom-up) (%) |
|---|---|---|
| Top-down approach | 7,981 | 40 |
| Bottom-up approach | 4,786 | |

Source: JICA Study Team
Note: Ratio = (Top-down – Bottom-up) / Top-down.

### Box 2.2.1 Technical Note on Vehicle Emission Factors and Efforts of Other ASEAN Countries

The figure below shows a flowchart for calculating the amount of emission from vehicles applying a Chassis dynamometer. Emissions data are determined by the driving cycle which indicates the driving conditions of the target city and the state of the vehicle traveling in the city. The state of the vehicles of the city varies according to composition of vehicle ages. There is a considerable number of used cars in Manila which needs to be appropriately reflected. The vehicle conditions are, needless to say, different from that of 1992 when the first emission cycles were developed in Manila.

If the driving cycle of other cities such as Bangkok and Jakarta are used for the calculation instead of that of Metro Manila which has not been updated for decades, the emission factor reflects the case of vehicles driven in Bangkok or Jakarta. In order to estimate emissions from vehicles in Manila, it is required to develop the driving cycle data and then emission factors obtained from Manila itself.

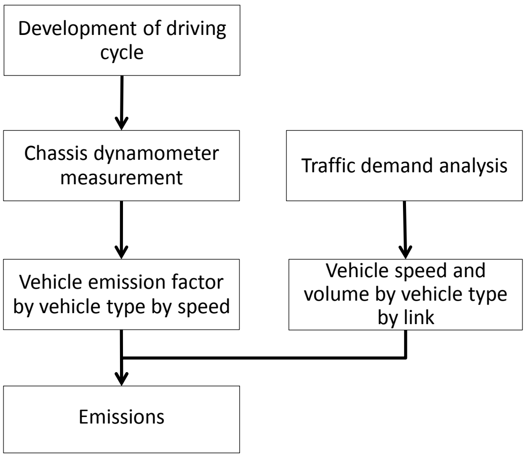


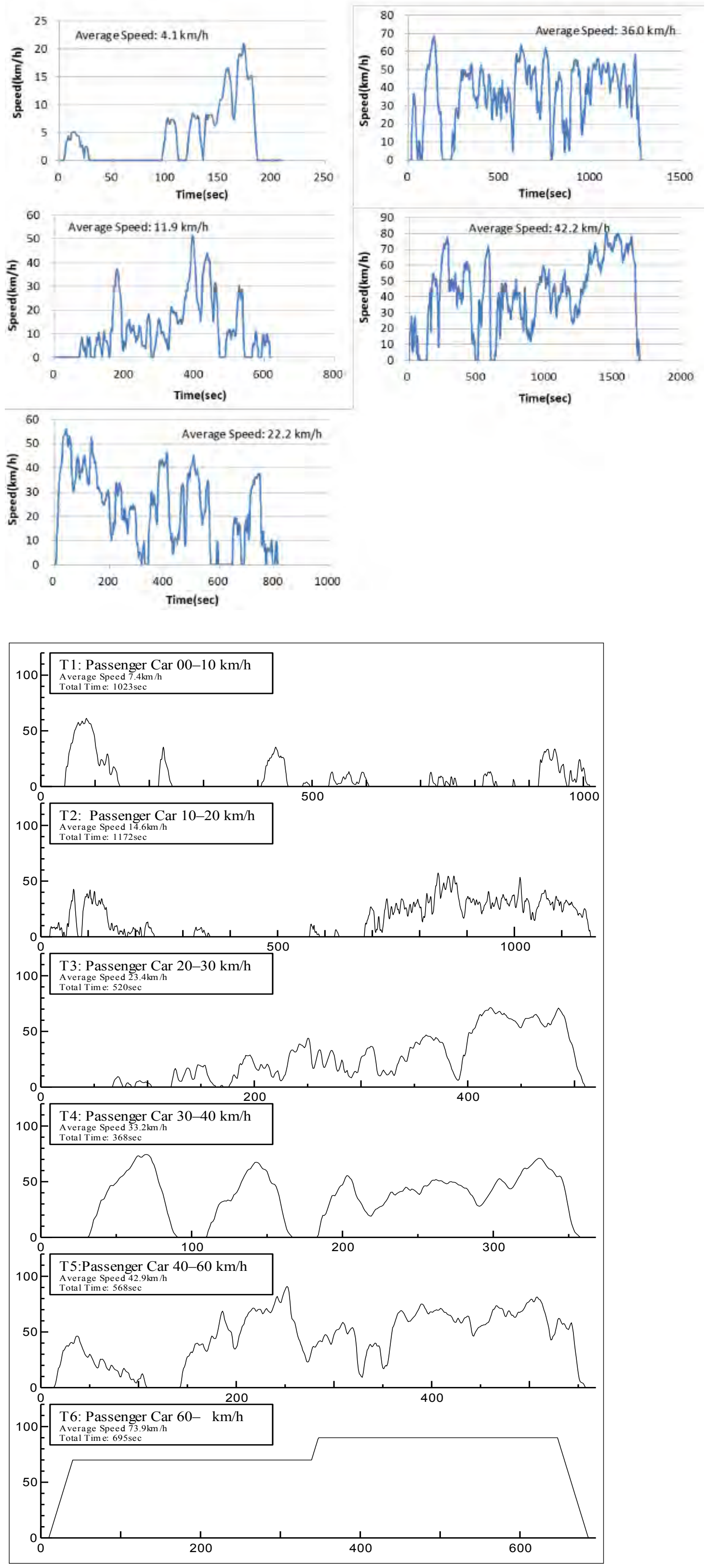

**Figure 2.3.3 Flowchart to Calculate the Amount of Emission from Vehicles**

- **Driving Cycle**

  Vehicle emission factor is one of the important parameters for estimating vehicle emissions. There are two methods to develop vehicle emission factors. One is a chassis dynamometer measurement; the other is an on-board measurement. Vehicle emission factor has been developed with a chassis dynamometer measurement in Manila. In order to develop it, a driving cycle by vehicle type is required in the target city or region.

  Driving cycle basically shows the representative road conditions of a city such as acceleration, deceleration, and idling. Every city has a specific driving cycle based on their road situations. The driving cycle is developed by vehicle type and by vehicle speed category.

  Figure 2.3.4 shows the driving cycles in Jakarta and Bangkok, respectively, as examples. Both driving cycles were developed with the support of the Government of Japan. First, the driving cycle of Bangkok was developed in 2003, followed by Jakarta in 2011. Since there are big changes in the road conditions of Bangkok between 2002 and 2013, it was pointed out that the driving cycle should be revised to fit the current situation. In Manila, NCTS developed a driving cycle for passenger car in 1996. Since then, the driving cycle has been revised by NCTS.




Source: Japan Automobile Research Institute (JARI), "A Study of the Road Transport Sector for Reducing $CO_2$ Emission", 2012 (in Japanese) for Jakarta, Ministry of Land, Infrastructure and Transport Japan (MLIT), "Study to Promote CDM Projects in Transport Sector in order to Resolve Global Environmental Problem (Bangkok Metropolitan Area Case)" (in Japanese) for Bangkok

**Figure 2.3.4 Passenger Car's Driving Cycles of Jakarta (above) and Bangkok (below)**

- **Chassis Dynamometer Measurement**

  In recent years, ASEAN countries started to introduce Euro standards for vehicle emission and fuel standard. The Philippines introduced the Euro 2 standard for vehicle emission a new passenger car since 2007 and will be expected to adopt Euro 4 for both a vehicle emission standard and a fuel standard from 2016. When new vehicles, which conform to a new standard, are distributed in the city, vehicle emission situations by vehicle type would be improved. Therefore, in case of the introduction of a new vehicle emission standard, vehicle emission factors should be revised properly so that total vehicle emissions could be assessed with more accuracy.

  The situations of chassis dynamometer facilities in some ASEAN countries are summarized in Table 2.3.9. These countries are trying to develop their own vehicle emission factors by their chassis dynamometer. They depended on international support for their development.

  Thailand introduced the chassis dynamometer system of its Pollution Control Department (PCD) under the budget of the Ministry of Natural Resource and Environment (MONRE) in 1995. However, the operation of the facility was not appropriately managed due to a lack of maintenance experience. In addition, vehicle emission factors could not be developed reflecting the Bangkok driving cycle. In 2002, the MLIT of Japan dispatched vehicle technical and science specialists to support the development of vehicle emission factors. As a result, Bangkok driving cycle and vehicle emission factors were developed. JICA has been supporting the PCD for VOCs emission factors and Pollutant Release and Transfer Register (PRTR) database development. The driving cycle should be revised due to the changes of the traffic situation in Bangkok.

  Indonesia established a small-sized chassis dynamometer with their own budget in 2005. The main target was biofuel and alternative fuel emission test. The development of the Jakarta driving cycle required international support due to a lack of experience. In 2010, the Jakarta driving cycle was developed with support of the Ministry of Economy, Trade and Industry (METI) of Japan. Further, vehicle emission factors were developed based on the driving cycle with the chassis dynamometer test with METI technical and investment support in 2011.

  Viet Nam has a specific traffic condition of having over 4 million motorcycles in Hanoi. In such a situation, the driving cycle of Hanoi was required to reflect their specific traffic conditions and developed with their own budget in 2008. However, the development of a chassis dynamometer system was difficult due to a lack of financial resources. In 2011, the Austrian government supported the development of a small-sized chassis dynamometer facility for motorcycle and Low Duty Vehicle (LDV). As a result, emission factors of Hanoi were developed in 2011.

  Malaysia is also trying to develop its own vehicle emission factors.

**Table 2.3.9 Representative Chassis Dynamometer In Major ASEAN Countries**

| City/Country | Location | Target | Year | Note |
|---|---|---|---|---|
| Bangkok/ Thailand | Pollution Control Department (PCD) | PC/Taxi, MC, HDV, LDV, Large bus, Minibus | 1995 | The chassis dynamometer in PCD was introduced by MONRE. On 2002, MLIT Japan dispatched environmental and mechanical specialists to PCD for developing the new Bangkok driving cycle. However, the equipment required full calibrations due to improper maintenance.<br>The specialist calibrated the chassis dynamometer with MLIT funding. In the meantime, MLIT contributed to developing the Bangkok driving cycle. Japan Government provides technical support continuously. |
| Hanoi/ Vietnam | Hanoi University of Science and Technology | Motorcycle, LDV | 2011 | A small-sized chassis dynamometer was set up in the laboratory of Hanoi University of Science and Technology. The equipment was able to measure motorcycle and LDV emissions. The laboratory was facilitated with AVL equipment sponsored by the Austrian government. |
| Jakarta/ Indonesia | Agency for the Assessment and Application of Technology (BPPT) | PC, LDV, MDV, HDV | 2005 Upgraded in 2011 | The chassis dynamometer was established in September 2005. METI Japan supported the development of the Jakarta driving cycle in 2010.The equipment was upgraded to Euro 4 vehicle measurement standards in 2011. Vehicle emission factors in Jakarta were developed with METI support in 2011. |
| Manila/ Philippines | UP Vehicle Research and Testing Laboratory (UP-VRTL) | PC, LDV | 2008 | The Chassis dynamometer was established with co-funding from DOST, DOE, and UP in 2008. The Manila driving cycle was developed and revised continuously by UP-NCTS. The facility cannot test a large-sized bus or jeepney due to its size problem. |

Source: JICA Study Team.

### 3) GHG Emission Reduction of Respective Projects under the Roadmap

2.52 GHG emission reductions can also be estimated for the respective projects based on feasibility study reports. This approach is required for the appropriate MRV (Measurement, Reporting and Verification) in the Clean Development Mechanism (CDM) scheme. A CDM methodology approved by UNFCCC defines how to monitor, report, and verify GHG emission reductions with a project. In the Joint Crediting Mechanism/ Bilateral Offset Crediting Mechanism (JCM/BOCM) proposed by Japan, an MRV methodology approved by the Joint Committee defines them. MRV plays a very important role to ensure reliability of GHG emission reductions in both schemes. NAMAs are also required for MRV; MRV will provide a proper evaluation of their mitigation actions. In recent years, many developing countries require external support to develop their MRV and to be provided programs for capacity building. JICA, GIZ, and other organizations provide support to them in these areas. The transport sector in the Philippines emitted 25.4 $MtCO_2$ in 2004. Therefore, the potential of GHG emission reductions will be higher and MRV of the transport sector should be developed to apply to any crediting mechanisms or NAMAs.

2.53 In calculating GHG emissions on a project basis, some projects of the roadmap were selected. These projects include railway projects, road transport project, and expressway project. A methodology for railway project has been developed in the CDM scheme. This methodology calculates GHG emission reductions based on passenger-kilometer. On the other hand, there is no CDM methodology for road transport and expressway projects. Therefore, a result of the evaluation of GHG emission reductions was confirmed by the existing feasibility studies in this study.

2.54 In regard to railway projects, three railway projects involved in the short-term program include a passenger modal shift project from road transportation to rail transportation. The NLEX-SLEX connector project and ITS project are also included in the short-term program. These are already committed and their costs are large.

(i) LRT1 – Cavite Extension
(ii) LRT2 – East Extension
(iii) MRT3 Capacity Expansion
(iv) NLEX-SLEX Connector
(v) ITS (3 Provincial Bus Terminal)

**(1) Railway Project**

2.55 This is a passenger modal shift project from road to rail. GHG emission reductions are calculated with passenger-kilometer. Emissions are calculated as follows:

*Baseline emissions:* $BE_y = \sum_i \left( BPKM_y \times MS_{i,y} \times EF_{PKM,i} \times 10^{-6} \right)$
*Project emissions:* $PE_y = EC_{elec} \times EF_{grid}$
*Emission reductions:* $ER_y = BE_y - PE_y$
*Where:*
*$BPKM_y$=Passenger kilometer of MRT in year y (pax-km/year),*
*$MS_{i,y}$=Share of passengers using transport mode i in the baseline scenario in year y,*
*EFPKM,i=$CO_2$ emission factor per passenger kilometer for transport mode i ($gCO_2$/pax-km),*
*ECelec=Electricity consumption associated with rail operation (MWh/year); and*
*EFgrid=Grid $CO_2$ emission factor ($tCO_2$/MWh).*

- **LRT1 – Cavite Extension**

2.56 Passenger demand will increase due to the extension of LRT1 to Cavite. In order to evaluate $CO_2$ emission reductions conservatively, it is assumed that LRT passengers in the future will shift from jeepney and bus only. The result of $CO_2$ emission reductions is estimated from 96,000 to 160,000 tons per year (see Table 2.3.10).

**Table 2.3.10 Parameter Setting for LRT1 Project**

| Parameter | Unit | Value | Source |
|---|---|---|---|
| BPKMy | pax-km/year | 3,101mil(2015), 3,602mil (2020), 4,173mil (2025), 4,841mil (2030) | FS (Feasibility Studies) |
| MSi,y | % | Jeepney: 50%, Bus: 50% as a conservative approach | Study Team |
| EFPKM,i | $gCO_2$/pax-km | Jeepney: 0.00005, Bus: 0.00003 | Study Team |
| ECelec | MWh/year | 39,246 (actual value between May 2012 and April 2013) | LRTA |
| EFgrid | $tCO_2$/MWh | 0.5014 | CCO |

Source: JICA Study Team
Note: FS is "LRT1 South Extension Project Updating of the Feasibility Study / Project Implementation Program" (DOTC, 2012).

**Table 2.3.11 Emission Reductions with LRT1 Project**

| | Unit | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|---|
| Baseline emissions | $tCO_2$/year | 116,448 | 135,275 | 156,718 | 181,816 |
| Project emissions | $tCO_2$/year | 19,678 | 19,678 | 19,678 | 19,678 |
| Emission reductions | $tCO_2$/year | 96,770 | 115,597 | 137,040 | 162,139 |

Source: JICA Study Team
Note: Electricity consumption is assumed as a constant.

- **LRT2 – East Extension**

2.57 In this project, as in the LRT1 extension, passenger demand will increase due to the extension. In order to evaluate $CO_2$ emission reductions conservatively, it is assumed that LRT passengers in the future will shift from jeepney and bus only. The result of $CO_2$ emission reductions is estimated from 22,000 to 45,000 tons per year (see Table 2.3.12). In comparison to the LRT1 project, the amount of emission reductions depends on passenger-km of each LRT.

**Table 2.3.12 Parameter Setting for LRT2 Project**

| Parameter | Unit | Value | Source |
|---|---|---|---|
| BPKMy | pax-km/year | 942mil(2015), 1,040mil (2020), 1,340mil (2025), 1,553mil (2030) | FS |
| MSi,y | % | Jeepney: 50%, Bus: 50% as a conservative approach | Study Team |
| EFPKM,i | $gCO_2$/pax-km | Jeepney: 0.00005, Bus: 0.00003 | Study Team |
| ECelec | MWh/year | 25,183 (actual value between May 2012 and April 2013) | LRTA |
| EFgrid | $tCO_2$/MWh | 0.5014 | CCO |

Source: JICA Study Team
Note: FS is "Preparatory Study for LRT Line Extension Project Final Report" (JICA, 2011)

**Table 2.3.13 Emission Reductions with LRT2 Project**

| | Unit | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|---|
| Baseline emissions | $tCO_2$/year | 35,387 | 39,070 | 50,328 | 58,344 |
| Project emissions | $tCO_2$/year | 12,627 | 12,627 | 12,627 | 12,627 |
| Emission reductions | $tCO_2$/year | 22,760 | 26,443 | 37,701 | 45,717 |

Source: JICA Study Team
Note: Electricity consumption is assumed as a constant.

- **MRT3 Capacity Expansion**

2.58 This is a capacity expansion project. Passenger demand will increase due to the expansion. In order to evaluate $CO_2$ emission reductions conservatively, it is assumed that MRT3 passengers in the future will shift from jeepney and bus only. The result of $CO_2$ emission reductions is estimated at approximately 4,000 to 10,000 tons per year (see Table 2.3.14). This estimation involves only the net increase of passengers in the future.

**Table 2.3.14 Parameter Setting for MRT3 Project**

| Parameter | Unit | Value | Source |
|---|---|---|---|
| BPKMy | pax-km/year | 1,126mil (2011). BPKM of phase 1,2 and 3 are assumed as the net increase of it. | MRTA, FS |
| MSi,y | % | Jeepney: 50%, Bus: 50% as a conservative approach | Study team |
| EFPKM,i | $gCO_2$/pax-km | Jeepney: 0.00005, Bus: 0.00003 | Study team |
| ECelec | MWh/year | 44,440 (actual value in 2012). EC of phase 1,2 and 3 are assumed as the net increase of it. | MRTA |
| EFgrid | $tCO_2$/MWh | 0.5014 | CCO |
| Others | | Phase1 and 2: 46 LRVs, Phase3: 21 LRVs | FS |

Source: JICA Study Team
Note: FS was "MRT3 Capacity Expansion Project Feasibility Study" (DOTC, 2012)

**Table 2.3.15 Emission Reductions with MRT3 Project**

| | Unit | Phase 1, 2 | Phase 3 |
|---|---|---|---|
| Baseline emissions | $tCO_2$/year | 10,741 | 22,774 |
| Project emissions | $tCO_2$/year | 6,685 | 11,998 |
| Emission reductions | $tCO_2$/year | 4,056 | 10,776 |

Source: JICA Study Team
Note: Estimations involve only the net increase of passengers.

### (2) Road-Based Projects

- **NLEX-SLEX Connector (Makati–Caloocan.)**

2.59 The GHG emission of the NLEX-SLEX Connector project was evaluated in the FS[4]. The results of the FS show that GHG emissions at the roads along the planned expressway in 2016, 2020, and 2030 will rise to about 82,000, 85,000, and 98,000 tons, respectively (see Table 2.3.16).

**Table 2.3.16 Emission Reductions with NLEX-SLEX Connector Project**

| | 2016 | | 2020 | | 2030 | |
|---|---|---|---|---|---|---|
| | Annual emissions (ton/year) | $CO_2$eq ($tCO_2$/year) | Annual emissions (ton/year) | $CO_2$eq ($tCO_2$/year) | Annual emissions (ton/year) | $CO_2$eq ($tCO_2$/year) |
| $CO_2$ | 61,320 | 61,320 | 65,700 | 65,700 | 75,920 | 75,920 |
| CH4 | 34 | 721 | 35 | 744 | 39 | 812 |
| $N_2O$ | 64 | 19,914 | 61 | 19,009 | 71 | 21,951 |
| Total | - | 81,955 | - | 85,453 | - | 98,683 |

Source: JICA Study Team.

- **3 Provincial Bus Terminals**

2.60 GHG emission of the 3 Provincial Bus Terminals project was also evaluated in the FS[5]. According to the FS, the daily $CO_2$ emissions in the year 2016 will rise to about 3.3 metric tons and 0.9 metric tons for the FTI (Food Terminal Inc.) and PRA (Philippine Reclamation Authority) sites, respectively in the “With Project” scenario (see Table 2.3.17). With this consideration, the respective mitigation measures have been incorporated while preparing the Environmental Management Plan.

**Table 2.3.17 Daily $CO_2$ Emissions at the Proposed Provincial Bus Terminal Sites in the “Without Project” and “With Project” Scenarios for Year 2016**

| Type of Vehicle | Type of Fuel Used | No. of Vehicles | | $CO_2$ Emissions (in Metric Ton) | |
|---|---|---|---|---|---|
| | | Without Project Scenario | With Project Scenario | Without Project Scenario | With Project Scenario |
| FTI Site (Yr 2016) | | | | | |
| Passenger Car | Gasoline | 41,282 | 46,431 | 17.46 | 19.64 |
| Bus | Diesel | 4,567 | 4,856 | 2.21 | 2.36 |
| AUV an PUJ | Diesel | 9,627 | 11,662 | 4.67 | 5.66 |
| PRA Site (Year 2016) | | | | | |
| Passenger Car | Gasoline | 17,814 | 18,736 | 7.54 | 7.93 |
| Bus | Diesel | 2,175 | 2,262 | 1.05 | 1.10 |
| AUV an PUJ | Diesel | 13,269 | 14,231 | 6.44 | 6.90 |
| Total | | - | - | 15.03 | 15.92 |

Source: JICA Study Team

[4] JICA, Project Preparation Survey on Highway Construction in the Mega Manila Zone, Philippines, 2011.
[5] Feedback Infrastructure Services Private Limited, Transaction Advisory Services for the Integrated Transport System (ITS) Project Detailed Feasibility Study Report, 2013.

### (3) Summary of the Project-based Approach

2.61 Emission reduction of the railway projects are significantly larger compare to other type of projects. The emission data are normally calculated at the project feasibility study (FS) stage in the Project-Based Approach. Specific parameters in the FS are utilized for calculation. Once the target projects are implemented, the parameters utilized for calculating emission reduction data should be regularly monitored and verified to come up with more accurate reduction data. This approach is required to estimate the impact of the GHG emission reduction data. Emission reduction data acquired through this approach can be reported in the biennial update reports (BURs) and NAMAs for international recognition.

## 2.4 National Plan and Strategies towards Low Carbon Transport

### 1) National Environmentally Sustainable Transport

2.62 Environmentally Sustainable Transport (EST) is the policy vision that was proposed by the Organization for Economic Cooperation and Development (OECD) and its commitment is to plan and implement policies on sustainable transport and environment based on a long-term perspective. By presenting the specific vision for future transportation, it is expected to increase awareness and choose transport activities and lifestyles with reduced environmental loads. An Integrated EST Strategy typically encompasses policies on transport management and infrastructure, public health, urban infrastructure, land use planning, and knowledge management, public participation and awareness (see Table 2.4.1).

2.63 Owing to the rapid increase in motorization due to economic development and increasing urbanization, various traffic and environmental issues have arisen such that immediate implementation of effective policies is crucial. The Ministry of the Environment, Government of Japan, together with United Nations Center for Regional Development (UNCRD), established the “Regional EST Forum in Asia” in 2005. While taking into account the specific characteristics of the Asian region, the Ministry has been actively contributing to realize environmentally sustainable transport in the Asian region through policy dialogues among participating countries. In the Philippines, the Department of Transportation and Communications (DOTC) together with Department of Environment and Natural Resources (DENR) are focal agencies to formulate the National Environmentally Sustainable Transport Strategy under Presidential Administrative Order No. 254, which was completed in 2010.

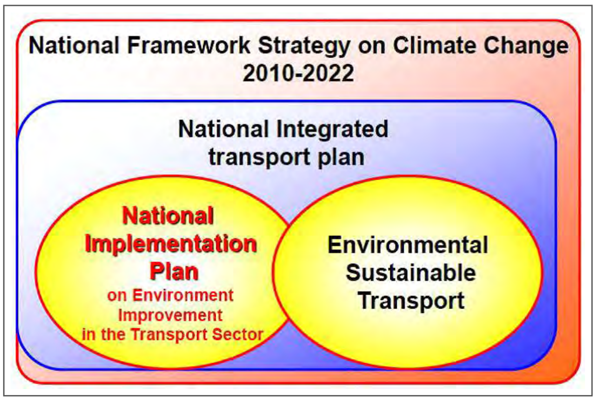
**Table 2.4.1 Integrated EST Strategy**

| No. | Topic |
|---|---|
| 1 | Public Health |
| 2 | Road Safety and Maintenance |
| 3 | Traffic Noise Management |
| 4 | Social Equity and Gender Perspectives |
| 5 | Public Transport Planning and Transport Demand Management(TDM) |
| 6 | Non-Motorized Transport(NMT) |
| 7 | Environment and People Friendly Urban Infrastructure |
| 8 | Cleaner Fuels |
| 9 | Strengthening Road Side Air Quality Monitoring and Assessment |
| 10 | Vehicle Emission Control, Standards, and Inspection and Maintenance(I/M) |
| 11 | Land Use Planning |
| 12 | Strengthening Knowledge Base, Public Participation and Awareness |

Source: DOTC (2011), National EST Strategy

### 2) National Implementation Plan on Environment Improvement in the Transport Sector

2.64 The National Integrated Transport Plan of the Philippines has been drafted and it includes EST. The plan highlights the low carbon and low emission transport systems in order to promote non-motorized transport systems and include maritime and aviation sectors. All plans in the NIP are expected to be included in the National Framework Strategy on Climate Change 2011–2022. The relationship of the programs is described in Figure 2.4.1. Despite all the efforts to mainstream a low carbon transport policy regime, the attempts to implement major policies are limited.




Source: DOTC

**Figure 2.4.1 Relationship among Different Programs Related to NIP in the Philippines**

2.65 There are no specific description of climate change mitigation measures in the MMDA prioritized projects in the transport sector as well as in national level policies and plans.

### 3) Mass Transit and Modal Shifts

2.66 The development of railway network is one of the most important and urgent priorities in Metro Manila where the vehicle population and traffic demand continue to increase. There is significant potential to reduce GHG by shifting passengers from private vehicles or taxis to the railway. The detailed description of existing railway lines, lines under construction, and lines which are planned to start construction are explained chapter 3 of the report (table on Railway Projects in the Last Decade).

2.67 Regarding a plan for a rail-based mass transit system (subway, elevated railway, etc.), in Metro Manila and advanced regions, the DOTC had not developed a longer term master plan on mass rapid transit systems which have specific time lines, although there have been substantial technical support to formulate plans. The schedule of the implementation of past transit systems have been considerably behind schedule.

2.68 BRT has a role to complement the network of railways and it is effective in areas where it is difficult to develop railways. There is potential to reduce in traffic through shifting passengers from passenger vehicles or taxis to BRT. If buses in the BRT system run on LPG, there will be additional positive impact on air quality.

### 4) Cleaner Fuels

2.69 Combining the strategy to reduce the country's dependence on imported oil, alternative fuels for transport are expected to provide a viable solution to cushion the impact of highly volatile petroleum prices on the economy with resource diversification as well as to promote clean and environment-friendly energies. Future supply potential of alternative fuels for transport use such as biofuels (bioethanol and biodiesel), CNG[6], and auto LPG are introduced in Metro Manila.

2.70 The Government of the Philippines promotes the use of CNG, not only for power generation but also for automobile fuel in recent years. The utilization of natural gas can reduce oil dependency and increase energy security. As for natural gas vehicles (NGV),

[6] Natural Gas Vehicle Program for Public transport (NGVPPT) is initiated by DOE and initially sixty buses are currently operating between Batangas and Metro Manila. There are limitations of expanding the program due to the limited number of CNG stations.

CNG does not emit PM and has low carbon content per unit of heat value. Therefore, introducing NGV and the conversion of automobiles from using gasoline or diesel to CNG vehicles has a potential to improve local air quality and to reduce GHG emissions.

### 5) Inspection and Maintenance

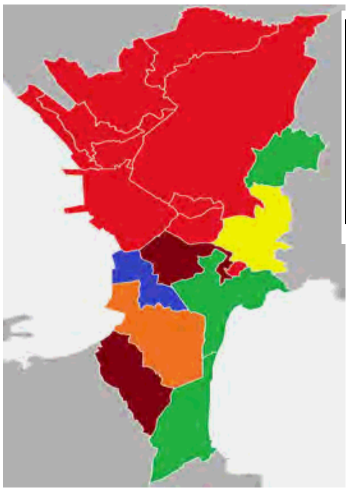
- **Anti-Smoke Belching Campaign**

2.71 The anti-smoke belching campaign was implemented by the DOTC's Land Transportation Office (LTO) on July 1, 2002. All vehicles have to pass emission tests from emission testing centers certified by DOTC before they get registered. In a concerted effort by DENR, LTO, Metro Manila's LGUs, MMDA, the Philippine Medical Association (PMA) and the Kapisanan ng mga Brodkaster ng Pilipinas (KBP), the campaign has been extended to form Anti-Smoke Belching Units (ASBU). These ASBUs are emission-monitoring groups strategically stationed in main thoroughfares in Metro Manila. Armed with what is called the smoke opacity meter or "opacimeter," these units flag down suspected smoke-belching vehicles and performs emission tests on-site. Violators are apprehended and fined.

### 6) Travel Demand Management

2.72 With the challenges that face the government to improve air quality, a number of emission control programs have been planned and some have already been implemented.

2.73 A traffic demand management strategy called the Unified Vehicular Volume Reduction Program (UVVRP) of the MMDA (under MMDA Reg. No. 95-001) has been implemented since December 1, 1995, which aims to reduce the volume of vehicular traffic on the streets of Metro Manila by using the last digit of plate numbers as coding system. For example, plate numbers ending with 1 and 2 are banned from travelling on designated streets from 7:00 a.m. to 7:00 p.m. on Mondays, those ending in 3 and 4 are banned on Tuesdays, and so on (see Figure 2.4.2).



| Day of the Week | Ending Numbers |
|---|---|
| • Monday | • 1 &2 |
| • Tuesday | • 3 &4 |
| • Wednesday | • 5 & 6 |
| • Thursday | • 7 & 8 |
| • Friday | • 9 &0 |

Implemented from 7:00 a.m. to 7:00 p.m. without window hours.
Implemented from 7:00 a.m. to 7:00 p.m. with window hours of 10:00 a.m. to 3:00 p.m.
Implemented from 7:00 a.m. to 7:00 p.m. without window hours, only on specific roads.
Implemented from 7:00 a.m. to 7:00 p.m. with window hours of 9:00 a.m. to 4:00 p.m.
Implemented from 7:00 a.m. to 7:00 p.m. with window hours of 10:00 a.m. to 3:00 p.m., except on specific roads.
Not implemented, except on specific roads (if applicable).

Source MMDA (MMDA Reg. No. 95-001)

**Figure 2.4.2 Current Implementation of the UVVRP**

2.74 The LTO's Motor Vehicle Inspection System (MVIS) is envisioned to contribute to emission reduction by implementing a comprehensive vehicle inspection and evaluation scheme to determine the roadworthiness (including safety) of vehicles in the country. However, this scheme is yet to be implemented awaiting the procurement of needed equipment.

2.75 Another emission reduction scheme is the conversion of 2-stroke motorcycles to 4-stroke. Based on the study of Shah and Harshadeep (2001), the PM10 emission factor of 4-stroke motorcycles is approximately 1/5 of the emission factor of 2-stroke motorcycles. The shift may have contributed a lot in the decreasing trend in the annual average TSP, especially in Metro Manila. This result was also projected in the MMUTIS study.

## 2.5 Towards Inclusive Transport

2.76 The above measures have been implemented one way or another in terms of pilot models or with substantial investment. The challenge of Metro Manila with regard to environment is the current status of quantifiable data regarding air quality and GHG. Residents are exposed to polluted air without recognizing the serious impact on their health, especially on children. Once more GHG reduction volumes are quantified in an appropriate manner, it will benefit the country by gaining the international recognition through NAMAs. There have been a number of strategies and measures undertaken by the Philippine Government, but the analytical data which shows positive effect on air quality and GHG reduction are still limited. An implementation plan without stringent assessment has materialized partially and behind the original time schedule.

2.77 Stakeholders of the transport sector have not fully addressed the concern over environmental issues and GHG reduction. One of the major reasons is that countermeasures definitely require coordination beyond the transport sector, namely, urban planning and land use planning, energy, health and social protection issues. Specifically, air pollution is not only the matter of emission, but more so of its impact on health based on a sound monitoring system. Close coordination is required to work with DENR, DOH, DOE, and their bureaus.

2.78 Considering the lack of coordinating bodies and a master plan on these critical matters attributed to the transport sector, the institutional set-up towards “Eco-cities” with sound low carbon transport is urgently required in line with the Manila Green Print currently supported by the World Bank and AusAID.

2.79 The prioritized projects in the roadmap would contribute to reduce air pollutants and GHG significantly as previously discussed. However there are some concerns over the implementation stage and evaluation stage. In order to solve the issues and to improve environment in Mega Manila, the following actions are proposed.

### 1) Air Pollution Control and Monitoring Systems

2.80 In the short term, a spatial and visual-based system of the air pollution control is recommended to be developed. Under the system of the Metro Manila emission inventory and a simplified air quality model, the air quality improvement with projects can be easily provided to policy makers. Policy makers will understand in which area and how much air pollutants will be decreased at the pre-project implementation stage. As a result, the system will assist to prioritize the most appropriate actions with regard to economic and social benefits of the citizens.

2.81 In the long term, an on-line air pollutant monitoring system utilizing the internet can be installed, like the flood alert system of the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAG-ASA). This web-based system involves a daily forecasting system for air pollution with both meteorological data by PAGASA and air pollutants monitoring data by EMB. Once the system will be opened to public, it will be utilized for public awareness on air pollution in Metro Manila. As a result, this will scientifically measure the effectiveness of air pollution improvement by transport infrastructure development.

### 2) Development of MRV for GHG Reduction

2.82 The most important issue for sound monitoring of GHG is the development of MRV. The MRV is required for the adaptation of international schemes such as NAMAs, CDM, JCM/BOCM, etc. In order to develop MRV appropriately, the MRV scheme is required for the clarification of the responsibility of the relevant organizations. Meanwhile, capacity building programs should be required such as seminars, workshops, training courses, etc. The current Metro Manila Greenhouse Gas Inventory shows about 40% of total GHG emissions in Metro Manila from the transport sector. Many developing countries seek international support for the establishment of the post-evaluation system with MRV. Moreover, a reliable MRV will facilitate connection to crediting mechanisms.

### 3) Evaluation of Air Pollution Improvement

2.83 The reduction of air pollution impact on health in Metro Manila has a high priority in the government policy. EMB is trying to establish a new forecasting system for air pollution in Metro Manila, which will be launched in 2014. While daily forecasting is important, pre-evaluation of various actions is also important to create the proper effectiveness of the actions in the transport sector. In this study, air pollutants were estimated by the bottom-up approach based on traffic assignment. On one hand, spatial distributions of air pollutants would provide useful information for pre-evaluation of future actions. This method was applied in the USAID study[7] in Metro Manila. JBIC[8] also studied in Bangkok using both air quality model and traffic demand model. This approach would contribute to reduce health impact effectively.

### 4) Revision of Emission Factors

2.84 As mentioned in the Technical Note, other ASEAN countries have been trying to develop their emission factors in order to properly evaluate the effects of their transport activities. In Metro Manila, vehicle emission factors were developed in 1992, the first among ASEAN countries, with support from ADB. Since then, however, no emission factors have been revised except the ones under the MMUTIS. The old emission factors developed in the 1990s are repeatedly used in the emission estimation as formal national data. However, these are deemed to be inappropriate as the road and vehicle conditions have drastically changed since then. In the Philippines, the Euro 2 emission standard for new passenger car was applied since 2007. In addition, the Euro 4 emission standard for new passenger car and the Euro 4 fuel standard will be applied in 2016. After passenger cars adapted to a new standard will be distributed in the city, vehicle emissions will be improved.

2.85 After applying a new fuel standard, vehicle emissions will also improve. The old emission factors should be definitely revised to adapt to current vehicle situations. Moreover, there is an issue that the chassis dynamometer of UP-NCTS cannot be applied to large-sized jeepneys and buses. Their contribution to air quality deterioration in Metro Manila should be evaluated quantifiably by the chassis dynamometer test. The facility, therefore, should be replaced with a larger sized facility to accommodate jeepneys and buses. Once replaced, the accuracy of the emission factors will improve to the standard

[7] Manila Observatory, Integrated Environmental Strategies Philippines Project Report Metropolitan Manila – Focus on the Transport Sector, 2005.

[8] Japan Transport Cooperation Association, Japan Weather Association and Transport System Lab. of Nihon University: Study for development of atmospheric environmental impact assessment methodologies on the extension of the subway blue line in Bangkok, Japan Bank for International Cooperation(JBIC), 2006

where international funding support might be considered like in other countries. Nationally Appropriate Mitigation Actions (NAMAs) consist of concrete projects, policies, and/or programs that shift a technology or sector in a country into a low-carbon development trajectory. Reviewing past efforts to formulate NAMAs, policies and programs which can seek for credits and international funding will be identified.

2.86 Within the international climate negotiations under the United Nations Framework Convention on Climate Change (UNFCCC), parties agreed that reporting should be enhanced to include BURs from developing countries. The new reporting requirements adopted present a considerable challenge for many developing countries—many of which struggle to produce regular national communications to the convention—both in terms of report quality, as well as in terms of institutional arrangements, processes and regulations that must be in place to ensure continuous high-quality reporting into the future. The efforts to improve overall emission data will also contribute to strengthen capacities to generate solid reporting systems of the BURs, in addition to contributing to the improvement of air quality and traffic management.

2.87 Specific activities recommended are as follows:

(i) Environmental monitoring systems are enhanced in order to verify the air pollution contamination level in order to contribute to specific policy formulation.

- Conduct capacity assessment on data analysis and environmental monitoring systems in public, private and academic sectors.
- Capacity building programs are conducted with domestic and international resources.

(ii) Environmental, social and economic assessment on current and future policy measures are conducted in line with Measurement, Reporting and Verification (MRV). Scenario analysis is required for various policy measures.

- Urban planning as well as transport sector's issues is jointly assessed in order to integrate the implementation plans.
- Significant items such as air pollution concentration, fatal accidents which directly impact on residents are monitored, assessed and information disseminated comprehensively in Metro Manila and adjacent urban centers. Capability assessment under the current institutional set-ups is required.
- Cost comparison with alternative measures is conducted considering the social costs such as resettlement and health impacts.
- The best scenario towards Eco-cities are identified based on the studies and continuing discussions and integrated into the master plan which all concerned agencies will follow including national level agencies as well as MMDA and LGUs.

2.88 Transport infrastructure investment will contribute to decreased air pollution as well as to GHG reduction. By strengthening the monitoring capacity of stakeholders in the country, widespread benefits in terms of social, economic, environmental gains are shared among the citizens. Further, it will contribute to compliance with international obligation to monitor GHG emission and actions to mitigate it. The above recommendation should be implemented in a concrete manner, with specific action plans shared among the relevant government agencies and other stakeholders.

## 2.6 Water Pollution

2.89 Provision of potable water to households in Metro manila is carried out by two concessionaires (Manila Waters Company and Maynilad Water Services) under contract with the Manila Waterworks an Sewerage System (MWSS). Some 95% of the population of the metropolis has access to potable water service. In terms of sewerage and sanitation, however, only about 15% is connected to sewer systems. Wastewater from toilets, sinks, and waterways has only two places to go: poorly-maintained residential septic tanks, or Metro Manila's rivers and sea. Metro Manila is currently experiencing a rising demand for potable water due to increase in population and urbanization which create serious concerns for water resource management. There are serious relevant diseases attributed to poor water quality, starting from diarrhea that induces malnutrition and mortality among young children of the poor families.

2.90 Manila Bay serves as a natural harbor and tourism spot, and has historical cultural and archaeological sites. However, the natural environment around the Manila Bay area is facing various threats from different factors: overpopulation, pollution discharges from land-based and sea-based sources, over-fishing, uncontrolled coastal development and habitat degradation. Their adverse effects on the ecosystem and on human health have resulted in increasing infrastructure and rehabilitation costs as well as health and social services expenditures.

# 3 DISASTER ANALYSIS BASED ON HAZARD MAPPING

## 3.1 Objectives

3.1 This section analyzes the hazards of various natural disasters in the study area, clarifies the distribution of risks, and identifies the high risk areas for natural disasters. The analyses utilize the database developed in the Study for Earthquake Impact Reduction for Metropolitan Manila in the Republic of the Philippines (MMEIRS) which was conducted by JICA from August 2002 to March 2004 with counterparts from MMDA and the Philippine Institute of Volcanology and Seismology (PHIVOLCS). Based on the database, hazards of several natural disasters such as earthquake, tsunami, flood, etc. will be investigated separately by hazard levels and expected damages and finally, a multi-hazard risk map will be prepared using these hazard maps. In addition, a socio-economic analysis with population distribution will be done to clarify the vulnerable areas to natural disasters and consequent damages. These can be utilized to identify the areas suitable and unsuitable for development.

3.2 The study area covers the GCR; however, the analyses are limited by the availability of necessary data and information. Therefore, Metro Manila has a first priority to be analyzed.

## 3.2 Target Disasters and Data Source

3.3 The target natural disasters focus on the three disasters which are expected to occur and bring heavy damages in Metro Manila, namely earthquake, tsunami and flood. The data for analyses must be updated by relevant agencies. However, if it is difficult, the existing data from previous reports are utilized. The data sources are shown below.

### 1) Earthquake

3.4 Metro Manila and GCR are in Luzon Island where numerous earthquake sources are located in and around it (see Figure 3.2.1). Among these faults, the Valley Fault System, which transects the study area, is considered to potentially cause the largest impact on the Metro Manila area should it generate a large earthquake. Many research studies indicate that active phases of the Valley Fault are approaching and the estimated magnitude will be around 7 or more on the Richter scale. Figure 3.2.2 shows the distribution of potential earthquake sources vis-a-vis the existing transport system. It shows that a fault is crossing the west side of Metro Manila and many roads are lying on the fault. It means that the roads have a risk of damage by earthquake hits.

3.5 To update the earthquake scenario, the Study Team contacted PHIVOLCS. However, they are still conducting an AusAID project entitled “The Risk Analysis Project for Greater Metro Manila Area (GMMA-RAP)” which analyzes flood, tropical typhoon, strong wind and earthquake and aims to update earthquake scenario and its potential damages. The results will be compiled in the final report in the middle of this year, therefore, they cannot provide any intermediate information. Thus, this Study utilizes the data of MMEIRS without any updates regarding the earthquake scenario and its damages and tsunami.

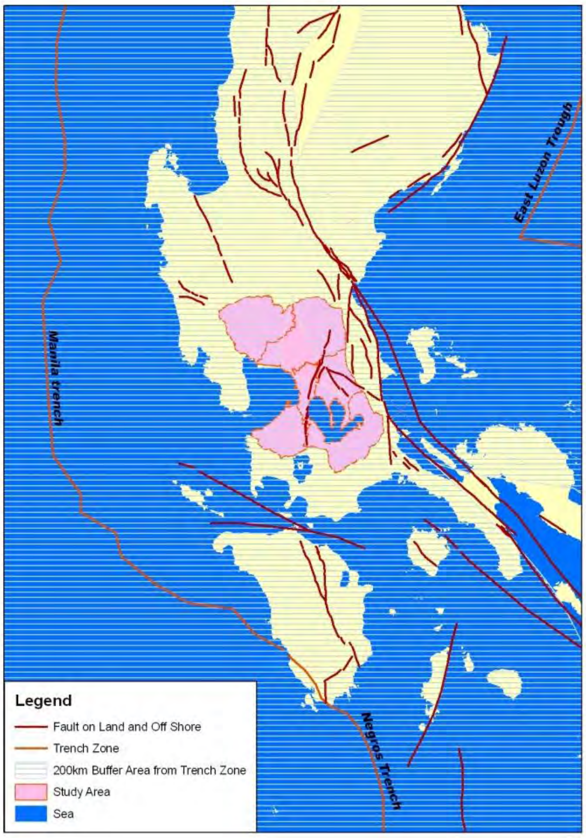
### 2) Tsunami

3.6 Recently, the USGS had pointed out the possibility of tsunami caused by an earthquake occurring in the Manila Trench. The MMEIRS indicated that hazards of tsunami occurring in the Manila Trench could reach to 2~4 m.

3.7 However, since the Study Team cannot be provided any updated scenario from PHIVOLCS, the data in MMEIRS are applied.

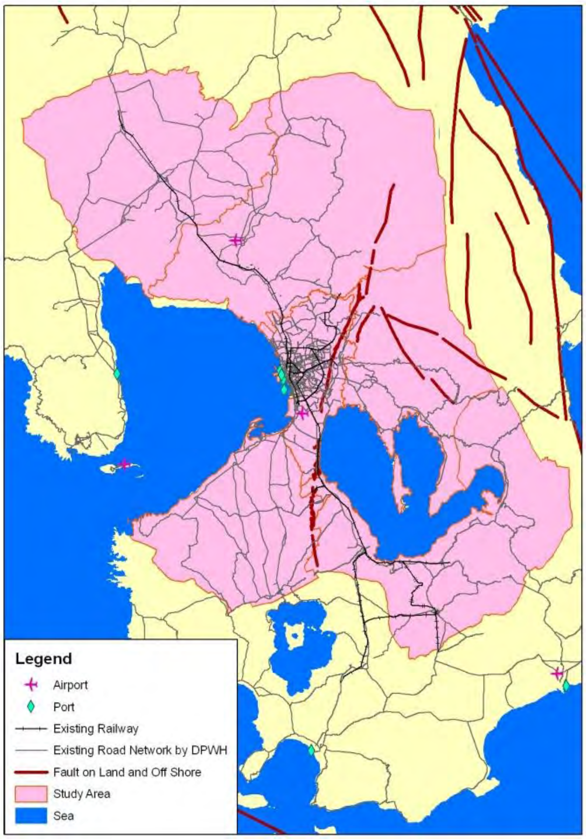
### 3) Flood

3.8 The Philippine islands are located in an area where tropical typhoons are generated frequently. Metro Manila is also hit by typhoons every year. In particular, the typhoon Ondoy hit Metro Manila in 2009 and caused the largest-ever damages. The affected areas should be depicted to identify the flood hazards.




Source: MMEIRS (JICA, 2004).

**Figure 3.2.1 Distribution of Faults and Trenches Around the Study Area**




Source: MMEIRS (JICA, 2004).

**Figure 3.2.2 Transport System & Distribution of Faults & Trenches Around the Study Area**

## 3.3 Earthquake Scenario and Vulnerability of Metro Manila to Earthquake (Review of MMEIRS)

3.9 In the MMEIRS, based on analyses of historically recorded earthquakes and instrumentally recorded earthquakes, 18 earthquakes were selected as scenario earthquakes which had potential damage effects on Metro Manila (see Table 3.3.1). The corresponding earthquake ground motion, liquefaction potential, slope stability and height of tsunami that might be generated were estimated. Finally, three models, Model 08 (West Valley Faults), Model 13 (Manila Trench) and Model 18 (1863 Manila Bay), were selected for detailed damage analysis because these scenario earthquakes might cause severe damages to Metro Manila. Particularly in the worst case of scenario earthquake model 08 (West Valley Fault, Magnitude 7.2), 170,000 residential houses would collapse, 340,000 residential houses would be partly damaged, 34,000 persons would die, and 114,000 persons would be injured. Fire would break out and burn approximately 1,710 hectares wherein a total of 18,000 additional persons would be killed by this secondary disaster. Moreover, infrastructure and lifelines would also be heavily damaged.

**Table 3.3.1 Scenario Earthquakes**

| Model | Model 08 | Model 13 | Model 18 |
|---|---|---|---|
| Magnitude | 7.2 | 7.9 | 6.5 |
| Fault Mechanism | Inland Fault | Subduction | Unknown |
| Seismic Intensity (PEIS) | Almost VIII, IX alongside Marikina River and Manila Bay, | VIII at West of Metropolitan Mania, VII at other area | Almost VIII, VII at Quezon City |
| Tsunami | Will not occur | Maximum 4 m, Average 2 m alongside Manila Bay | Small effect |

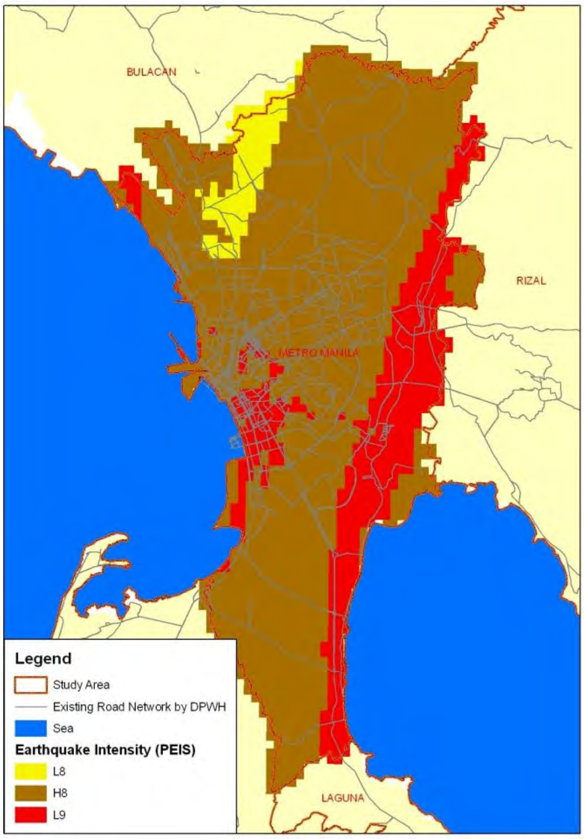
Source: MMEIRS (JICA, 2004).

3.10 The scenario earthquake model 08 (West Valley Fault, Magnitude 7.2) was determined to cause the heaviest damages compared with the other two scenarios. The possible intensity and liquefaction potential are shown in Figure 3.3.1.

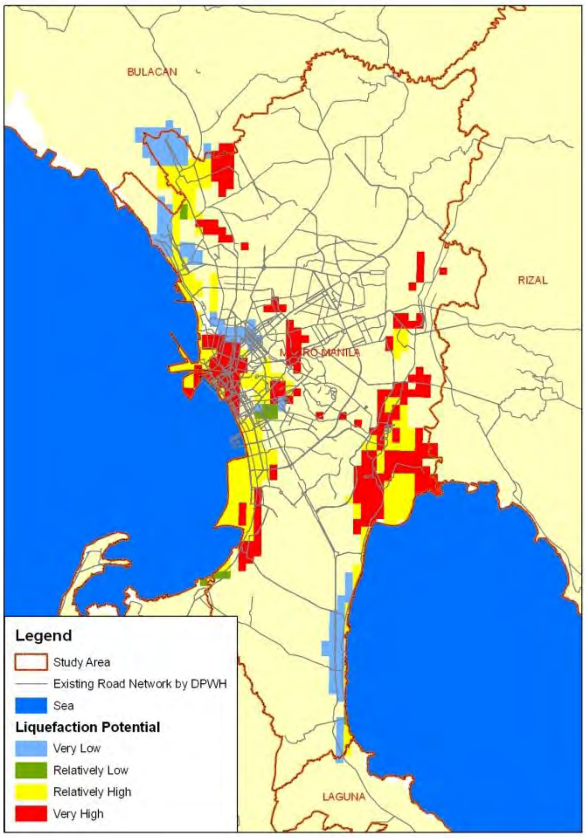
3.11 MMEIRS evaluated the urban vulnerability, which consists of building collapse, flammability, and evacuation difficulty, utilizing the methodology shown in Figure 3.3.2. The results of evaluation were used to determine the comprehensive regional vulnerability of Metro Manila.

3.12 In addition, the damages brought by the scenario earthquake would not only destroy infrastructure and lifelines directly but also bring secondary damages physically and socially. MMEIRS estimated these damages as shown in Table 3.3.2 and depicted these in Figure 3.3.3.

3.13 Finally, MMEIRS estimated the regional vulnerability of Metro Manila based on the urban vulnerabilities (see Figure 3.3.4). Table 3.3.3 summarizes the highly vulnerable areas by type and Table 3.3.4 describes the areas of possible regional separation.




Earthquake Intensity[1)]

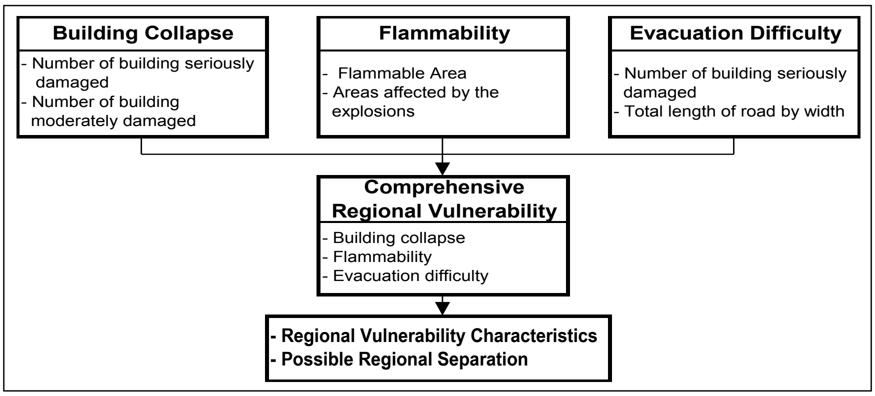



Liquefaction Potential

Source: MMEIRS (JICA, 2004).

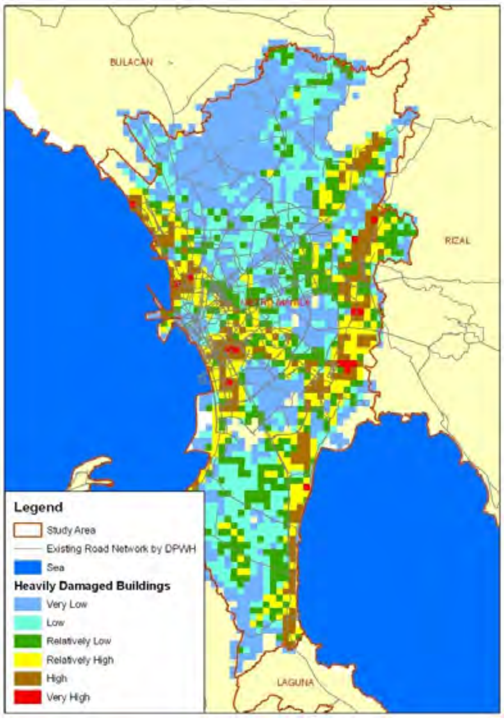
1) PEIS (PHIVOLCS Earthquake Intensity Scale): L8＝Lower PEIS VIII (equivalent to 5-6 of Japan Metrological Agency Intensity), H8= Higher PEIS VIII, L9 = Lower PEIS IX (equivalent to 7 of Japan Metrological Agency Intensity).

**Figure 3.3.1 Possible Earthquake Intensity and Liquefaction Potential**

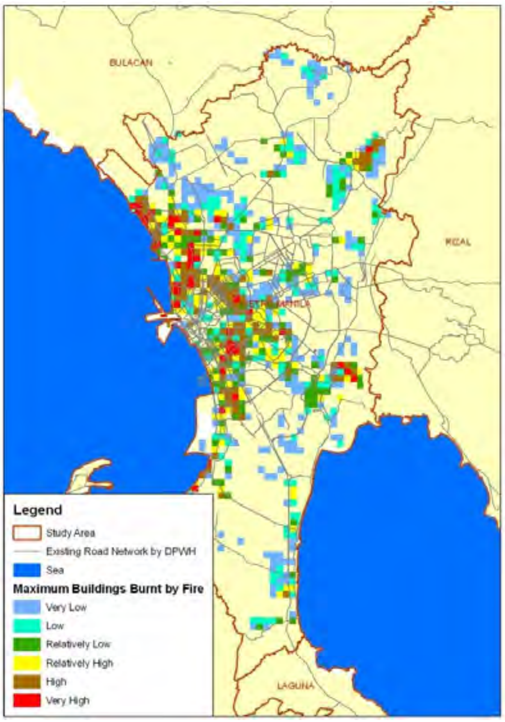



Source: MMEIRS (JICA, 2004).

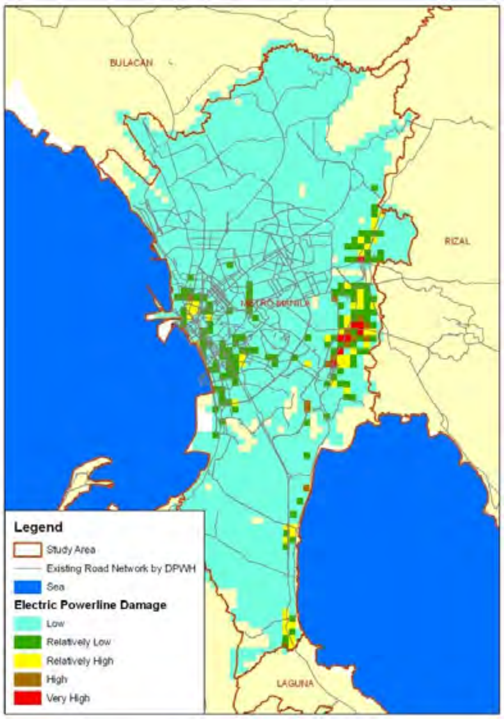
**Figure 3.3.2 Methodology of Urban Vulnerability Evaluation for Earthquake Scenario in Metro Manila**



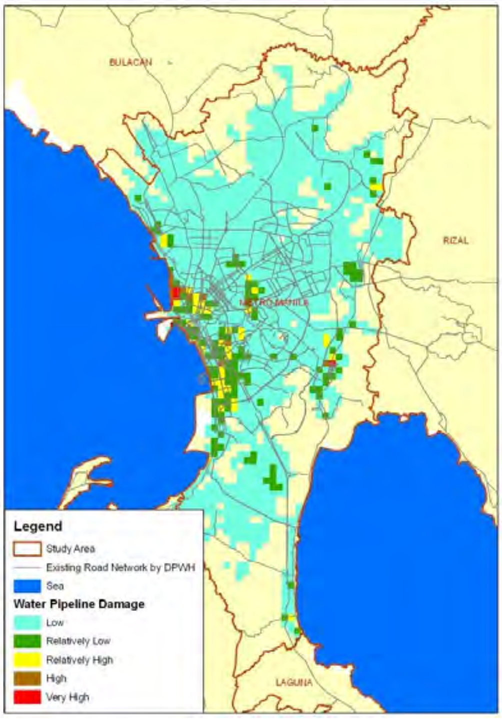

Heavily Damaged Buildings




Damages by Fire




Damages to Electricity




Damages to Water Supply

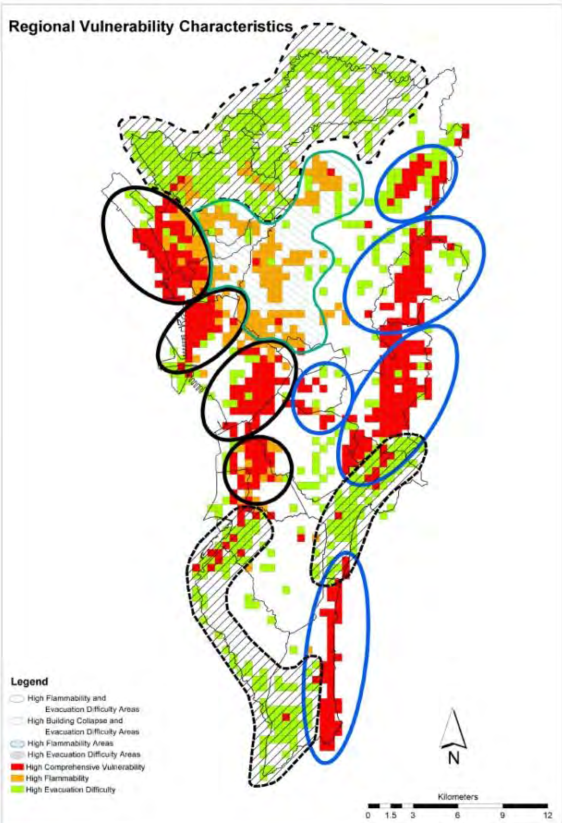
Source: MMEIRS (JICA, 2004).

**Figure 3.3.3 Estimated Damages by Scenario Earthquake**

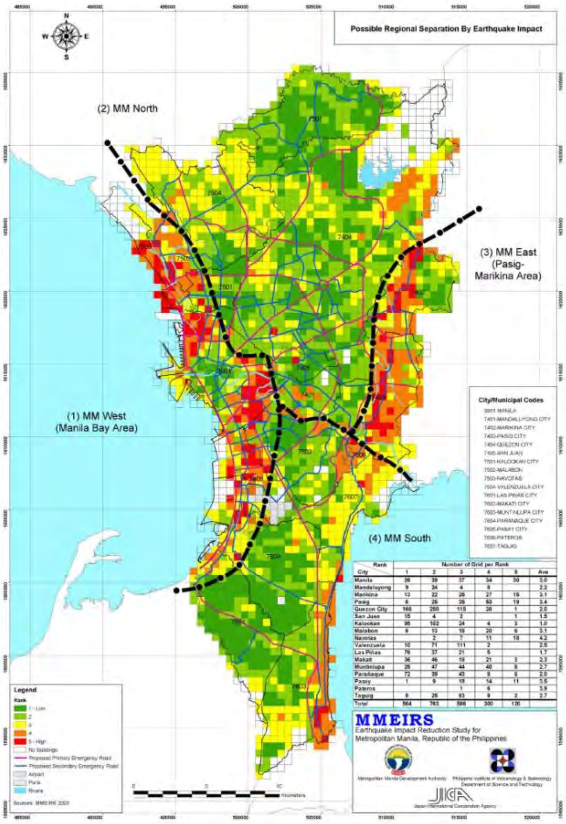
**Table 3.3.2 Summary of Estimated Damages (MMEIRS, Model 08)**

| | | | |
|---|---|---|---|
| Scenario Earthquake | Model 08 | | West Valley Fault |
| | Magnitude | | 7.2 |
| | Fault Mechanism | | Inland Fault |
| Residential Building 1,325,896 | Damage | Heavily | 170,000 (12.7%) |
| | | Partly | 340,000 (25.6%) |
| Fire (Wind Speed 8m/s) | Outbreak | | 500 |
| | Burnt Area | | 1,700 ha |
| | Burnt Buildings | | 100,000 |
| | Casualty | | 18,000 (0.2%) |
| Bridge 213, Flyover 80 | | Large possibility of falling-off | Bridge 7, Flyover 0 |
| Water Supply Distribution Pipes Total 4,615km | | Breaking of pipes or joints | 4,000 points |
| Electric Power Transmission and Distribution Line Total 4,862km | | Cutting of cables | 30 km |
| PLDT Telephone Aerial Cable 9,445 km Underground Cable 3,906 km | | Cutting of cables | 95 km |
| Public Purpose Buildings (Hospital 177, School 1,412, Fire Fighting 124, Police 43, MMDCC Organizations and 17 LGU City and Municipal Halls 53) | | Heavily Damaged | 8 – 10 % |
| | | Partly Damaged | 20 – 25 % |

Source: MMEIRS (JICA, 2004).




Regional Vulnerability Characteristics




Possible Regional Separation by Earthquake Impact

Source: MMEIRS (JICA, 2004).

**Figure 3.3.4 Regional Vulnerability by Estimated Damages of Scenario Earthquake**

**Table 3.3.3 Highly Vulnerable Areas by Type**

| Type of Vulnerability | Area |
|---|---|
| Flammability and Evacuation Difficulty | 1) Navotas Bay Area<br>2) Manila North Port Area<br>3) South Eastern Manila City Area<br>4) Central Manila Bay Area |
| Building Collapse and Evacuation Difficulty | 5) North Eastern Quezon City Area<br>6) Western Marikina City Area<br>7) Eastern Pasig City Area<br>8) Muntinlupa Laguna Bay Area<br>9) Mandaluyong – Makati – Manila City Border Area |
| Flammability | 10) Valenzuela – Kalookan South – Quezon west intersection |
| Evacuation Difficulty | 11) Metropolitan Manila Fringes<br>12) Northern Fringe<br>13) Taguig Fringe<br>14) Las Pinas Fringe |

Source: MMEIRS (JICA, 2004).

**Table 3.3.4 Possible Regional Separation**

| Area | Description |
|---|---|
| West Area | Western part of Metro Manila will be isolated from other parts of Metro Manila by fire and building collapse |
| North and South Areas | Northern and Southern parts of Metro Manila will be separated by building collapse and the geographical condition. The intersecting area between Mandaluyong and Makati has a high possibility of building collapse; moreover, Pasig River is running through east-west which is naturally disadvantageous in terms of separation. |
| East Area | All road networks running east-west which are on the fault will be broken due to the movement. Other roads running north-south in fault areas will be difficult to use due to the high number of building collapse. |

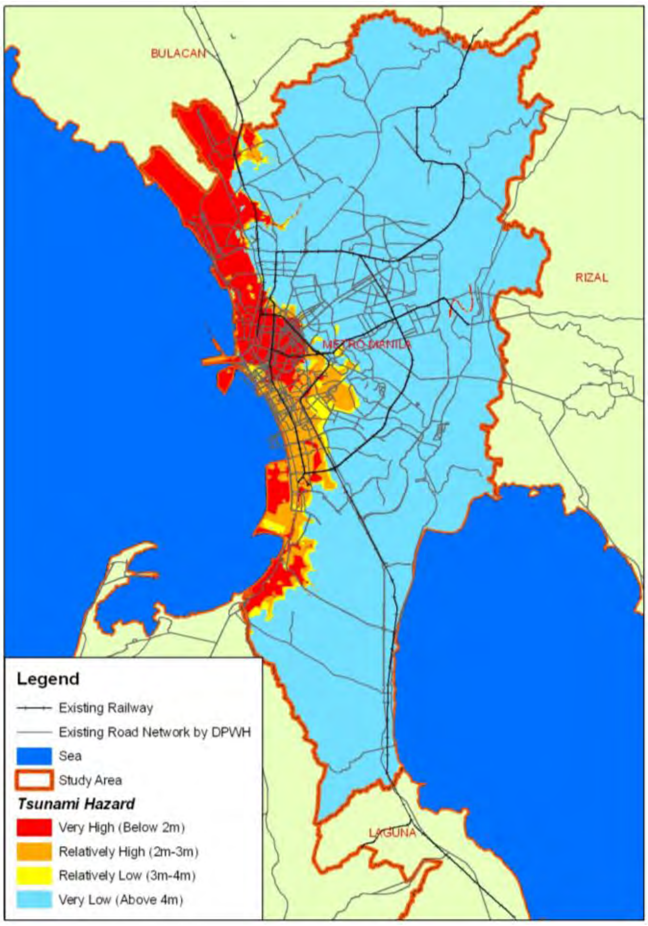
Source: MMEIRS (JICA, 2004).

## 3.4 Tsunami

3.14 MMEIRS estimated the tsunami hazard (without consideration of the influence by islands and shape of Manila Bay) based on the other scenario earthquake which occurs at the Manila Trench with magnitude 7 and causes the tsunami. The possible height of tsunami was estimated at 2 m to 4 m and arrival time was estimated at 70 minutes after earthquake occurrence.

3.15 After the heavy earthquake in Sumatra in December 2004, USGS pointed out the possibility of a magnitude 8 class earthquake and incidental tsunami. In relation to this, PHIVOLCS is reviewing the assumption, though the results have not yet been made known to the public. The analyses in this Study utilize the data of MMEIRS.

3.16 Figure 3.4.1 shows the tsunami hazard utilizing the possible tsunami height. High tsunami hazard areas are located along the seashores with low altitudes.




Source: MMEIRS (JICA, 2004).

**Figure 3.4.1 Estimated Tsunami Hazard**

## 3.5 Flood

3.17 The extent of damages by flood was estimated in the Study on Climate Change Impact over Asian Mega Cities (Phase 2): Metro Manila conducted by JBIC in 2008. This was a joint study among JBIC, WB and ADB which aimed to analyze the effects of climate change scenarios in Asian mega cities. JBICI focused on Metro Manila and studied the possible sea level rise and affected areas by flood when meteorological disasters occurred additionally. Utilizing the flood simulation, further analyses on impacts to socio-economic activities and infrastructure were conducted. Figure 3.5.1 shows the result of flood simulation under the scenario with return period of 30 years and no additional flood management measures in the Pasig-Marikina river basin. Figure 3.5.2 shows the existing water system in Metro Manila.

3.18 Typhoon Ondoy that hit Metro Manila in September 2009 caused unprecedented floods and heavy damages to the economy and livelihood. The experiences from this typhoon can be regarded as the hazards of flood such as flood area, flood depth and flood duration. This information must be collected as much as possible and analyzed to identify the flood hazard level. The analysis results can be utilized for mid- and long-term flood management and land use planning and can provide directions for formulating countermeasures. The WB conducted a project on the “Master Plan for Flood Management in Metro Manila and Surrounding Areas” in 2012 and simulated the flood areas affected by typhoon Ondoy. The results of simulation are illustrated in Figures 3.5.3 and Figure 3.5.4 which show flood depth and flood duration. This WB Master Plan elaborated a flood risk assessment study for Metro Manila and surrounding areas, prepared a comprehensive flood risk management plan, and proposed a set of priority structural and non-structural measures that will provide sustainable flood risk management up to a certain safety level. The following 11 projects are proposed for the structural mitigation measures for the Short-list (see Table 3.5.1).

**Table 3.5.1 Priority Structural Measures for Sustainable Flood Risk Management**

| Short-listed Projects | Priority |
|---|---|
| (i) Pasig-Marikina River Improvement with Large Marikina Dam:<br>▪ Improvements of the Upper Marikina River (upstream from bifurcation of Mangahan Floodway to the existing Wawa Dam)<br>▪ Construction of Marikina Large Dam<br>▪ Re-improvement of the Pasig River and Lower Marikina River and improvement of the San Juan River and the Napindan Channel | very high priority |
| (ii) Meycauayan River Improvement | high priority |
| (iii) Malabon–Tullahan River Improvement | high priority |
| (iv) South Parañaque–Las Piñas River Improvement | marginal priority |
| (v) Laguna Lakeshore Protection: West Laguna Lakeshore Land Raising<br>▪ Raising lakeshore land is proposed for the west lakeshore area.<br>▪ The raised land can be utilized for improvement of road transportation and development of the lakeshore area for tourism, commercial, cultural places etc. by utilizing the valuable natural environment including ecosystem and landscape of Laguna Lake. | very high priority |
| (vi) Land Raising for Small Cities around Laguna Lake | high priority |
| (vii) East Mangahan Floodway: with high priority | high priority |
| (viii) Improvements of the Inflow Rivers to Laguna Lake | high priority |
| (ix) Manila Core Area Drainage Improvement | high priority |
| (x) West Mangahan Area Drainage Improvement | marginal priority |
| (xi) Valenzuela, Obando and Meycauayan (VOM) Area Drainage Improvement: still conceptual plan only, and to be studied more. | |

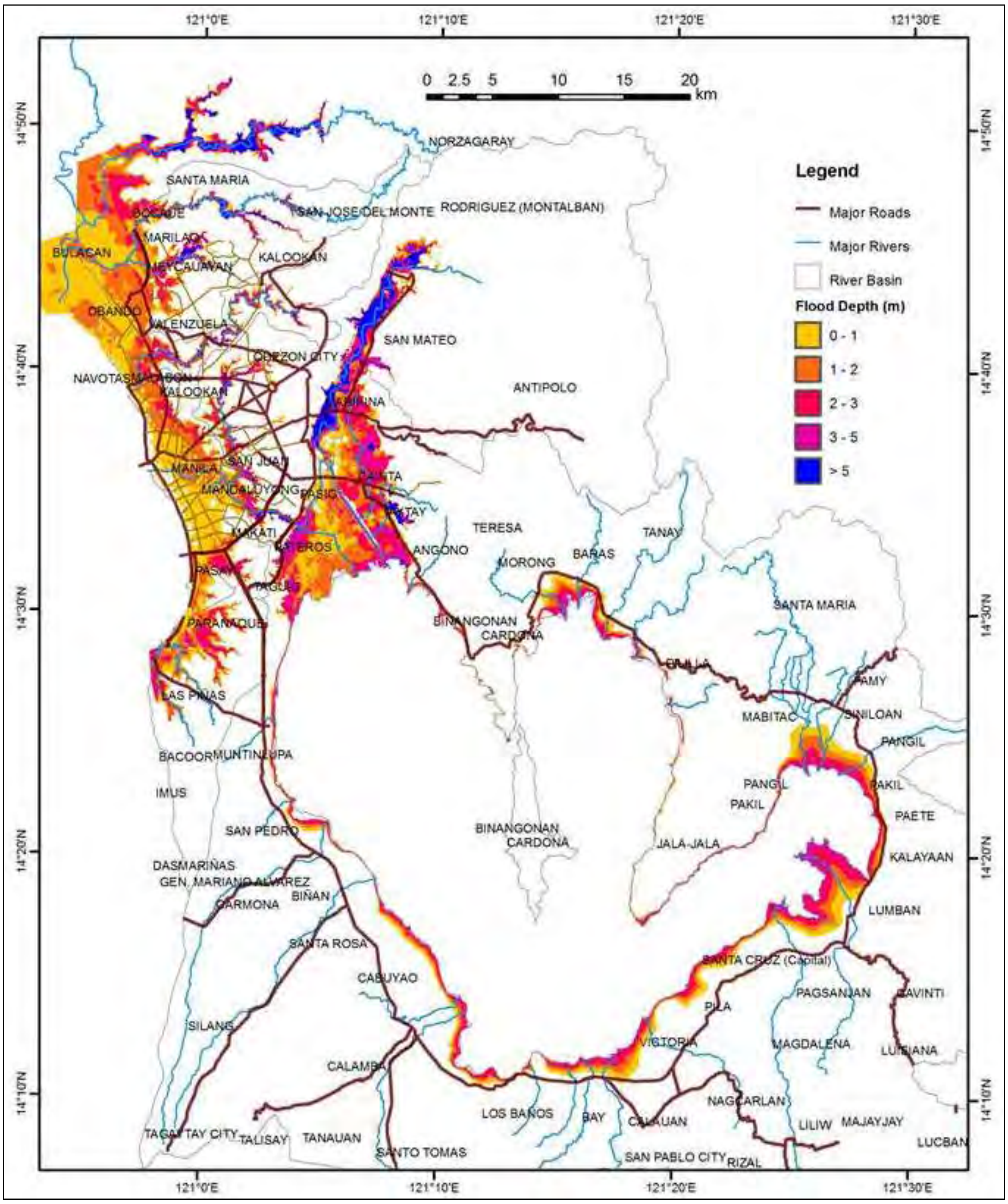
Source: Compiled from Master Plan for Flood Management in Metro Manila and Surrounding Areas, World Bank, 2012.


Source: The Study on Climate Change Impact over Asian Mega Cities (Phase 2): Metro Manila (JBIC, 2008).

**Figure 3.5.1 Flood Hazard (Pasig-Marikina River Basin)**

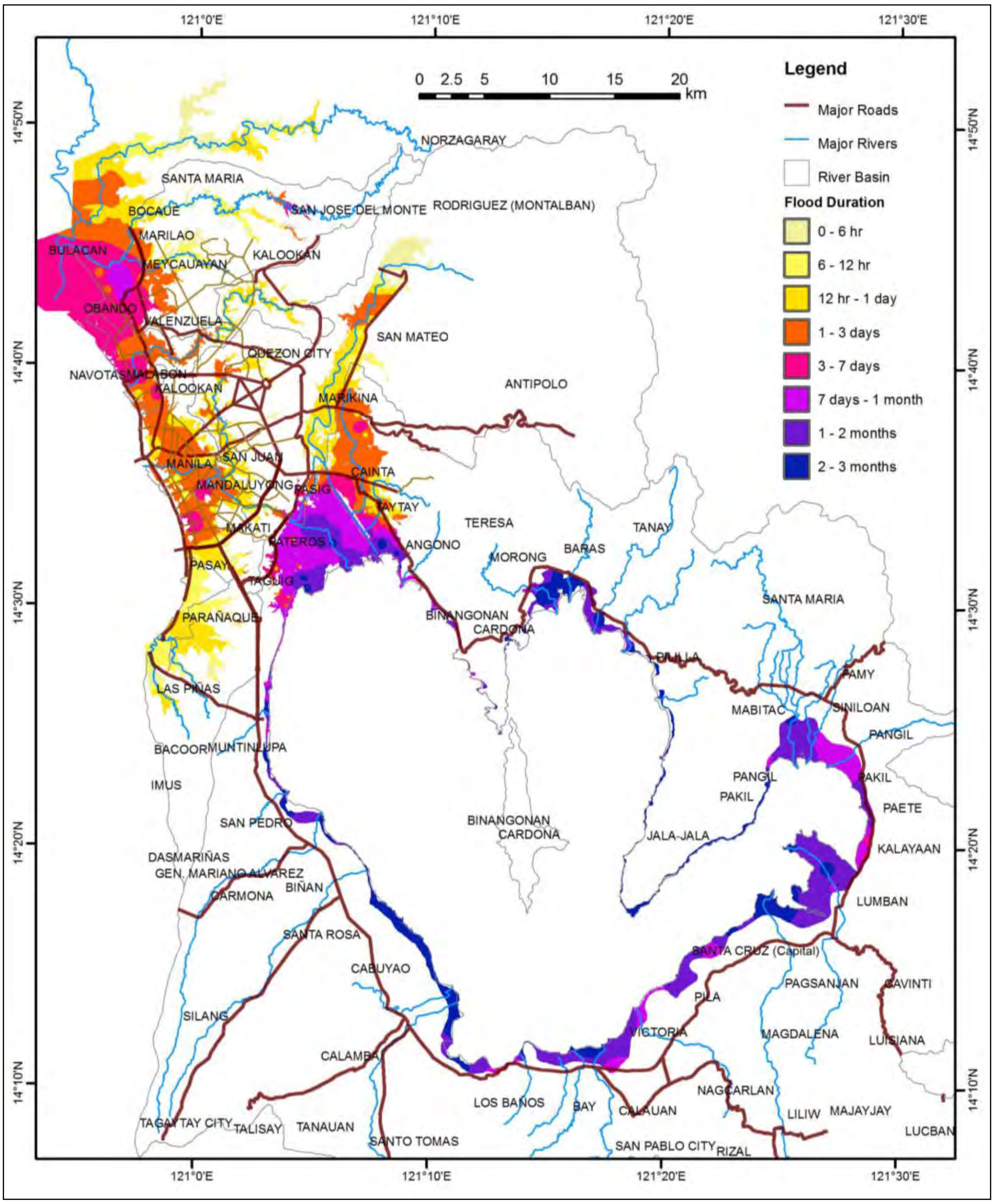

Source: MMEIRS (JICA, 2004).

**Figure 3.5.2 Water System**




Source: Master Plan for Flood Management in Metro Manila and Surrounding Areas, World Bank, 2012.

**Figure 3.5.3 Flood Depth Simulation of Typhoon Ondoy**




Source: Master Plan for Flood Management in Metro Manila and Surrounding Areas, World Bank, 2012.

**Figure 3.5.4 Flood Duration Simulation of Typhoon Ondoy**

## 3.6 Multi-Hazard Risk Map

3.19 The possible hazards by natural disasters are evaluated according to hazard level marked by hazard scores of three levels (high, moderate, low). The scores are compiled into a 500m grid and mapped on GIS. A multi-hazard risk map is prepared by summing up those scores and reclassified as high, moderate and low levels of multi-hazard risk. The evaluation criteria of hazards are summarized in Table 3.6.1. In addition, these risk scores can be utilized for analysis of regional vulnerability and socio-economic impacts. These results can be a basis for urban planning and transport system planning. Figure 3.6.1 shows the workflow of multi-hazard risk mapping.

### 1) Liquefaction Potential

3.20 The liquefaction potential for individual layers is analyzed by the FL method. ISSMFE (1993)[9] describes the details of these procedures. Figure 3.6.2 (1) shows the distribution of risk scores of liquefaction potential for Scenario Earthquake Model 08.

### 2) Building Collapse

3.21 The damage functions, which are the relation between seismic intensity and the damage ratio of buildings, were established through the analysis of the 1990 Luzon Earthquake damages compiled by AIJ (1992). It is necessary to classify the existing buildings in Metro Manila to know their quantitative distribution, and to establish the damage function of each building classification for the estimation of the building damage by earthquake. For the present condition of the buildings, the building inventory of each 500m grid was estimated based on the 2000 Census of Population and Housing by the National Statistics Office (NSO) and the newly compiled Land Use Map in the MMEIRS. The seismic vibration and liquefaction are picked up as the direct causes of building damage. Figure 3.6.2 (2) shows the distribution of risk scores of heavily damaged buildings.

### 3) Flammability

3.22 Metro Manila is constantly suffering from occurrence and spread of fire. After an earthquake, fire may also break out due to many origins. Estimation of the number of fire outbreaks after earthquake requires consideration of many indefinite elements. Unfortunately, there is no statistical data concerning earthquake and fire outbreak in the Philippines. Therefore, the fire outbreaks are estimated based on the experience in Kobe from the 1995 Kobe Earthquake. Figure 3.6.2 (3) shows the distribution of risk scores of the maximum number of burned buildings.

### 4) Earthquake Hazard Map

3.23 The risk scores calculated in 1) to 3) are compiled into an earthquake hazard map, as shown in Figure 3.6.2 (4). This figure shows the distribution of hazard level to earthquake. The high hazard areas are located along Manila Bay including Manila City, Pasay City, Paranaque City, Navotas City, and along Laguna Lake including Pasig City, Pateros, and surrounding areas.

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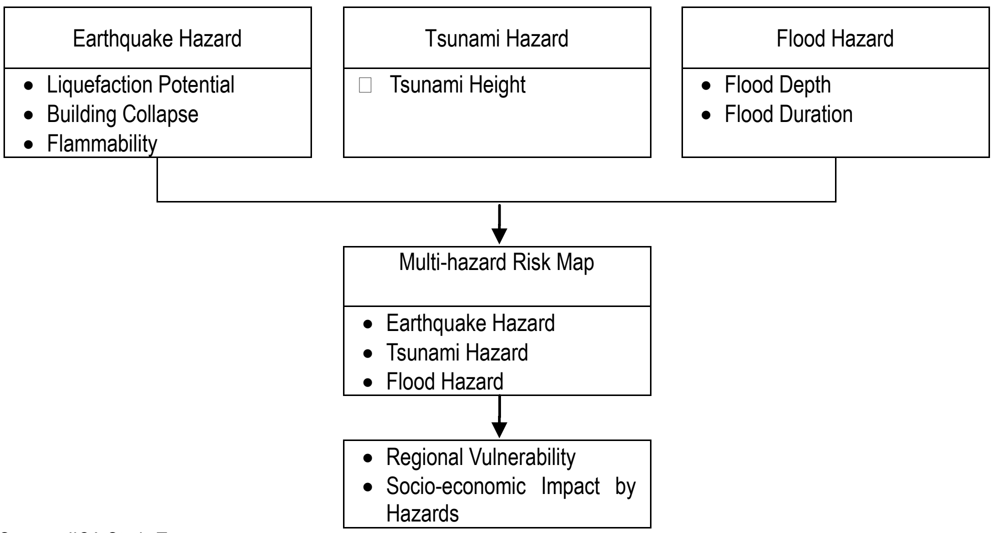
[9] Manual for Zonation on Seismic Geotechnical Hazards, Technical Committee for Earthquake Geotechnical Engineering, TC 4, International Society of Soil Mechanics and Foundation Engineering (ISSMFE), 1993.

**Table 3.6.1 Hazard Evaluation Criteria**

| Disaster | Hazard | Criteria | Description | Level | Score |
|---|---|---|---|---|---|
| Earthquake | Liquefaction Potential | PL=0 | Liquefaction prone area | None | 0 |
| | | 0<PL≤5 | Investigation of important building is required | Low | 1 |
| | | 5<PL≤15 | Ground improvement is required, Investigation of important structures is indispensable | Moderate | 2 |
| | | 15<PL | Ground improvement is indispensable | High | 3 |
| | Building Collapse | PB=0 | Building collapse prone area | None | 0 |
| | | 0<PB≤50 | Few buildings are collapsed | Low | 1 |
| | | 50<PB≤200 | Almost half of building are collapsed | Moderate | 2 |
| | | 200<PB | Most of buildings are collapsed | High | 3 |
| | Flammability | PF=0 | Fire prone area | None | 0 |
| | | 0<PF≤50 | Few fire are spread | Low | 1 |
| | | 50<PF≤200 | Easy to spread fires but some open spaces prevent the spreads | Moderate | 2 |
| | | 200<PF | Easy to spread fires and less open space | High | 3 |
| Tsunami | Elevation | 4.1- (m) | Tsunami prone area | None | 0 |
| | | 3.1-4.0 (m) | Partly affected by tsunami | Low | 1 |
| | | 2.1-3.0 (m) | Mostly affected by tsunami | Moderate | 2 |
| | | -2.0 (m) | Completely affected by tsunami | High | 3 |
| Flood | Flood Depth | 0 (m) | Flood prone area in regard of depth | None | 0 |
| | | 0.1-1.0 (m) | Flooded up to waist of adult | Low | 1 |
| | | 1.1-2.0 (m) | Ground floor is damaged heavily | Moderate | 2 |
| | | 2.1- (m) | First floor is damaged | High | 3 |
| | Flood Duration | 0 (hours) | Flood prone area in regard of duration | None | 0 |
| | | | | Low | 1 |
| | | | | Moderate | 2 |
| | | | | High | 3 |

Source: Prepared by JICA Study Team based on MMEIRS and World Bank's Flood Master Plan




Source: JICA Study Team.

**Figure 3.6.1 Work Flow of Multi-Hazard Risk Mapping**

## 5) Tsunami Hazard Map

3.24 A tsunami hazard map was prepared in MMEIRS (see Figure 3.6.3). The height of tsunami affected area is interpreted into hazard scores except the area evaluated as "very low" (which has over 4m of altitude and is safe from tsunami). The map shows the distribution of tsunami hazard levels. The high hazard areas are located in the cities of Navotas, Malabon, Valenzuela, Manila, Paranaque and Las Pinas.

### 6) Flood Hazard Map

3.25 A flood hazard map is prepared utilizing the flood depth and the flood duration of the affected areas by typhoon Ondoy. The simulation results are interpreted into three levels of hazard score and compiled in Figure 3.6.4. The high hazard areas are located along the rivers, particularly the cities of Navotas, Malabon, Valenzuela, Manila, Quezon City, Mandaluyong, Makati, Pasay, Paranaque, Las Pinas, Taguig, Pateros, Pasig and Marikina. However, damages occurred almost all over Metro Manila.

### 7) Multi-Hazard Risk Map

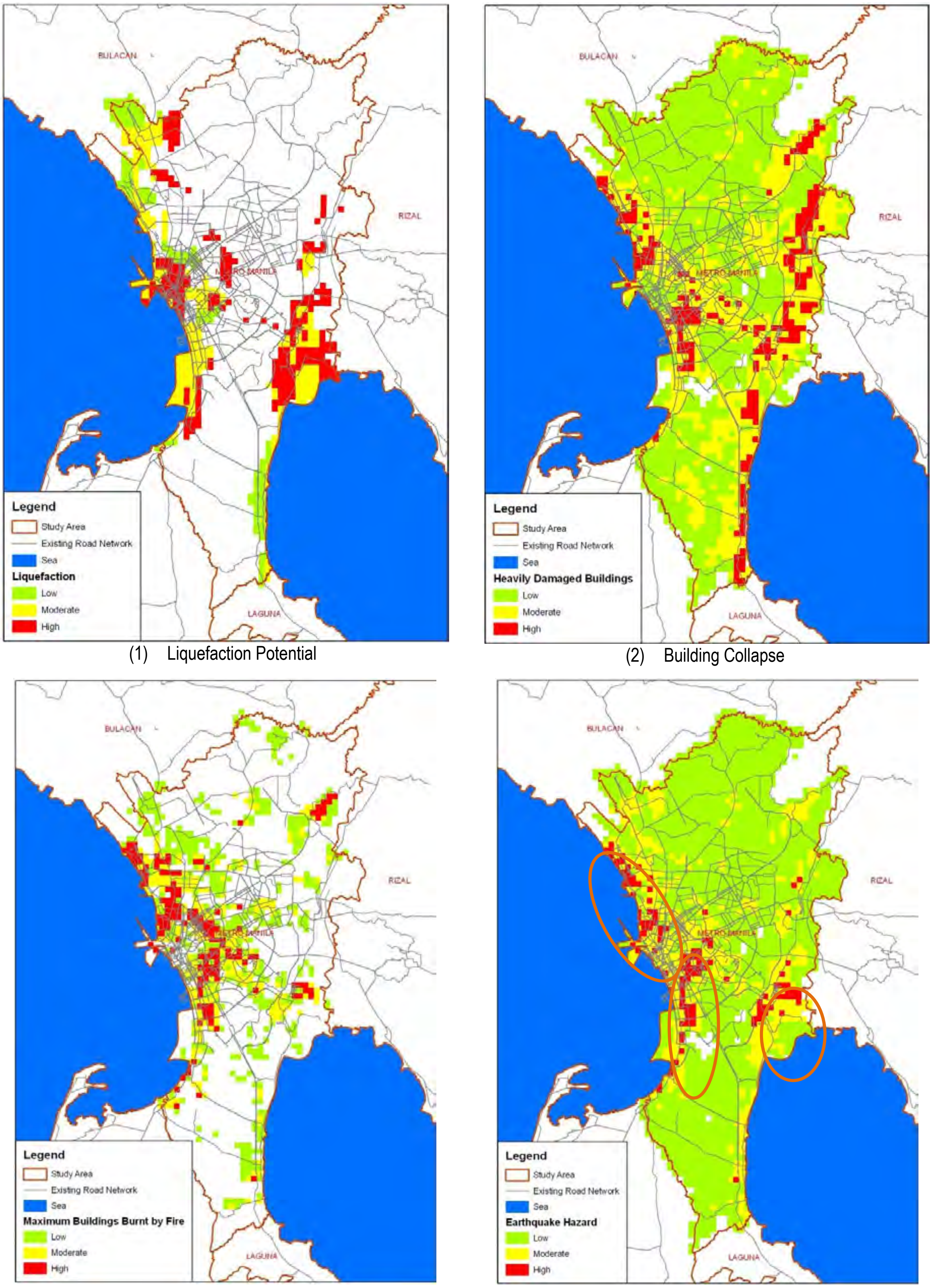
3.26 The hazard scores calculated in 4) to 6) are summed up and evaluated into three levels of multi-hazard risk scores. The distribution of the scores is shown in Figure 3.6.5. The high hazard areas are located in Navotas, Malabon, Valenzuela, Manila, Pasay, Paranaque, Las Pinas, Taguig, Pateros, Pasig and Marikina.

3.27 Table 3.6.2 summarizes the high hazard areas evaluated by the above analyses.

**Table 3.6.2 High Hazard Areas**

| City/Municipality | | Hazards | | | |
|---|---|---|---|---|---|
| | | Earthquake | Tsunami | Flood | Multi-hazard |
| 1 | Manila | X | X | X | X |
| 2 | Mandaluyong | - | - | X | X |
| 3 | Marikina | - | - | X | X |
| 4 | Pasig | X | - | X | X |
| 5 | Quezon | - | - | X | X |
| 6 | San Juan | - | - | X | X |
| 7 | Caloocan | - | - | X | X |
| 8 | Malabon | - | X | X | X |
| 9 | Navotas | X | X | X | X |
| 10 | Valenzuela | - | X | X | X |
| 11 | Las Pinas | - | X | X | X |
| 12 | Makati | - | - | X | X |
| 13 | Muntinlupa | - | - | - | - |
| 14 | Paranaque | X | X | X | X |
| 15 | Pasay | X | - | X | X |
| 16 | Pateros | X | - | X | X |
| 17 | Taguig | - | - | X | X |

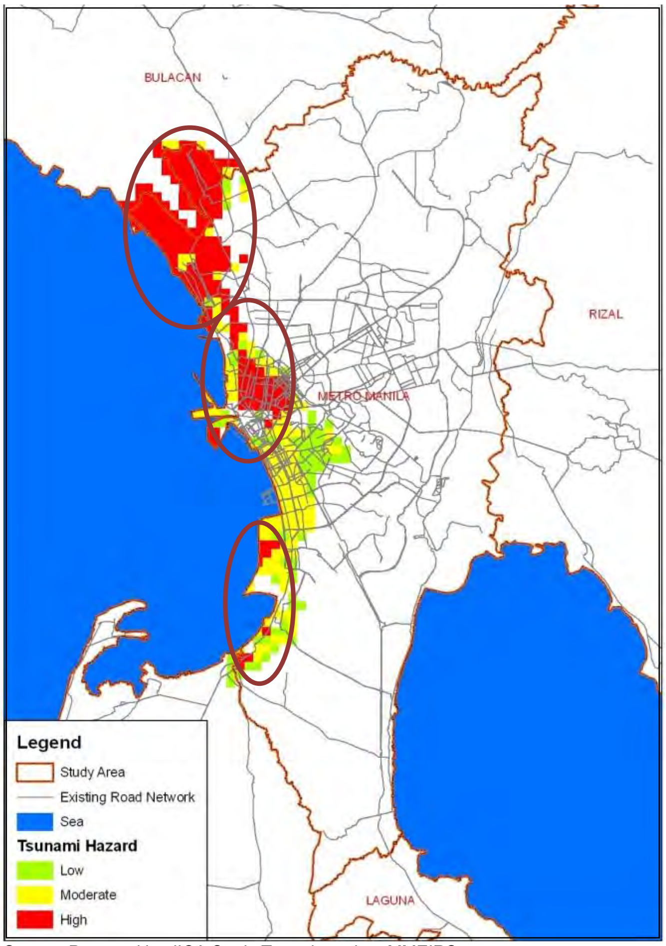
Source: JICA Study Team.




(1) Liquefaction Potential
(2) Building Collapse
**(3)** Flammability
**(4)** Earthquake Hazard Map

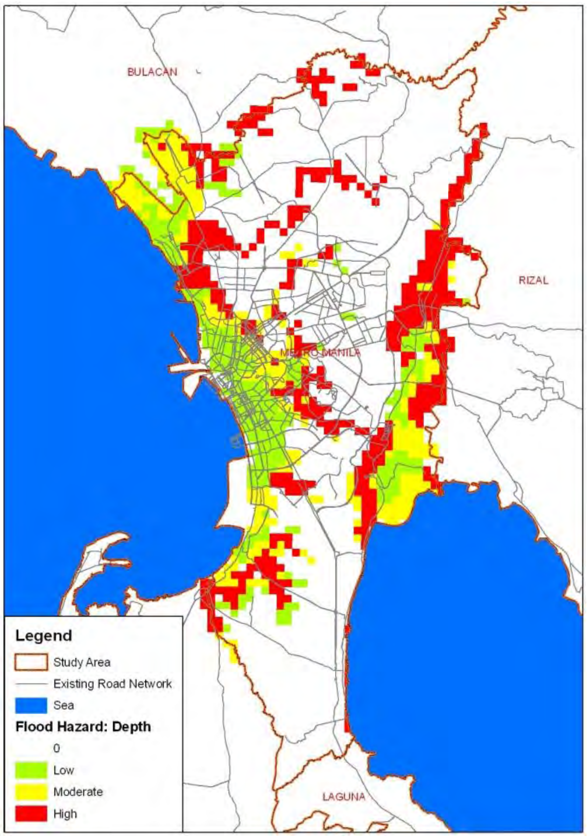
Source: Prepared by JICA Study Team based on MMEIRS.

**Figure 3.6.2 Earthquake Hazard Map**

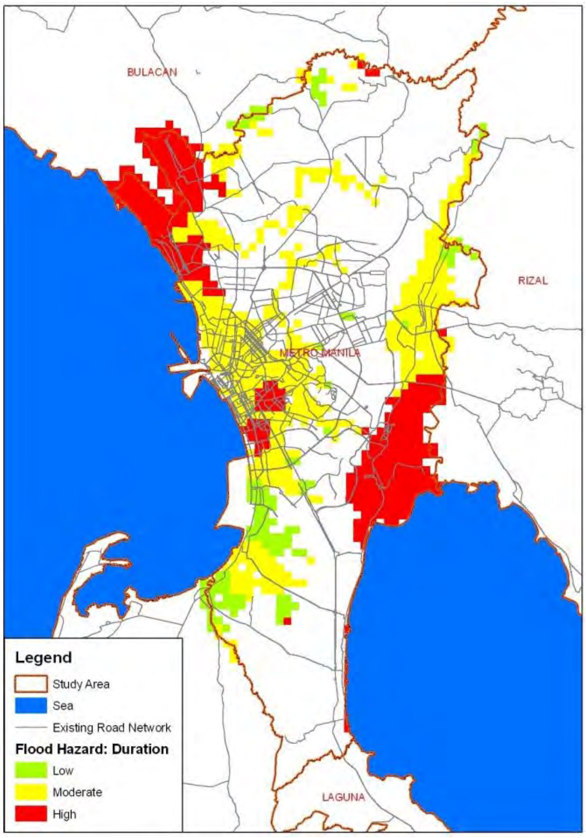



Source: Prepared by JICA Study Team based on MMEIRS.

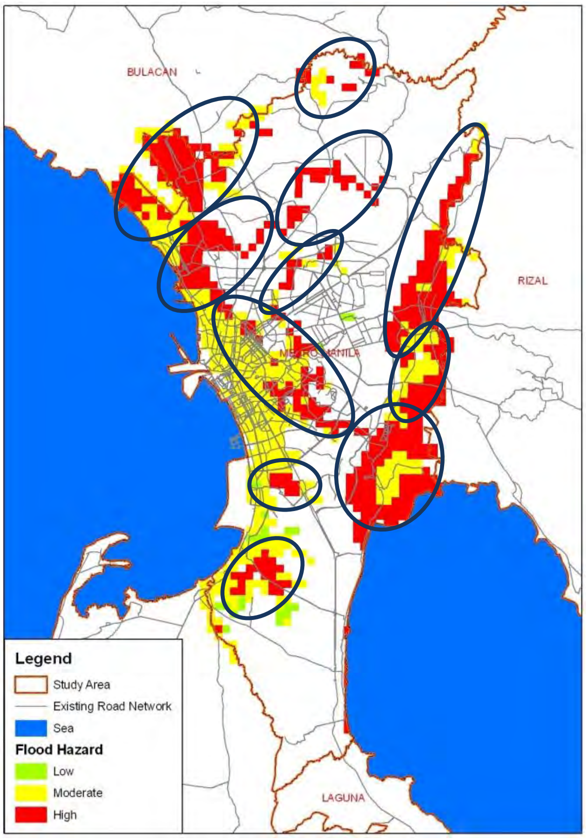
**Figure 3.6.3 Tsunami Hazard Map**




(1) Flood Depth



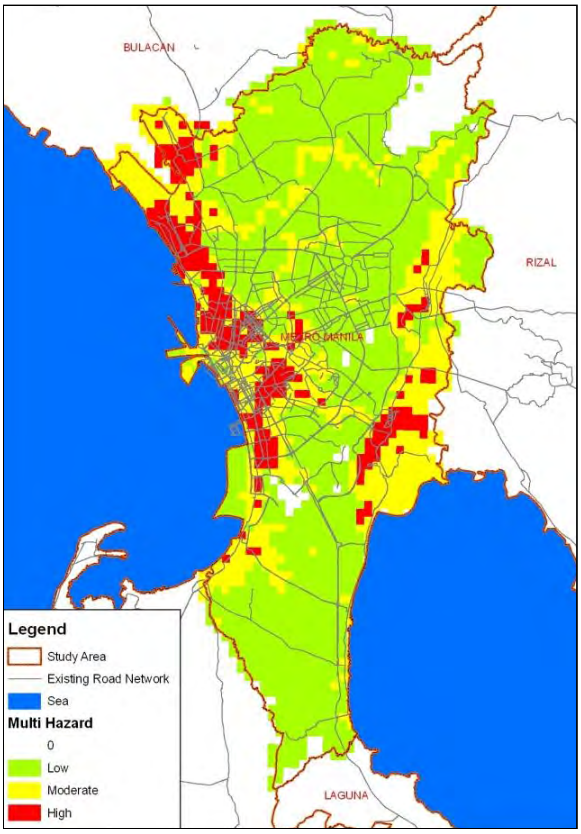

(2) Flood Duration




(3) Flood Hazard Map

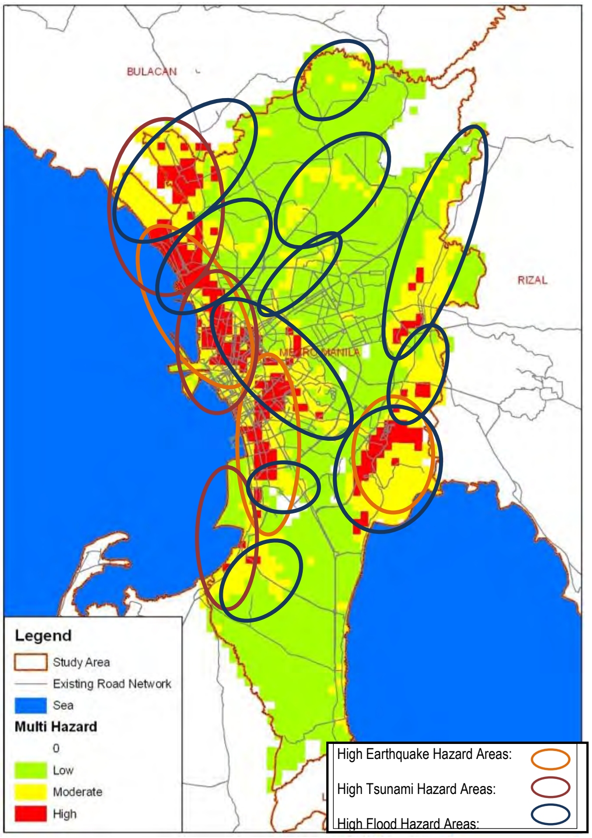
Source: JICA Study Team based on Data from World Bank Study.

**Figure 3.6.4 Flood Hazard Map**




Source: JICA Study Team based on Various Data Source

**Figure 3.6.5 Multi-Hazard Risk Map**




Source: JICA Study Team based on Various Data Sources.

**Figure 3.6.6 Multi-Hazard Risk Map and Vulnerable Areas to Each Hazard**

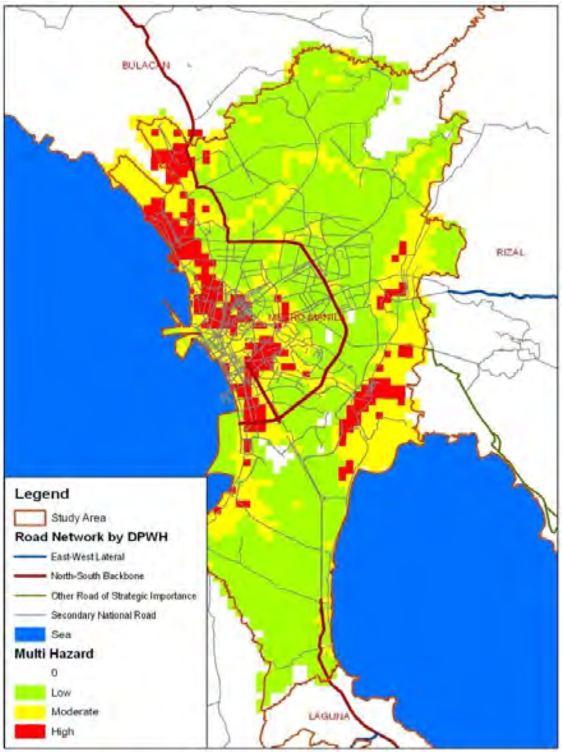
## 3.7 Socio-economic Impact of Hazards

3.28 When the damages caused by natural disasters affect infrastructure and lifelines, their functions will be lost and smooth rescue and recovery operations will be disrupted. Moreover, civilian lives and economic activities will suffer from the loss of infrastructure functions. This section analyzes the possibility of damages to infrastructure and lifelines by overlaying their locations on the multi-hazard risk map.

3.29 In addition, the effects on the residents are also analyzed utilizing distribution of population density and identifying the areas and population volume in high risk areas. These areas and population can be a target of redevelopment projects.

### 1) Infrastructure

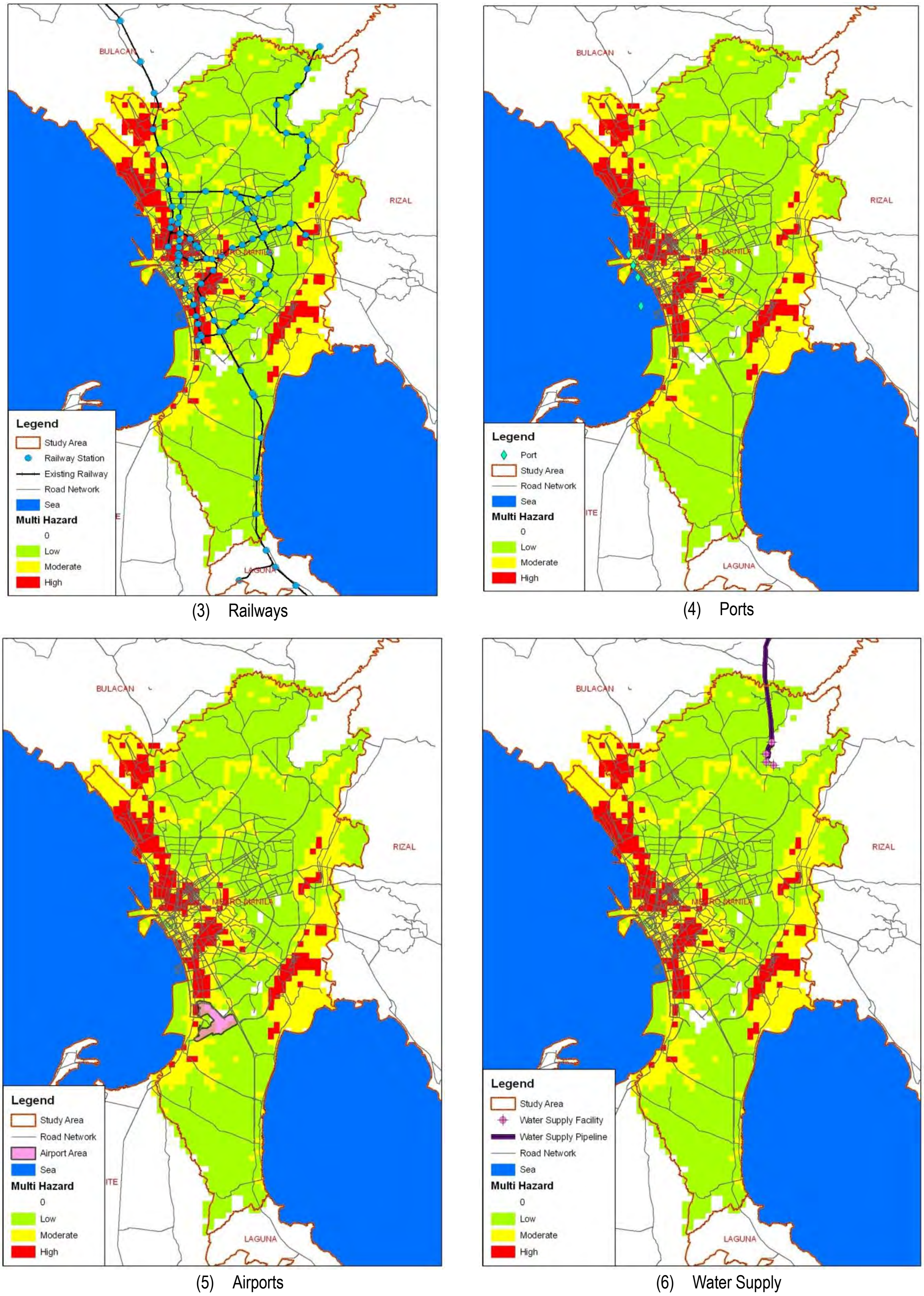
3.30 This analysis focuses on the infrastructure which is important in transporting the necessary materials and persons in the event of disasters. These are roads, bridges, railways, ports, airports and water supply. Figure 3.7.1 shows the location of infrastructure overlaid on the multi-hazard risk map.




(1) Roads

(location data from MMEIRS is not applicable to Multi-hazard risk map. Therefore, analysis could not be conducted)

(2) Bridges



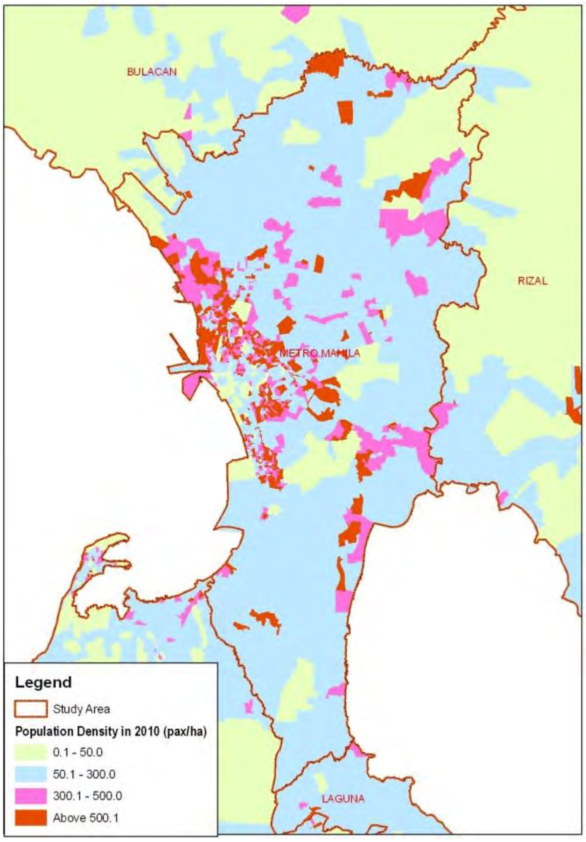

Source: JICA Study Team based on data from DPWH, DOTC, etc.

**Figure 3.7.1 Earthquake Hazard Map and Socio-economic Infrastructure**

### 2) Population

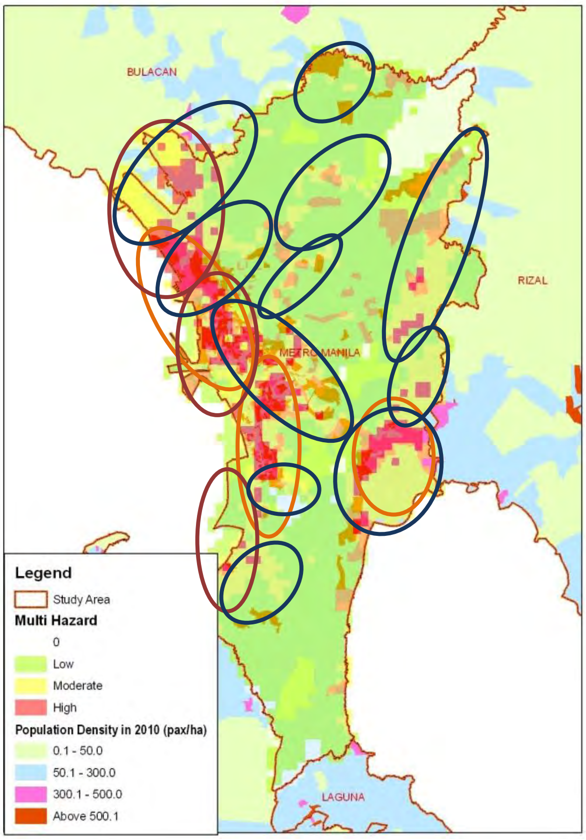
3.31 The areas and the population affected by the disasters are analyzed by overlaying the distribution of population density on the multi-hazard risk map. Figure 3.7.2 shows the distribution of population density based on census in 2010. Figure 3.7.3 shows the overlaid map.

3.32 The areas where both population density and multi-hazard risks are high total 15 cities and 700 barangays, affecting a total population of 2,739,215.




Source: Prepared by JICA Study Team based on Census 2010.

**Figure 3.7.2 Distribution of Population Density (2010)**




Source: Prepared by JICA Study Team based on Census 2010.

**Figure 3.7.3 Distribution of Population Density and Multi-Hazard Risk Map**

## 3.8 Required Measures

3.33 Based on the analyses of various hazard maps, the following measures are proposed in urban planning with necessary transport infrastructure design in Metro Manila (see Table 3.8.1).

**Table 3.8.1 Measures Required Against Possible Impacts of Multi-Hazards**

| | | Possible Damages | Measures |
|---|---|---|---|
| Infra-structure | Roads | Divided by earthquake and be impassable | Inside of study area: Strengthening of emergency transport network<br>Outside of study area: Strengthening of transport function to connect alternative ports and airports of Clark and Subic in the north and the ones in the south. |
| | Bridges | Collapsed by earthquake and be impassable | Strengthening of emergency transport network requires secure bridges. Bridges should be strengthened with appropriate measures based on earthquake resistance assessment. |
| | Railways | Collapsed by earthquake and be impossible to operate | Strengthening of railway is required for those located on high liquefaction potential areas. |
| | Ports | Collapsed by liquefaction caused by earthquake when they are located on alluvium | Pier and port facilities should be strengthened to maintain their functionality when earthquake occurs because ports are utilized for rescue operation. |
| | Airports | Collapsed by liquefaction caused by earthquake when they are located on alluvium | Some facilities of the airport, such as runway, control tower and terminal, should be strengthened because airports are utilized as a gateway for transporting rescue crews and aid materials. |
| | Water Supply | Pipelines can be collapsed by earthquake | The pipeline connecting Angat Dam and Quezon should be strengthened to keep the water supply function in the event of earthquake. |
| Living Area | Residents | Affected by building collapse and fire | Wide area evacuation sites and open spaces should be secured together with urban redevelopment. Urban planning tools to create these areas should be developed. |
| | Building | Collapsed by earthquake and burnt by fire | Buildings which are vulnerable to earthquake and fire should be strengthened or rebuilt to become earthquake resilient through appropriate measures, e.g., building code or urban redevelopment tools. On the other hand, residential areas should be formed by fire-resilient belts with wide roads and fire-resilient buildings utilizing urban redevelopment tools. |

Source: JICA Study Team.

# 4 ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT OF THE SHORT-TERM PROGRAM (2014–2016)

## 4.1 Environmental Impact Assessment and Strategic Environmental Assessment

4.1 The environmental impact assessment (EIA) system is the process of predicting the likely environmental consequences of implementing a project and designing appropriate mitigating and enhancement measures as an input to decision making. The EIA is conducted by a project proponent or an expert group commissioned by the proponent. In the Philippines, the results of the EIA are documented and submitted to the DENR's EMB for review as the major basis for decisions on Environmental Compliance Certificate (ECC) applications. The contents of the ECC are: (i) Scope and limitations of approved activities/components; (ii) Conditions to ensure compliance with Environmental Management Plans (EMPs); and (iii) Recommendations to other agencies. If it is a denial letter, it specifies the basis for the decision. ECCs of projects not implemented within five years from its date of issuance are deemed expired.

4.2 The Philippine EIA System is regarded as well-established including a mandate, administration, procedure and guidelines.[10] "DAO No. 30 of 2003 Implementing Rules and Regulations (IRR) for the Philippine Environmental Impact Statement (EIS) System" was issued in 2003, then the "Revised Procedural Manual for DAO 30/2003" was issued in 2007. Mainstreaming of environment and social issues in the development project level started under these mandates and manual in early the 2000s.

4.3 There are, however, a number of weaknesses that prevent the effective implementation of the EIA. For one, the EIS system is viewed by many stakeholders as too stringent and obstructive to investment. Moreover, the lack of qualified staff, equipment, and accredited laboratories to analyze the samples is always an issue when preparing the EIA. Underfunded environmental management programs lacked baseline environmental data, which is also a great barrier for proponents when there's a need to prepare a sound EIA based on reliable data and analysis. This situation exacerbates the costs of commissioning EIAs for large infrastructure projects and has become one of the reasons of implementation delays.

4.4 The limited scope and function of the EIA system and technical weaknesses have resulted in difficulties in meeting new challenges. There are many issues that can only be addressed at the policy and strategic levels. This study, the transport sector roadmap for the sustainable development of the Greater Capital Region, is a framework for the integrated development of the transport system in Metro Manila, Regions III and IV-A, and it has adopted an analytical approach for mainstreaming economic, environmental, and social issues in decision making and implementation processes at the strategic level.

4.5 Taking the current concerns of environmental and social issues into consideration, this section elaborates the cumulative and indirectly induced environmental effects of the planned roadmap into the proposed Short-term Program (2014-2016)[11].

[10] Environmental Impact Assessment Regulations and Strategic Environmental Assessment Requirements, The World Bank, April 2006.
[11] Refer to Chapters 3 and 4 of this study's Main Report for details of the Short-term Program (2014-2016).

## 4.2 Current Status of EIA Implementation in the Proposed Short-Term Program

4.6 In recognition of the possible impacts of infrastructure projects to the environment, the DPWH through Memorandum Order dated 16 January 1996 organized a specialized EIA group as part of the program on strengthening the EIA capability of the department's Planning Service staff. A total of 20 individuals from the Planning Division and other project management offices (PMOs) of the DPWH were organized and detailed at the department's Environmental Impact Assessment Project Office (EIAPO).

4.7 In 1999, Department Order 220 entitled "Strengthening of EIAPO," was issued in order to give the EIA team adequate capability to ensure that all DPWH projects are screened according to the DENR requirements and that necessary environmental assessment, mitigation measures, and compensation are carried out and monitored. The EIAPO as the environmental arm of the department projects environmental and social support for foreign and locally funded projects being implemented by project proponents of the department (i.e., bureaus, PMOs, and regional/district offices). In particular, the EIAPO is responsible for overseeing EIA preparation, and once approved, the application of the DPWH environment policy. The role of the EIAPO covers project planning, preparation, design, implementation, monitoring, and post implementation evaluation.

4.8 The functions of the EIAPO are as follows:

(i) Assess environmental and social impact, and land acquisition;

(ii) Prepare relevant reports such as Initial Environmental Examinations (IEEs), Environmental Impact Statements (EISs), Environmental Management Plans (EMPs), Resettlement Action Plans (RAPs), and other necessary documents;

(iii) Facilitate consultation and information dissemination to project-affected people and other relevant stakeholders;

(iv) Conduct environmental monitoring, monitor RAP implementation, and conduct post implementation evaluation;

(v) Provide guidance to regional and district level DPWH staff and local authorities in carrying out the above studies, preparation of documents, and RAP implementation;

(vi) Provide training at regional, district, and local level for consultation/participation, RAP implementation, environmental management planning, environmental monitoring, EIA tools and other new techniques;

(vii) Maintain and update the existing data bank and geographical information system (GIS); and

(viii) Coordinate environmental concerns with other DPWH offices, government agencies, local government units, and non-governmental organizations.

4.9 In 2004, Department Order 58 was issued to rename the EIAPO to the Environmental and Social Services Office (ESSO).

4.10 In the past decade or so, ESSO has been the recipient of continuous capacity development support from the World Bank, ADB, and JICA. These programs have made significant contributions in the preparation of the "Social and Environmental Management System Operation Manual 2003".

4.11 To date, ESSO has 11 staff and with the DPWH rationalization plan, ESSO will become organic to the department with 25 permanent personnel to undertake the EIA and

RAP; promote gender and development (GAD) and climate change adaptation; and implement the National Sewerage and Septage Management Program (NSSMP).

4.12 It is apparent that ESSO specializes in RAPs and covers the right-of-way and social aspects of a project. However, the lack of tools to conduct air and water quality sampling, as well as noise and vibration measurements, together with a shortage of trained personnel to do the job, makes ESSO incapable of assessing these physical environment components. As a provider of vital transport infrastructure (i.e., roads and bridges), it would be a constructive option for the DPWH to consider procuring tools and enhancing the expertise at ESSO to enable them to measure levels of pollution as by-products of road construction and operation.

4.13 ESSO also conducts capacity development for PMO engineers of various projects to familiarize them with environmental and social impact assessment. ESSO has capacity to prepare environment reports at the IEE level using secondary data/information from other government agencies.

4.14 Most of the FS reports were made by consigned consultants and ESSO has no access to these reports. These consultants do not furnish ESSO with copies of EIA reports for the latter's review because ESSO is not the approving body and to have ESSO review the reports will only cause further delay in the processing of ECCs. Accessing these reports remains a prerogative of the consultants and or the agencies/proponents of projects until reports are finalized or the ECCs have been issued. The Project Management Office for Feasibility Study (PMO-FS) has trained regional offices and other PMOs under the DPWH in formulating FS reports. At present, the PMO-FS reviews reports produced by regional offices and assists or advises on traffic surveys, traffic analysis, economic evaluation, etc. upon request.

4.15 The general tendency of DPWH offices (regional and PMOs) is to consign consultants to prepare comprehensive environmental assessment reports (EIS, programmatic IEEs or EIS) depending on the categories required in the EIS system. There is no efficient databank of all EIA reports their respective offices have generated. Therefore, it is hard to track down a project status in one office.

4.16 Meanwhile, the DOTC does not have internal offices to provide environmental and social services. All procedures are done by project proponents who usually outsource the EIAs and RAPs and submit necessary documents to the EMB. Ports and airports are financed by the private entities and there are no requirements for NEDA Board approval of such reports.

4.17 Projects under this study's Short-Term Program (2014-2016) are already committed for implementation and are in various stages of preparing EIAs, submitting EIAs, or awaiting ECC accreditation. The respective statuses of these projects are summarized in Table 4.2.1. However, the EIA and RAP status of some projects was not tracked down because of the conditions explained above. The overall Short-Term Program should, ideally, be collectively assessed to establish the overall degree or magnitude of the individual and collective impact of projects to the environment under the Philippine EIA system.

### Table 4.2.1 Environmental Impact Assessment and Resettlement Status of Projects Included in the Short-term Program

### (1) Highways, Expressways, and Other Roads

| | Name of Project | | Area | Status | New/ Upgrade | EIA[1] | Resettlement |
|---|---|---|---|---|---|---|---|
| A. HIGHWAYS | 1. C5 Missing Link Southern Section | a. Flyover on CP Garcia in Sucat | NCR | Committed | New | | |
| A. HIGHWAYS | 1. C5 Missing Link Southern Section | b. Coastal Rd/C5 Ext. South Flyover | NCR | Committed | New | | |
| A. HIGHWAYS | 1. C5 Missing Link Southern Section | c. C5 South Extn. Flyover at SLEX | NCR | Proposed | New | | |
| A. HIGHWAYS | 2. Global City to Ortigas Center Link Road | | NCR | Proposed | New | | |
| A. HIGHWAYS | 3. Skyway – FTI - C5 Connector | | NCR | Committed | New | | |
| A. HIGHWAYS | 4. C3 Missing Links (San Juan to Makati) | | NCR | Proposed | New | | |
| A. HIGHWAYS | 5. Rehabilitation of EDSA (C-4) | | NCR | Committed | Improve | | |
| A. HIGHWAYS | 6. Arterial Road Bypass Project Phase II, Plaridel Bypass | | BRLC | Committed | New | | |
| A. HIGHWAYS | 7. EDSA – Taft Flyover | | NCR | Committed | New | | |
| A. HIGHWAYS | 7. Metro Manila Interchanges/ Flyovers | a. C2 (Gov. Forbes)/ R-7 (Espana) | NCR | Committed | New | | |
| A. HIGHWAYS | 7. Metro Manila Interchanges/ Flyovers | b. C-3 (Aranet Ave.)/E. Rodriguez St. | NCR | Committed | New | | |
| A. HIGHWAYS | 7. Metro Manila Interchanges/ Flyovers | c. C-5/Lanuza St. – Julia Vargas Ave. | NCR | Committed | New | | |
| A. HIGHWAYS | 7. Metro Manila Interchanges/ Flyovers | d. EDSA/North Ave. – West Ave. – Mindanao Ave. and EDSA/Roosevelt Ave. | NCR | Committed | New | IEE | Submitted 201/09 31 HHs |
| A. HIGHWAYS | 7. Metro Manila Interchanges/ Flyovers | e. C-5/Kalayaan Ave. | NCR | Committed | New | | |
| A. HIGHWAYS | 7. Metro Manila Interchanges/ Flyovers | f. C5: Green Meadows/Acropolis/Calle Industria | NCR | Committed | New | | |
| A. HIGHWAYS | 7. Metro Manila Interchanges/ Flyovers | g. P. Tuazon/ Katipunan | NCR | Committed | New | | |
| B. EXPRESSWAYS | 1. Daang Hari-SLEX Link Project | | BRLC | Committed | New | ECC issued 12/2008 | |
| B. EXPRESSWAYS | 2. NLEX-SLEX Connector Project | a. Link Expressway | NCR | Committed | New | ECC issued 02/2010 | |
| B. EXPRESSWAYS | 2. NLEX-SLEX Connector Project | b. Skyway Stage 3 | NCR | Committed | New | ECC issued 02/2010 | |
| B. EXPRESSWAYS | 2. NLEX-SLEX Connector Project | c. Seg. 9 &10, and connection to R10 | NCR | Committed | New | ECC issued 02/2010 | |
| B. EXPRESSWAYS | 3. NAIA Expressway, phase II | | NCR | Committed | New | ECC issued 06/2002 | Submitted 2012 Informal settlers, commercial lessees, government institutes. |
| B. EXPRESSWAYS | 4. Cavite – Laguna Expressway Project | | BRLC | Committed | New | ECC issued 01/2013 | |
| B. EXPRESSWAYS | 5. CLLEX Phase I | | GCR | Committed | New | ECC issued 02/2010 | |
| B. EXPRESSWAYS | 6. Calamba-Los Baños Expressway | | BRLC | Proposed | New | | |
| B. EXPRESSWAYS | 7. C6 extension – Flood Control Dike Expressway | | BRLC | Committed | New | | |
| B. EXPRESSWAYS | 8. Segment 8.2 of NLEx to Commonwealth | | NCR | Proposed | New | | |
| B. EXPRESSWAYS | 9. Southern Tagalog Arterial Road (STAR)- Batangas -Lipa | | GCR | Committed | | | |
| C. OTHER ROADS | 1. Secondary Road Packages for Metro Manila, Bulacan and Cavite | 1. Bulacan Road Packages 1 and 2 | BRLC | Proposed | New/ Upgrade | | |
| C. OTHER ROADS | 1. Secondary Road Packages for Metro Manila, Bulacan and Cavite | 2. Cavite Secondary Roads | BRLC | Proposed | New/ Upgrade | | |
| C. OTHER ROADS | 1. Secondary Road Packages for Metro Manila, Bulacan and Cavite | 3. Sucat Road Upgrade | NCR | Proposed | Upgrade | | |
| C. OTHER ROADS | 1. Secondary Road Packages for Metro Manila, Bulacan and Cavite | 4. Quirino Road (Paranaque) | NCR | Proposed | Upgrade | | |
| C. OTHER ROADS | 1. Secondary Road Packages for Metro Manila, Bulacan and Cavite | 5. Paranague Road Package | NCR | Proposed | Upgrade | | |
| C. OTHER ROADS | 2.Prepared studies for several projects | | GCR | Proposed | - | | |
| C. OTHER ROADS | 3. Other Central Luzon Road Projects | | GCR | Committed | - | | |
| C. OTHER ROADS | 4. Other Southern Luzon Road Projects | | GCR | Committed | - | | |

## (Cont'd) Table 4.2.1 Environmental Impact Assessment and Resettlement Status of Projects Included in the Short-term Program

### (2) Railways

| Name of Project | Area | Status | EIA[1] | Resettlement |
|---|---|---|---|---|
| 1. LRT Line1 Cavite Extension and O&M | NCR/BRLC | Committed | ECC was issued in 2002 and requested to revise | 02/2012 RAP was submitted to NEDA |
| 2. LRT Line2 East Extension | NCR/BRLC | Committed | | Not applicable (elevated railway) |
| 3. MRT3 Capacity Expansion | NCR | Committed | CNC | - |
| 4. MRT 7 stage1 (Quezon Ave. – Commonwealth Ave.) | NCR/BRLC | Committed | ECC issued 2009/05 2010/02? | |
| 5. Contactless Automatic Fare Collection System (AFCS) | NCR | Committed | CNC 2013/01 | |
| 6. Line1 and Line2 System Rehabilitation | NCR | Committed | - | |
| 7. Manila – Malolos Commuter Line | NCR/BRLC | Proposed | JICA pre-FS conducted and FS started in June, EIA study will be included. | |
| 8. Metro Manila CBD Transit System Project | NCR | Proposed | - | |
| 9. Mega Manila Subway Study | NCR/BRLC | Proposed | - | |
| 10. Common Station for LRT1, MRT3 and MRT7 | NCR | Committed | - | |

### (3) Road-based Public Transport

| Name of Project | Status | EIA[1] | Resettlement |
|---|---|---|---|
| 1. Integrated Provincial Bus Terminal System (3 Provincial Bus Terminals) | Committed | | |
| 2. Road-based Public Transport Service Modernization Study | Proposed | | |
| 3. BRT System 1 (Quezon Ave., C5, Ortigas) | Proposed | | |

### (4) Traffic Management

| Name of Project | Status | EIA[1] | Resettlement |
|---|---|---|---|
| 1. Modernization of traffic signaling system, Communication and Monitoring | Committed | | |
| 2. Systematic Road Safety Interventions Study | Proposed | | |
| 3. Comprehensive Traffic Management Study | Proposed | | |

### (5) Airports

| Name of Project | | Status | EIA[1] | Resettlement |
|---|---|---|---|---|
| 1. NAIA | a. NAIA Improvement– airside package | Committed | Unsolicited Proposal[2] | |
| | b. NAIA improvements – landside package | Committed | Unsolicited Proposal[2] | |
| 2. Clark International Airport Construction of a Budget/LCC Terminal | | Committed | ECC 2010/03 | |
| 3. Feasibility Study of a New NAIA | | Proposed | | |

### (6) Ports

| Name of Project | Status | EIA[1] | Resettlement |
|---|---|---|---|
| 1. Projects for North Harbor | Committed | Unsolicited Proposal[2] | |
| 2. Projects for South Harbor | Committed | ECC issued 2000/08 | |
| 3. MICT | Committed | Unsolicited Proposal[2] | |
| 4. F/S of NH Redevelopment | Proposed | | |
| 5. Other Ports | Proposed | | |

Sources: DPWH, EMB, NAIA, JICA.
[1] This is from the point of view of government agencies.
[2] Unsolicited Proposal means private proponent will apply for an ECC.
Notes: CNC-Certificate of Non-Coverage; ECC-Environmental Compliance Certificate; HH-household