DEPARTMENT OF
PUBLIC WORKS AND HIGHWAYS
THE REPUBLIC OF THE PHILIPPINES

THE PREPARATORY STUDY FOR SECTOR LOAN ON DISASTER RISK MANAGEMENT IN THE REPUBLIC OF THE PHILIPPINES

FINAL REPORT

NEEDS ASSESSMENT STUDY ON FLOOD DISASTERS CAUSED BY TYPHOONS No.16 (ONDOY) AND No.17 (PEPENG)

JANUARY 2010

JAPAN INTERNATIONAL COOPERATION AGENCY

CTI ENGINEERING INTERNATIONAL CO., LTD.
in association with
NIPPON KOEI CO., LTD

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Summary

1 Background

Tropical Storm Ondoy (international name “Ketsana”) brought a heavy rain to Central Luzon and Visayas, the Philippines, and caused severe flood disasters in Metropolitan Manila, surrounding and Laguna Lake area on September 26, 2009 and Typhoon Pepeng (international name “Parma”), which followed soon after Ondoy, affected Northern and Central Luzon during October 3-9, 2009, and caused flood disasters in the Agno, Laoag, Cagayan, Pampanga and Bucao rivers and also landslide disasters in CAR, Regions I and II. The tracks of Tropical Storm Ondoy and Typhoon Pepeng are shown in **Figures 1.1.1 and 1.1.2**.

Accordingly JICA dispatched a study team to Manila from 27th of October to 2nd of December 2009 through *the Preparatory Study for Sector loan on Disaster Risk Management in the republic of the Philippines* and conducted needs assessment study on disasters and disaster areas in the Metropolitan Manila/surrounding and the North/central Luzon by the Tropical Storm Ondoy and the Typhoon Pepeng.

This report has compiled the results of the need assessment study on disasters and disaster areas from floods and landslides during the Tropical Storm Ondoy and Typhoon Pepeng and a draft plan for medium and long term needs for rehabilitation and restoration of the disaster areas, which were prepared based on lessons and recommendations from the disasters and opinions for the implemented JICA projects including the study on disaster sector loan. Also the study team has participated with *the Post Disaster Needs Assessment (PDNA)* conducted by World Bank (WB) as a member of the flood disaster working group (WB, ADB, UNICEF, JICA, DPWH and MMDA) from the mid October to Mid November, 2009 and shared the information on post disaster rehabilitation and reconstruction with the flood disaster working group.

The study objectives are:

1) To conduct needs assessment on disasters and disaster areas from floods and landslides during the Tropical Storm Ondoy and Typhoon Pepeng, and
2) To prepare draft medium and long-term rehabilitation and restoration plans.

The study areas are flood and landslide disaster areas by Ondoy and Pepeng in Philippines and the study was carried out at Metropolitan Manila based on the following policy:

1） To grasp the actual conditions of the disasters caused by Tropical Storm Ondoy and Typhoon Pepeng as basic information for needs assessment of the flood disasters:

2） To review effectiveness of the existing flood control and drainage projects carried out by the JICA (or JBIC);

3） To review the disaster risk management system of the Central and Local Governments.

2 Disasters by Ondoy and Pepeng

(1) According to information from the National Disaster Coordinating Committee (NDCC) - Office of Civil Defense (OCD) (Table 2.1.1) Ondoy has affected about one million of families and 4.9 million of persons and took a heavy loss of lives/missing of 500. Loss of lives was mostly in the three regions: 52% in NCR (241 lives), 35% in Region IV-A (160 lives) and 12% in Region III (56 lives).

(2) Pepeng caused numerous landslides and affected about 0.95 million families and 4.5 million of persons. The loss of lives was 539 in total. 75% of the loss was in Cordillera Administrative Region (CAR) and 20% in Region I (Ilocos) which includes the Aguno and Laoag rivers.

(3) Ondoy brought an extremely heavy rainfall of 455 mm/day from 8:00 am to 8:00 pm on September 26, 2009. **Table 2.2.2** shows 138 mm/hr and 460 mm/day at Catomon, 92 mm/hr and 455 mm/day at Science Garden, 44 mm/hr and 258.5 mm/day at Port Area. The hourly rainfall and daily rainfall amounts at Science Garden are assessed as over once in 20-year and over 100-year. The daily rainfall of 455 mm over 100-year was supposed fell in the Marikina River and Laguna Lake Basins.

(4) The hourly and daily rainfall amounts at Port Area are assessed as once in 2~5-year and about 10-year, but the daily rainfall over 10-year were supposed fell in the core area of Metropolitan Manila, because of the heavy rainfall at Science Garden nearby.

(5) During Pepeng heavy daily rainfalls were recorded at Baguio 531 mm/day on October 3 and 685 mm/day on October 8, 2009 as shown in **Table 2.2.3**. The scale of the rainfall amounts is reported about 50-year return period.

(Flood disasters by Ondoy)

(6) Flood disasters in Metropolitan Manila and surrounding by Ondoy are shown in **Figures 2.2.2~4**. Ondoy caused severe floods in the Marikina River. The flood water was inundating along the Marikina River and in the East/West Areas of Mangahan Floodway. There are no exact flood stage record, but the flood discharge of the Marikina River was estimated as over 4,000 m^3/s*, which exceeds by far the existing conveyance capacities and the design flood discharges of the Pasig-Marikina River.

**: About the flood peak discharge during Ondoy the Laguna Lake Development Authority (LLDA) has estimated as 4,150 m3/s and UP-National Hydraulic Research Center (NHRC) did 5,770 m3/s.*

(7) About 3,000 m^3/s of the flood water of the Marikina River was estimated to flow in Laguna Lake through Mangahan Floodway, of which design capacity is 2,400 m^3/s, also about 150 m^3/s of the rest of flood water was estimated to flow backward to Napindan channel, which caused flooding in the West Area of Mangahan floodway.

(8) The Pasig River escaped flood disasters by Ondoy because the flood peak discharge was reduced by Mangahan Floodway and Napindan channel. However, the core area of Metropolitan Manila where the Pasig River flows through, was widely inundated by heavy storm waters. Flood Maps (depth and duration) during Ondoy have been developed based on the survey data from NAMRIA and the Study Team's field survey conducted for Metropolitan Manila and surrounding and shown in **Figures 2.2.3 and 2.2.4.**

(9) In Metropolitan Manila the drainage system took for about three days to drain the area. During Ondoy operation was temporally stopped at five pumping stations (Pandacan, Paco, Makati, Quiapo and Sta. Clara) because they were submerged by flashfloods, but the other ten pumping stations were operating.

(10) Metropolitan Manila is expanding by the population increase and the San Juan, Tullahan and Parañaque rivers, which are located surrounding the Core Area of Metropolitan Manila, were flooding

(11) .During Ondoy the water level of Laguna Lake rose about 1.2 m in a short time to EL.13.84 (about 40-year return period) and a wide area of the lake shore without shore dike was submerged. At the West Area of Mangahan Floodway, of which the lakeshore dike is partly tentative level and partly not completed, was submerged. Three of the four pumping stations were stopped operation because of some of equipment submerged. Usually flood damages increase when the lake water level rises over 12.00 m.

(Disasters by Typhoon Pepeng)

(12) Pepeng took about six days (From October 3 to October 8) to pass the Northern Luzon and brought heavy rains which caused floods and landslides in the Northern and Central Luzon. It was reported that severe flood disasters were occurred in the Agno, Cagayan, Pampanga, Laoag and Bucao River basins. At the Aguno river basin the inadequate dam operation at San Roque Dam was indicated and debated as the cause of the flood disaster the Cities and Municipalities affected by Pepeng (Flood) are shown in **Figure 2.2.6**.

(13) There were numerous landslides occurred in Baguio city and La Trinidad city in Benguet Province in CAR. According to the geo-hazard mapping and assessment of MGB, the mountain slopes in the area are mostly identified as susceptible to landslide due to the region's geographic and geologic setting. Instable and susceptible slopes to landslide are widely distributed in the Benguet area and numerous landslides were caused by the extreme heavy rainfalls of Pepeng. It suggests that those rivers, which have their stream heads in Benguet area have possibilities of increasing sediment related disasters like flashfloods and mudflows, and that further investigation will be required.

2.1 Effects of Existing Flood/Drainage Facilities

2.1.1 Effects and Tasks of Existing Flood Control and Drainage Facilities

In Metro Manila and the Northern and Central Luzon there are several flood control and drainage projects which have been carried out until now by the Japanese ODA. The location of the projects in Metro Manila is shown in **Figure 2.3.1** and their effectiveness against the floods caused by Ondoy is assessed as follow:

(Metropolitan Manila and Surrounding)

(1) Mangahan Floodway with Rosario Weir (1984-1988) :

After completion of the project in 1988 the operation and maintenance (O&M) of the control gates of Rosario Weir were conducted by DPWH. In 2002 the O&M for the facilities were transferred to MMDA, but the O&M has not conducted by MMDA since 2006.

During Ondoy the flood discharge from the Upper Marikina River was estimated to be over 4,000 m^3/s, of which about 3,000 m^3/s was diverted to Laguna Lake through Rosario Weir –Mangahan Floodway. As the result the flood water safely flew the lower reach of the Pasig River through the core area of Metro Manila without overtopping or flooding due to the effects of Mangahan floodway.

(2) Metro Manila Drainage System Rehabilitation (1976-1998):

The core area (73 km^2) of Metro Manila is mostly low lying. The flood control and drainage systems for 70% of the core area depend on mechanical (pumping) drainage system and the 30% depend on gravity drainage system. The project provided the core area with 15 major drainage pumping stations (Total discharge capacity: 230.6 m^3/s) and the existing drainage networks which are composed of 74 km of estero/creeks, 35 km of drainage mains and about 400 km laterals.

The flood control and drainage system is designed 10-year return period (269mm/day) for drainage pumps. During Ondoy the stormwater was supposed to be by far larger than the design one and required 1-3 days to drain. According to the operation records of 15 pumping stations and the hours of operation (high operating rate group: 70~100%, low operating group: about 50%), most of drainage channels are losing their discharge capacities due to sedimentation and deposition of solid wastes and the available capacities of pumps are not utilized fully. The existing flood control and drainage system should be effective, but maintenance of the existing facilities by dredging and removing deposits and solid wastes in drainage channels. The project and locations of facilities are shown in **Figure 2.3.3**.

According to the JICA Study in 2005, 12 of the major pumping stations have already been superannuated and need rehabilitation, and drainage channels need dredging. Also there are small scale inundation in the road, local depression area and low-lying area during torrential rainstorm. For urgent drainage emergency mobile pumps are considered at Manila City and several other cities. The rehabilitation of major pumping stations is divided three groups in the following box.

Proposed 12 Pumping Stations for rehabilitation:

- **Group 1**: Very old and serious conditions

  Aviles (Discharge capacity: 18.6 cu. m/s, Construction year: 1976),

  Quiapo (10.8 cu. m/s, 1976), **Valencia** (10.8 cu. m/s, 1976),

  Tripa de Gallina (57.0 cu. m/s, 1977)

- **Group 2**: Old and marginal service life

  Pandacan (4.4 cu. m/s, 1976), **Paco** (7.6 cu. m/s, 1977), **Sta. Clara** (5.3 cu. m/s,1977),

  Libertad (42.0 cu. m/s, 1977), **Makati** (7.0 cu. m/s, 1984), **Binondo** (11.6 cu. m/s, 1985)

- **Group 3**: Submergible pumps of outdoor type

  Escolta (1.5 cu. m/s, 1982) and **Balete** (3.0 cu. m/s, 1988)

Source: The Study on Drainage Improvement in the Core Area of Metropolitan Manila (JICA, 2005)

(3) Metro Manila Flood Control Project-West Mangahan Floodway Project (2000-2007)：

The West Area of Mangahan Floodway is low lying of flood prone areas and suffered from the floodwaters of the Marikina River and Laguna Lake. The project provided the area with lakeshore dike: 9.4 km, drainage pumping stations: 4 stations (Total discharge capacity: 36.0 m^3/s) and flood control gates: 8 sites. During Ondoy about 80% of residential areas were flooded from the Marikina River for one to three weeks and three pumping stations were submerged and stopped operation for four days at Taguig, three days at Hagonoy, 14 days at Tapayan） by abnormal increase of inland water level. The people experienced flooding for two to three months in the past, but the project shows positive effects by reducing the duration of inundation period. However, the east part of lakeshore dike is still temporally one and need early completion. The project and locations of facilities are shown in **Figure 2.3.3**.

(4) KAMANAVA Area Flood Control and Drainage System Improvement Project (2002-2009)：

KAMANAVA is low lying coastal area. The project is composed of five major drainage pumping stations (Maypajo, Spine, Bankulasi, Catmon, and North Navotas), gates and ring levee. During Ondoy Catomon pumping station was temporary stopped operation by abnormal increase of inland water levels caused flood from the Malabon-Tullahan River. The five pumping stations continued operation and had a good effect on reducing the flood disasters, and also the low tide level did much to the drainage system.
The project and pumping stations, gates and dikes are shown in **Figure 2.3.4**.

(5) Effective Flood Control Operation and Warning System project (EFCOS) (2000-2002)：

EFCOS was originally installed by DPWH in 1978, and new system was constructed in 1992 by OECF and rehabilitated in 2001 by JICA grant. Through this system, PAGASA issued flood bulletins. After the rehabilitation EFCOS was transferred from DPWH to MMDA in 2002. MMDA operated it until 2006, when MMDA shut down its operation due to budget constrain. During Ondoy the flood control operation

and warning system was not utilized, and the observation equipment of Nangka gauging station and the cable of water gauge at Santo. Nino was damaged. In order to conduct flood warning for Metropolitan Manila rehabilitation of EFCOS and replacement of managing organization from MMDA to the other responsible agency should be required.

(6) Pasig-Marikina River Improvement (Phase I) (Commenced in December 2008)

The project has finished the preparatory stage and start driving steel sheet piles, which were procured in the preparatory stage for bank protection. The project is to conduct river improvement of 17 km and to complete in 2013. However, the project is not including any flood control measures for the mid and upper Marikina River upstream the Marikina Bridge. In order to protect people in the flood hazard area along the Marikina River structural measures for flood control and non-structural measures for flood disaster risk reduction will be required.

(7) Urgent Tasks

The rainfall amount in the Metropolitan Manila and surrounding during Ondoy was by far exceeding the design rainfall amount. By the heavy storm water some of the major pumping stations were submerged and temporarily stopped their operation, but there were no major damages to the flood control and drainage facilities except several spots of the drainage channels constructed by the local government in the past. The major urgent tasks are summarized as follows:

1) Urgent rehabilitation of 3 drainage pumping stations (Aviles, Quiapo and Tripa de Gallina);
2) Necessity of improvement of managing organizations for flood control and major drainage facilities in NCR;
3) Review of the design criteria for the flood control and drainage facilities considering excess floods and climate changes;
4) Rehabilitation of the existing drainage networks and drainage channels;
5) Review of the JICA master plan in 1990 and implementation plan for the proposed projects;

(Northern and Central Luzon)

Flood control and drainage projects have been implemented at the Pampanga river, Aguno river, Mr. Pinatubo and Laoag river. During Pepeng at the Agno and Laoag rivers some part of the flood control dykes were breached and eroded, and severe flood disasters were caused. The effectiveness of their flood control facilities and urgent tasks are outlined as follow:

(1) Agno and Allied River Urgent Rehabilitation Project (1995 - 20029/Agno River Flood Control Project (Ⅱ-A) (1998 – 2009)

The Agno river is the fifth largest in the Philippines and the third largest in the Luzon with a catchment area of 5,952 km²and a total length of 221 km, originated in the Cordillera mountains and flows through the plain of Pangasinan and discharges into the gulf of Lingayen. In the upper reach there are three

multipurpose dams (Ambukulao Dam: constructed in 1956, Binga Dam: constructed in 1960 and San Roque Dam: constructed in 2003) which are belonged to NPC in the upper reach. The flood control project which aims to protect the Pangasinan plain, was commenced in 1995 from the lower reach of 54 km (Phase 1:1995-2002) and constructed flood dikes with revetments, groins and restoration of existing facilities, and completed the mid reach of 23 km (Phase Ⅱ: 1998-2009) including retarding basins, dikes with revetments by 2009. Now the upper reach of 47 km (Phase Ⅲ) is proposed for implementation.

During Pepeng the flood water breached some parts of the old dyke, which were constructed in 1960s and 1990s) located at the mid and upper reaches, and caused severe floods affecting about one million families and 4.5 million persons in the Pangasinan plain. The flood waters not only breached flood dykes but also eroded dykes and revetments at several sites. The rehabilitation and restoration of damaged flood dykes and eroded revetments have been proposed.

In the Agno river basin the wide area of agricultural land and numerous peoples in the Pangasinan plain were suffered from the flood by breached old flood dykes at the mid and upper reach. The flood control facilities implemented by the project are protecting the areas along the lower reach of the Agno river and effective for flood disaster risk reduction.

And it is indicated that the flood disasters may be caused by the emergency discharge from San Roque Dam which discharged 5,354 m^3/s on October 9 that is by far larger than the design flow capacity (3,960 m^3/s.) of the upper reach of the Agno river.

(2) Laoag River Basin Flood Control and Sabo Project (2001-2008)

The Laoag river basin is located in the province of Ilocos Norte in Region I with a catchment of 1,353 km^2, originated in the Cordillera and flows through the Ilocos Norte and discharge into the South China Sea. The project is composed of river improvement works of 14 km for the Laoag-Bongo river and four alluvial fan river improvement works of 39 km in total and implemented from 2001 to 2008.

During Pepeng the flood water breached a part of the flood dykes of Madongan river and inundated, and also eroded parts of the flood dykes of Madongan, Papa and Cura rivers to critical condition. Rehabilitation and restoration of damaged flood dykes have been proposed.

By the flood from the Madongan river the agricultural areas in the upper and mid reaches may be affected, but the flood control facilities showed the effectiveness by protecting most of the flood prevention area.

(3) Urgent Tasks

The major urgent tasks are summarized as follow:

1) It is necessary for the Paganini area to implement the Phase Ⅲ as early as possible in order to increase the safety level from the flood disaster risks

The flooding from the right bank of the Phase Ⅲ area shall affect a wide area of the Pangacinan plain as shown by the last flood and also by the existing landform. Early implementation of Phase Ⅲ will be very important from flood disaster risk management aspects.

2) Increase accuracy of flood forecast and improvement of dam operation rules for San Roque Dam

The inadequate operation of San Roque Dam during the Pepeng flood was indicated. They are the delay of operation of out flow for flood control and inappropriately large discharge of 5,354 m^3/s compared with the design flow capacity of 3,960 m^3/s in the down stream of the dam. The flood suggests that ① It is necessary for flood forecast services to issue quantitative flood forecast such as describing range of expected flood peaks by improving the present flood forecast system and ② It is necessary to review and update the dam operation manuals for flood control and conduct reasonable operation for reduction of flood peaks and flood disaster risks at the down stream.

3) Flood control facilities shall require periodical O&M activities

Flood control facilities especially flood dykes and revetments shall require regular O&M activities and immediate rehabilitation shall be carried out if some defects were identified. Even small defect shall cause severe flood disasters.

2.1.2 Flood Forecasting and Warning System

(1) Hydro-Meteorological Division (HMD) of PAGASA issues and broadcasts: 1) Weather Forecast, 2) Severe Weather Bulletin and Tropical Cyclone Warning, 3) Flood Bulletin, and 4) other information such as Status of major Dams in Luzon. Target areas of basin Flood Bulletin are four river basins in Luzon, namely Pampanga, Agno, Bicol and Cagayan, where forecasting and warning system are installed, so-called Pampanga, Agno, Bicol and Cagayan Flood Forecasting and warning System. For Metropolitan Manila, PAGASA has not issued Flood Bulletins since 2006.

(2) The NDCC receives such flood information as weather advisory, typhoon bulletin, flood advisory, food bulletin, gate openings and dam status from PAGASA and transmits it to the agencies concerned.

3. Assistance Programs of the GOP and the Other Donors

3.1 Assistance Programs of the Central and Local Governments

(1) According to PD 1566 of 1978, the NDCC is the highest policy-making and coordinating body for disaster risk management. It is supported by the Office of Civil Defense (OCD) under the Department of National Defense (DND). The OCD serves as the Secretariat of the NDCC, and implements policies and programs on disaster risk management. The NDCC is chaired by the Secretary of the DND and has 19 member government departments and agencies, which are to be given specific roles and responsibilities in disaster risk management.

(2) Disasters are handled by several layers of Disaster Coordinating Councils (DCCs) in the country. The DCC is composed of the six (6) levels, 1) NDCC; 2) 17 Regional DCCs; 3) 81 Provincial DCCs; 4) 117 City DCCs; 5) 1,496 Municipal DCCs; 6) 41, 945 Barangay DCCs. The DCCs are to provide services in three (3) phases of disaster management: namely the pre-disaster, disaster and post-disaster phases. Every DCCs should have disaster risk management plans, but mostly do not seem ready for disaster risk management in the three (3) phases except emergency responses in disaster.

(3) The NDCC has reformed its disaster management policy and strategy from reactive and emergency management to a pro-active one toward disaster risk reduction and a more integrated approach to disaster risk management (DRM) on natural disasters since 2004, adapting the Hyogo Framework for Action (HFA) for 2005-2015. The NDCC developed the Strategic National Action Plan (SNAP) for 2009-2019 (Consultation Version 5.2) in December 2008. It is necessary for the NDCC to review and update the functions and responsibilities to make them pro-active and attain the objectives of DRM.

(4) UNDP and AusAID have been supporting NDCC-OCD to conduct the READY Projects (2006-2011), which NDCC-OCD is to prepare hazards maps for effective community based DRM at the 27 high risk provinces with collaboration with MGB, NAMRIA, PAGASA and PHIVOLCS.

4. Needs Assessment for Post-disaster

4.1 Needs and Countermeasures

The flood disaster areas by the Tropical Storm Ondoy are the Marikina River, Laguna Lake and Metropolitan Manila and surrounding, and the flood disaster areas by the Typhoon Pepeng are major rivers in the Northern and Central Luzon. The major cause of disasters and required measures are listed as follows:

(1) Marikina River (Including East and west areas of Mangahan Floodway)

Cause of flood	Required Countermeasures
Floods from the Marikina River and its tributaries	Flood control measures against designed flood and excess floods: ・ Control of flood peak (Construction of dam and retarding basin) ・ Increase conveyance capacity (River improvement) ・ Improvement of tributaries (Cainta River , Taytay River and others) ・ Drainage improvement Flood disaster risk reduction by non-structural measures:

	・ River and flood plain management and land use control ・ Establishment of community based flood early warning system ・ Promotion of IEC campaign ・ River basin and watershed management (Recovery of forest area and reforestation)

(2) Laguna Lake Area

Cause of flood	Required Countermeasures
Rising of lake water level	Flood control measures against designed flood and excess floods: ・ Flood control facilities (Construction of Lakeshore dike) Flood disaster risk reduction by non-structural measures: ・ Lakeshore floodplain management ・ Establishment of community based flood early warning ・ Promotion of IEC campaign

(3) Metropolitan Manila Core Area and Surrounding

Cause of flood	Required Countermeasures
Floods caused by storm water and flashflood	Flood control measures against designed flood and excess floods ・ Rehabilitation of drainage pumping stations and drainage facilities in the core area of the metropolitan Manila ・ Rehabilitation of EFCOS ・ Drainage improvement of VOM area ・ Improvement of small rivers: the San Juan, Tollahan and Paranaque rivers Flood disaster risk reduction by non-structural measures ・ Establishment of community based flood early warning ・ Promotion of IEC campaign

(4) North and Central Luzon

Cause of flood	Required Countermeasures
Floods caused by heavy rain	Flood control measures against designed flood and excess floods: ・ Strengthening river embankments for major rivers ・ Regular O&M activities for flood control facilities

4.2 Rehabilitation and Restoration Plan

(1) Post-disaster Reconstruction

The Tropical Storm Ondoy caused flood disasters in Metropolitan Manila/National Capital Region and the Typhoon Pepeng did flood disasters in the Northern, Central Luzon and others, and landslide disasters in the Northern Luzon. Post-disaster reconstruction needs are selected from the flood control and drainage facilities damaged by Ondoy and Pepeng in NCR and Luzon based on the data from DPWH and MMDA, and estimated at Php716.8 million and regions/priority projects/cost are shown in **Table 4.1.1**. The reconstruction works are scheduled to be implemented in 2010 as proposed by the PDNA.

(2) Medium-Term (2010 ~ 2012)

Medium-Term needs are also planned to be conducted for three years (2010～2012) as proposed by the PDNA. The proposed projects are selected based on the information from DPWH (implementing agency of flood control measures) and MMDA (O&M agency for flood control facilities) to implement in the next Medium Term Philippine Development Plan (MTPDP). The projects proposed for NCR and Luzon are composed of structural and non-structural measures necessary for flood risk reduction and estimated to be Php8.05 Billion and shown in **Table 4.1.2**.

1) Proposed Flood Management and Control Projects in Metropolitan Manila

A) Existing key flood management and drainage systems

(a) Valenzuela-Obando-Meycauayan (VOM) Area Drainage Improvement and Related Work Projects (Phase 1/2): F/S was completed by DPWH in 2008

(b) Metro Manila Flood Control Projects, East of Mangahan Floodway (Phase 1/2): F/S was completed by DPWH in 2007

(c) Tullahan River Improvement Project (Phase 1/2): Lower section of the Tullahan River is Malabon River which was part of the KAMANAVA Area flood control & drainage improvement project

(d) Paranaque River Improvement Project ((Phase 1/2): F/S was completed by JETRO (Japan External Trade Organization)

(e) Drainage improvement & Pump Rehabilitation in Core Area of Metro Manila (Phase 1/2): F/S

was completed by JICA in 2005

B) Improvement of flood risk management

(a) Making of fund and emergency maintenance equipment available for regular maintenance

(b) Establishment of system-specific operation and maintenance (O&M) needs

(c) Re-establishment and development of the management information system and appropriate flood forecasting and warning systems

(d) Establishment of optimum water and river management agency responsible for flood management and drainage in the Pasig-Marikina and Laguna Lake basin.

(e) Conduct of a risk assessment study for the entire basin area and update the master plan of the 1990 to come up with a comprehensive development program

2) Proposed Flood Management and Control Projects in the Northern and Central Luzon

A) Cagayan River Flood Control Project (Part 1/2)

B) Aguno and Allied Rivers Urgent Rehabilitation Project Phase III (Part 1/2)

C) Flood Control Measures in the Pinatubo Devastated Areas and rehabilitation of School Buildings (Part 1/2)

D) Tarlac River Overall Improvement Project (Part 1/2)

(3) Long-Term (2013 ~ 2016 Beyond)

Long-Term needs are planed to be conducted for 2013～2016 beyond considering the next MTPDP. Projects are to be continued from the Medium-Term as Phase 2 or Part 2. Lakeshore Dike Project for Laguna Lake and Marikina Flood Control Dam Project for Marikina River are proposed. The plan is prepared based on the information from DPWH and MMDA. The Projects proposed for NCR and Luzon are Php44.85 Billion and shown in **Table 4.1.3**.

1) Proposed flood management and control projects in Metropolitan Manila

A) Existing key flood management and drainage systems

B) Existing key flood management and drainage systems in Metro Manila, Rizal and Laguna

2) Northern and Central Luzon

A) River bank strengthening for key rivers

5. Preparation of Draft Programs for Rehabilitation and Restoration Plan

5.1 Lesson from the Disaster

The flood control and drainage improvement projects conducted by the Japanese ODA in NCR have a big effect to protect NCR from the flood disasters and to reduce the flood disaster risk caused by Ondoy. If the Mangahan Floodway were not constructed, by an extraordinary flood from the Pasig River Metropolitan Manila had had a devastating damage, and without the flood control and drainage projects

for the core area of Metropolitan Manila, KAMANAVA area and West of Mangahan the areas had inundated for a long time. The structural measures by the Japanese ODA have protected NCR from severe flood disaster, but it is revealed that flood protection measures have been delayed for the mid and upper Marikina River and there are high needs for implementation of structural measures and non-structural measures for excessive floods. As the lesson from the flood disasters it is necessary for the disaster sector loan and also for the implemented and new JICA projects to consider the following factors.

(1) Promotion of flood control and drainage improvement structural and non-structural measures for Marikina River basin and Laguna lake area;

The core area of Metropolitan Manila has luckily escaped severe flood disasters, but the area along the Marikina River has widely suffered from the severe flood disasters and the delay in flood control measures at the mid and upper Marikina River becomes clear. If the excessive flood and the climate change in future are considered, flood control reservoirs and flood retarding basins as flood control measures in the upper reach of Marikina River and flood plain management along the Marikina River, lake shore dykes and flood plain management as flood control measures at Laguna Lake area will be required. Normally structural measures will take a long time before their completion, therefore community based flood disaster risk reduction measures as non-structural measures will be urgently promoted.

(2) Maintenance of the function of the existing flood control and drainage facilities and periodical rehabilitation;

In the core area of Metropolitan Manila the flood control and drainage systems based on the 15 major drainage pumping stations been developed since 1970s, but many of the pumping facilities of the drainage systems have been superannuated and need rehabilitation. The drainage channels have mostly decreased their conveyance capacities because of sedimentation and accumulation of solid wastes. The function of the existing drainage facilities are very important for the core area of Metropolitan Manila and should be maintained by periodical rehabilitation.

(3) Introduction of river management and flood plain management, and centralization of river and flood management authorities and flood plain management in NCR;

In NCR there are numerous agencies like DPWH, MMDA, LLDA, DENR and LGUs concerned for flood management and the agencies are to act on the basis of their proper authorities. It is suggested that it is necessary for the Pasig-Marikina-Laguna lake area to conduct proper management based on the river basin and that it is necessary to select one responsible agency to carry out planning, implementing and conducting O&M for flood control in order to conduct proper flood risk management in NCR. At the same time it will be necessary to introduce river and flood plain management.

(4) Early assistance for non-structural measures for flood disaster risk reduction at LGUs and IEC campaign;

It is necessary to assist LGUs to develop an effective flood disaster risk management plan. It is suggested that there are needs to assist LGUs, which have a high risk against flood disasters, in developing flood hazard maps based on the last flood and also in preparing flood disaster risk management plan (flood prevention, flood warning and evacuation system) and IEC campaign.

(5) Improvement of flood risk management for NCR through implementation of pilot projects at LGU and community level;

To enhance the effectiveness of the flood disaster risk reduction in NCR it is necessary to select pilot LGUs from the flood hazard area and conduct a pilot project. Though LGU has an obligation to develop a disaster prevention plan including flood disasters, it is necessary for LGU to have technical and financial assistance for formulating effective flood disaster risk management plan. Pilot LGUs should be selected from the flood hazard areas of the Marikina River, West Mangahan Area and the core area of Metropolitan Manila.

5.2 Recommendation for Disaster Sector Loan and JICA project

JICA project required structural and non-structural measures for the flood disaster risk reduction in NCR, Northern and Central Luzon are recommended as follows:

(1) Implementation of reconstruction, rehabilitation and projects

1) Early completion of Pasig-Marikina River Channel Improvement Project

- Upper Marikina River: Construction stage 2 (from immediate vicinity of Napindan HCS to Mangahan Floodway), and
- Upper Marikina River: Construction stage 3 (from Mangahan Floodway to Marikina Bridge)

2) Implementation of key flood management and drainage systems in Metropolitan Manila

3) Implementation of proposed flood management and control projects in the Northern and Central Luzon

4) Rehabilitation of EFCOS for flood warning system of Metropolitan Manila

(2) Assistance for preparatory study

1) Flood control projects for the upper Marikina River and Laguna Lake area

(3) Assistance for pilot non-structural measures in NCR

1) Improvement of managing organization for river management and flood disaster risk management in NCR or Metropolitan Manila and surrounding;

2) Preparation of flood risk management plan for pilot LGUs and establishment of community based flood warning and evacuation systems;

3) Promotion of IEC campaign for enhancement of public awareness for flood risk management.

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Abbreviations and Acronyms

ADB	Asian Development Bank
ASSEC	Assistant Secretary
AusAID	Australian Agency for International Development
BDCC	Barangay Disaster Coordinating Council
CIDA	Canadian International Development Agency
CD	Capacity Development
CDCC	City Disaster Coordinating Council
CLUP	Comprehensive Land Use Plan
DCC	Disaster Coordinating Council
DENR-EMB	DENR – Environmental and Management Board
DILG	Department of Interior and Local Government
DND	Department of National Defense
DOST	Department of Science and Technology
DOTC	Department of Transportation and Communications
DPWH	Department of Public Works and Highways
DRM	Disaster Risk Management
DRR	Disaster Risk Reduction
DSWD	Department of Social Welfare and Development
EC	European Commission
EFCOS	Effective Flood Control Operating System
EO	Executive Order
EU	European Union
FCSEC	Flood Control and Sabo Engineering Center
GAA	General Appropriation Act
GIS	Geographic Information System
GPS	Global Positioning System
GTZ	Deutsche Gesellschaft fur Technische Zusammenartbeit
ha (s)	hectare (s)
HFA	Hyogo Framework for Action
HMD	Hydrology and Meteorology Division
Hr/hr	Hour
HUDCC	Housing and Urban Coordinating Council
IEC Campaign	Information, Education and Communication Campaign
IPCC	Intergovernmental Panel on Climate Change
IRA	Internal Revenue Allotment
IRR	Implementing Rules and Regulations

JBIC	Japan Bank for International Cooperation
JICA	Japan International Cooperation Agency
km	kilometer
LCF	Local Calamity Fund
LDCC	Local Disaster Coordinating Council
LDF	Local Development Fund
LGC	Local Government Code (RA 7160)
LGUs	Local Government Units
LLDA	Laguna Lake Development Authority
MCM	Million Cubic Meter
MDCC	Municipal Disaster Coordinating Council
MGB	Mines and Geosciences Bureau (DENR)
MMDA	Metro Manila Development Authority
MMDCC	Metro Manila Disaster Coordinating Council
MTPDP	Medium Term Philippine Development Plan
m^2	Square Meter
m^3	Cubic Meter
NAMRIA	National Mapping and Resources Information and Authority
NCF	National Calamity Fund
NCR	National Capital Region
NDCC	National Disaster Coordinating Council
NDMC	National Disaster Management Council
NEDA	National Economic Development Authority
NGOs	Non – Government Organizations
NPC	National Power Corporation
NSO	National Statistic Office
NWRB	National Water Resources Board
O&M	Operation and Maintenance
OCD	Office of Civil Defense
ODA	Office Development Assistance
OECF	Overseas Economic Cooperation Fund of Japan (JBIC)
PAGASA	Philippine Atmospheric Geophysical and Astronomical Services Administration
PD	Presidential Decree
PDCC	Provincial Disaster Coordinating Council
PDNA	Post-Disaster Needs Assessment
PHIVOLCS	Philippine Institute of Volcanology and Seismology
PIA	Philippine Information Agency
PIF	Philippine Infrastructure Fund

PMO	Project Management Office (DPWH)
PNRC	Philippine National Red Cross
PS	Planning Service
QRF	Quick Response Fund
RA	Republic Act
RDCC	Regional Disaster Coordinating Council
READY	Hazards Mapping and Assessment for Effective Community-Based Disaster Risk Management Project
RNG	Royal Netherlands Government
SNAP	Strategic National Action Plan
UN	United Nations
UNDP	United Nations Development Programme
UNICEF	United Nations Children Fund
UP	University of the Philippines
UPLB	University of the Philippines at Los Baños
USAID	United States Agency for International Development
USEC	Undersecretary
WB	World Bank

1. Introduction

1.1 Background

Tropical storm Ondoy (international name "Ketsana") brought a heavy rain to Central Luzon and Visayas and caused severe flood disasters in Metropolitan Manila, surrounding and Laguna Lake area on September 26, 2009. The heavy rainfall of 453 mm/day (at Science Garden in Quezon City) caused severe flood disasters along the Marikina River, around Laguna Lake and the Core Area of Metro Manila, resulting in the death/missing of almost 500 people and causing massive damage to the Metropolitan Manila and surrounding. The Pasig-Marikina-Laguna Lake Basin and the track of Tropical Storm Ondoy are shown in **Figure 1.1.1**.

Typhoon Pepeng (international name "Parma"), which followed soon after Ondoy, affected the Philippines during October 3-9, 2009, following irregular track which cross over Northern Luzon, and caused flood disasters in the Agno, Laoag, Cagayan, Pampanga and Bucao rivers and also landslide disasters in CAR, Regions I and II in the Northern Luzon. The track of Typhoon Pepeng is shown in **Figure 1.1.2**.

Accordingly JICA dispatched a study team to Manila from 27th of October to 2nd of December 2009 through the study "*the Preparatory Study for Sector loan on Disaster Risk Management in the republic of the Philippines"* and conducted needs assessment study on disasters and disaster areas by the Tropical Storm Ondoy and the Typhoon Pepeng.

This report has compiled the results of the need assessment study on disasters and disaster areas from floods and landslides during the Tropical Storm Ondoy and Typhoon Pepeng and a draft plan for medium and long term needs for rehabilitation and restoration of the disaster areas, which were prepared based on lessons and recommendations from the disasters and opinions for the implemented JICA projects including the study on disaster sector loan. Also the study team has participated with *the Post Disaster Needs Assessment (PDNA)* conducted by World Bank (WB) as a member of the flood disaster working group (WB, ADB, UNICEF, JICA, DPWH and MMDA) from the mid October to Mid November, 2009 and shared the information on post disaster rehabilitation and reconstruction with the flood disaster working group.

1.2 Objective of the Study

The study objective is

1) to conduct needs assessment on disasters and disaster areas from floods and landslides during the Tropical Storm Ondoy and Typhoon Pepeng), and
2) To prepare draft medium and long-term rehabilitation and restoration plans.

1.3 Study Area

The study areas are flood and landslide disaster areas by Ondoy and Pepeng in Philippines. Ondoy affected

Metropolitan Manila and surrounding, and Pepeng did Northern and Central Luzon. The study was conducted at Metropolitan Manila.

1.4 Counterpart Agency

The counterpart agency for the study is the Department of Public Works and Highways (DPWH).

1.5 Study Team Member

The study team is composed of three members as follow:

Name	Technical Field in Charge	Belonging to
Hajime TANAKA	Rehabilitation/restoration plan	CTI Engineering International Co., LTD
Keigo ITO	Flood control measure plan	CTI Engineering International Co., LTD
Kouji KAWAMURA	Flood warning /evacuation plan	Nippon Koei Co., LTD

1.6 Study Policy

The study policy is as follows:

1) To grasp the actual conditions of the disasters caused by tropical storm Ondoy and typhoon Pepeng as basic information for needs assessment of the flood disasters:
   - To collect hydro-meteorological dada and develop inundation maps of Metropolitan Manila as basic information for needs assessment of the flood disasters.
   - To collect hydro-meteorological data and flood and landslide hazard areas by city and municipality

2) To review effectiveness of the existing flood control and drainage project carried out by the JICA (or JBIC):
   - To review effects of existing flood control and drainage facilities developed in Metropolitan Manila and surrounding during the flood caused by Ondoy

3) To review the disaster risk management system of the Central and Local Governments.
   - To review flood warning and evacuation systems in Metropolitan Manila
   - To review the actual operation during flood
   - To review current community based flood disaster risk management systems

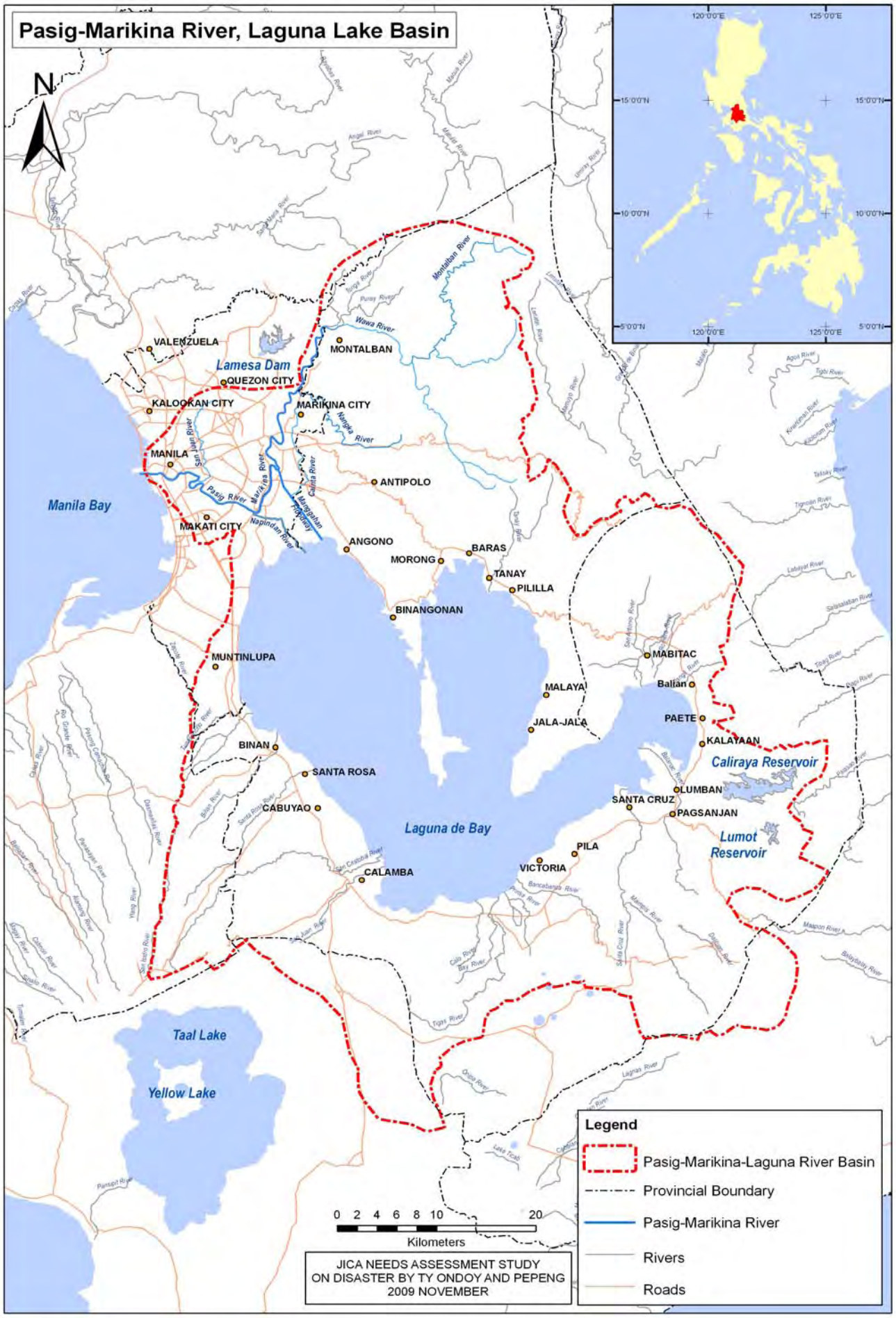
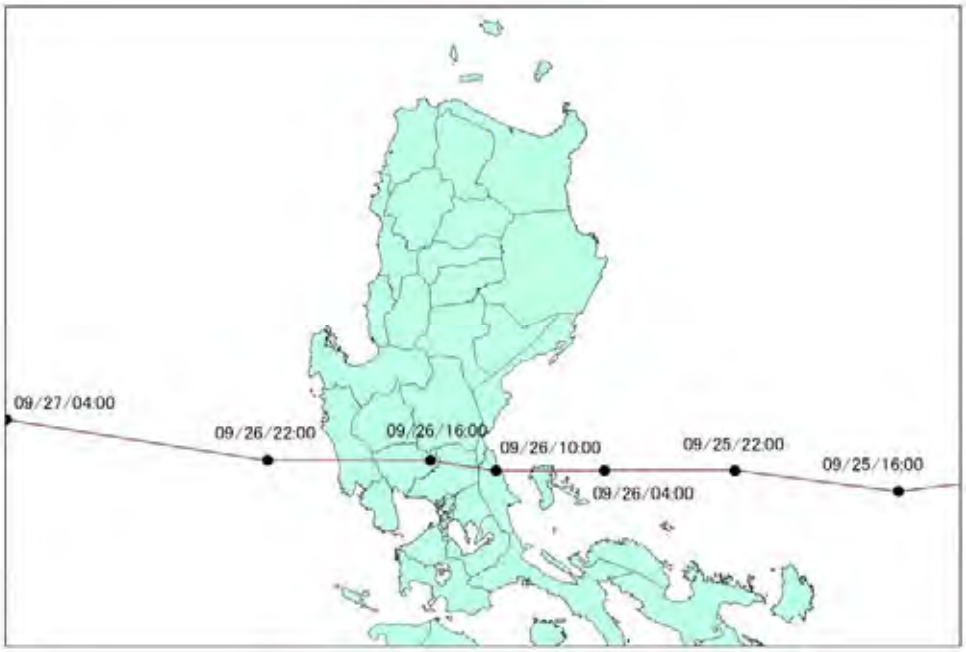
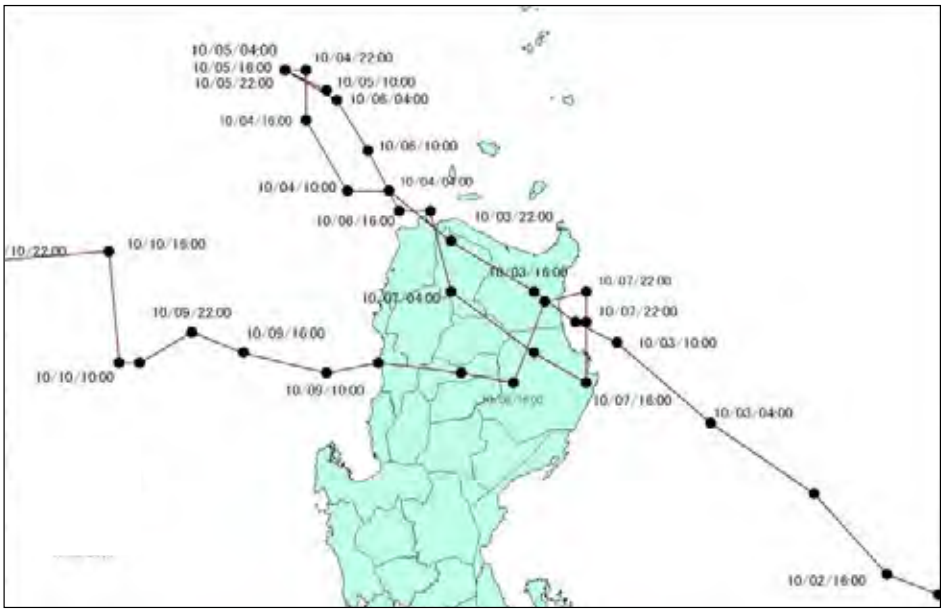


Figure 1.1.1 Laguna Lake Basin including Pasig-Marikina River Basin



Track of Tropical Storm Ondoy



Track of Tropical Storm Pepeng

Figure 1.1.2 Track of Tropical Storms of Ondoy and Pepeng

2. Disasters Caused by Typhoon No.16 (Ondoy) and No.17 (Pepeng)

2.1 Disasters Damage

According to the NDCC-OCD's information the disasters caused by Ondoy and Pepeng the losses in terms of number of affected families and persons, dead, missing, injured houses totally damaged are shown in the following **Table 2.1.1**.

Table 2.1.1 Disasters Caused by Tropical Storms Ondoy and Pepeng

	TS ONDOY- 26 Sep. 2009 (Ketsana)	TY PEPENG- 03 Oct. 2009 (Parma)
Affected Population	993,227 families	954,087 families
	4,901,234 persons	4,478,284 persons
	2,018 barangays	5,486 barangays
	172 municipalities	364 municipalities
	16 cities	36 cities
	26 provinces Regions I, II, III, IV-A, IV-B, V, VI, IX, XII, ARMM, CAR and NCR	27 provinces Regions I, II, III, IV-A, IV-B, V, VI, CAR and NCR
Casualties (persons) Dead	464	492
Missing	37	47
Injured	529	207
Evacuation (as of Nov./05/2009)	244 evacuation centers	54 evacuation centers
(maximum)	15,798 families	3,258 families
	70,124 persons	14,892 persons
Damages - houses	185,004 houses	54,373 houses
Totally	30,082 houses	6,253 houses
Partially	154,922 houses	48,120 houses
Estimated cost of damage (PhP)	10.952 billion	27.297 billion
Infrastructure (PhP)	4,284 billion	6,799 billion
Agriculture (PhP)	6.669 billion	20.495 billion
Private property (PhP)	0 billion	0.003 billion
Total number of schools damaged	1,383 schools	1,531 schools
	1,131 elementary schools	1,280 elementary schools
	252 high school	251 high school
	239 day care centers	69 evacuation families per 3 schools
Institutional materials + school equipment (PhP)	-	767.45 million

Source: NDCC, Philippines, as of November 20, 2009

Ondoy has affected about one million of families and 4.9 million of persons and took a heavy loss of lives/missing of 500. Loss of lives was mostly in the three regions: 52% in NCR (241 lives), 35% in Region IV-A (160 lives) and 12% in Region III (56 lives).

Pepeng caused numerous landslides and affected about 0.95 million families and 4.5 million of persons. The loss of lives was 539 in total. 75% of the loss was in Cordillera Administrative Region (CAR) and 20% in Region I (Ilocos) which includes the Aguno River and Laoag River.

2.2 Rainfall

(1) Rainfall Observation

There are 10 rainfall stations in and around Metropolitan Manila, where hourly rainfall has been recorded, as below:

Table 2.2.1 Rainfall Stations in and around Metro Manila

Name of Station	Operated by	Location		Status of Recording During Typhoon Ondoy
		Latitude	Longitude	
Science Garden	PAGASA	14° 38' 48"	121° 02' 23"	Completely recorded
Port Area	PAGASA	14° 34' __"	121° 05' __"	Completely recorded
NAIA	PAGASA	14° 30' __"	121° 00' __"	Data not yet collected
Napindan	EFCOS (MMDA)	14° 33' 32"	121° 04' 01"	Not recorded
Mt. Campana	EFCOS (MMDA)	14° 40' 06"	121° 17' 29"	Not recorded
Aries	EFCOS (MMDA)	14° 39' 46"	121° 10' 08"	Partly recorded
Nangka	EFCOS (MMDA)	14° 36' 58"	121° 08' 55"	Partly recorded
Boso-boso	EFCOS (MMDA)	14° 38' 24"	121° 13' 23"	Completely recorded
Mt. Oro	EFCOS (MMDA)	14° 46' 48"	121° 09' 28"	Partly recorded
Catmon	DPWH	14° 38' 48"	14° 38' 48"	Completely recorded

Source: PAGASA, EFCOS, DPWH

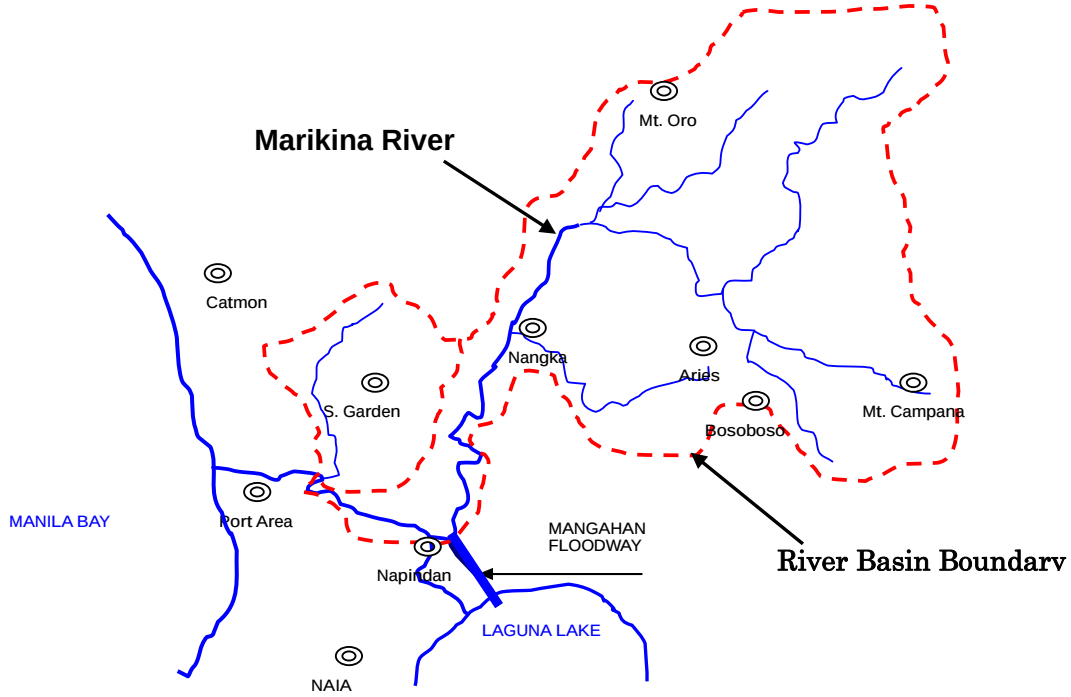


Figure 2.2.1 Rainfall Stations in and around Metro Manila

(2) Rainfall in tropical storm Ondoy

During Ondoy the heavy rain had started at 8 a.m. on September 26, 2009 and almost stopped at 8 p.m. on the same day.

Among the recorded hourly and daily rainfalls, the maximum data was recorded at Catmon Station of 138 mm/hr and 460 mm/day, followed by at Science Garden of 92 mm/hr and 455 mm/day and Port Area of 44 mm/hr and 258.5 mm/day as shown in **Table 2.2.2**.

Table 2.2.2 Hourly and Daily Rainfall Record during Typhoon Ondoy

Day	from	to	Science Garden	Port Area	Catmon	Boso-Boso	Aries	Mt. Oro	Nangka	Science Garden-24h	Port Area-24h	Catmon-24h
25	8	9	0.0	0.0	0.0							
	9	10	0.0	0.0	0.0							
	10	11	0.0	0.0	0.0							
	11	12	0.0	0.0	0.0							
	12	13	0.0	0.0	0.0							
	13	14	0.0	0.0	0.0							
	14	15	0.0	0.0	0.0							
	15	16	0.0	0.0	0.0							
	16	17	0.0	0.0	0.0							
	17	18	0.0	0.0	0.0							
	18	19	2.0	0.5	3.0							
	19	20	1.0	2.0	3.0							
	20	21	5.5	0.5	8.0							
	21	22	6.5	5.0	11.0							
	22	23	5.0	5.5	8.0							
	23	24	6.0	4.5	7.0							
26	0	1	11.0	2.5	17.0							
	1	2	13.0	13.5	16.0							
	2	3	8.5	7.0	18.0							
	3	4	17.5	7.0	34.0							
	4	5	4.0	10.0	9.0							
	5	6	12.0	4.5	1.0							
	6	7	1.5	1.0	4.0							
	7	8	0.5	1.0	0.0					94.0	64.5	139.0
	8	9	8.0	0.5	4.0	7	1	1	2			
	9	10	49.5	9.5	18.0	41.0	27.0	36.0	19.0			
	10	11	82.0	37.0	38.0	58.0	56.0	73.0	54.0			
	11	12	92.0	30.0	24.0	57.0	77.0	53.0	91.0			
	12	13	55.0	33.0	66.0	47.0	47.0	43.0	57.0			
	13	14	63.0	44.0	138.0	30.0	33.0	18.0	48.0			
	14	15	40.0	39.0	64.0	53.0	********	********	********			
	15	16	19.0	22.0	29.0	13.0	********	********	********			
	16	17	8.5	12.0	32.0	12.0	********	********	********			
	17	18	11.0	11.0	11.0	11.0	8.0	7.0	********			
	18	19	12.5	7.0	15.0	9.0	10.0	11.0	********			
	19	20	12.0	5.0	5.0	2.0	3.0	2.0	********			
	20	21	0.0	0.5	3.0	3.0	8.0	1.0	********			
	21	22	3.0	4.0	5.0	4.0	5.0	5.0	********			
	22	23	4.0	3.0	7.0	0.0	0.0	0.0	0.0			
	23	24	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
27	0	1	0.5	0.5	0.0	1.0	0.0	0.0	0.0			
	1	2	0.0	0.5	1.0	0.0	0.0	0.0	0.0			
	2	3	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
	3	4	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
	4	5	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
	5	6	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
	6	7	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
	7	8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	455.0	258.5	460.0

Source: PAGASA

At Science Garden 92 mm/hr is more than once in 20-year, and 455 mm/day estimated as more than 100-year return period fell in the Marikina River basin and Laguna Lake basin. At Port Area hourly rainfall is 2~5-year return period, daily rainfall about 10-year return period, but it is assumed that the rain fall amount more than 10-year return period fell in the core area of Metropolitan Manila during Ondoy, considering the rainfall amount at Science Garden nearby.

(3) Rainfall in Typhoon Pepeng

During typhoon Pepeng heavy daily rainfalls were recorded at Baguio 531 mm/day on October 3 and 685 mm/day on October 8, 2009 as shown in **Table 2.2.3**. The rainfall amounts were reported about 50-year return period.

Table 2.2.3 Daily Rainfall Record during Typhoon Pepeng

Rainfall Observation

Date	Badayan	Apunan	Bobok	Ambuklao	Binga	Ampucao	Pitikan	San Roque	Baguio	Dagupan
2009 1-Oct	0	0	5	0	2	0	0	0	0.4	T
2-Oct	31	22	15	13	11	11	13	9	20	25.5
3-Oct	120	138	138	150	178	286	183	73	531	159.5
4-Oct	8	18	8	3	9	33	13	3	38.2	8
5-Oct	0	0	1	0	0	0	0	0	4.6	T
6-Oct	72	101	68	78	68	183	74	24	260	36.2
7-Oct	176	101	78	88	88	84	82	58	276	
8-Oct	250	236	259	441	360	385	116	328	685	443.5
9-Oct	7	20	12	17	21	77	22	8		35
10-Oct	0	0	0	0	0	0	0	0	0	0
11-Oct									0	0
12-Oct									T	0
13-Oct									T	0
14-Oct									2	T

Source: PAGASA

(4) Flood disasters caused by Ondoy

1) Ondoy brought extremely heavy rainfalls (93 mm/hr: Over 20-year return period, 174 mm/2hr: about 50-year, 455 mm/day: over 100-year recorded at Science Garden) and there are no observed data for the flood discharge of the Marikina River, but estimated as over 4,000 m^3/s*, and the flood water caused severe flood disasters along the Marikina River and also in the East/West Areas of Mangahan Floodway. The Lakeshore Area and part of the East/West Areas of Mangahan Floodway were suffered from sudden increase of the water level of Laguna Lake about 1.2 meters (from EL.12.6 meters to EL. 13.8 meters). Flood Maps (depth and duration) during Ondoy have been developed based on the survey data from NAMRIA and the Study Team's field survey conducted for Metropolitan Manila and surrounding and shown in **Figures 2.2.3 and 2.2.4**, and the water level records of Laguna Lake from Laguna Lake Development Authority (LLDA) are shown in **Figure 2.2.5**.

**: About the flood peak discharge during Ondoy the Laguna Lake Development Authority (LLDA) has estimated as 4,150 m3/s and UP-National Hydraulic Research Center (NHRC) did 5,770 m3/s.*

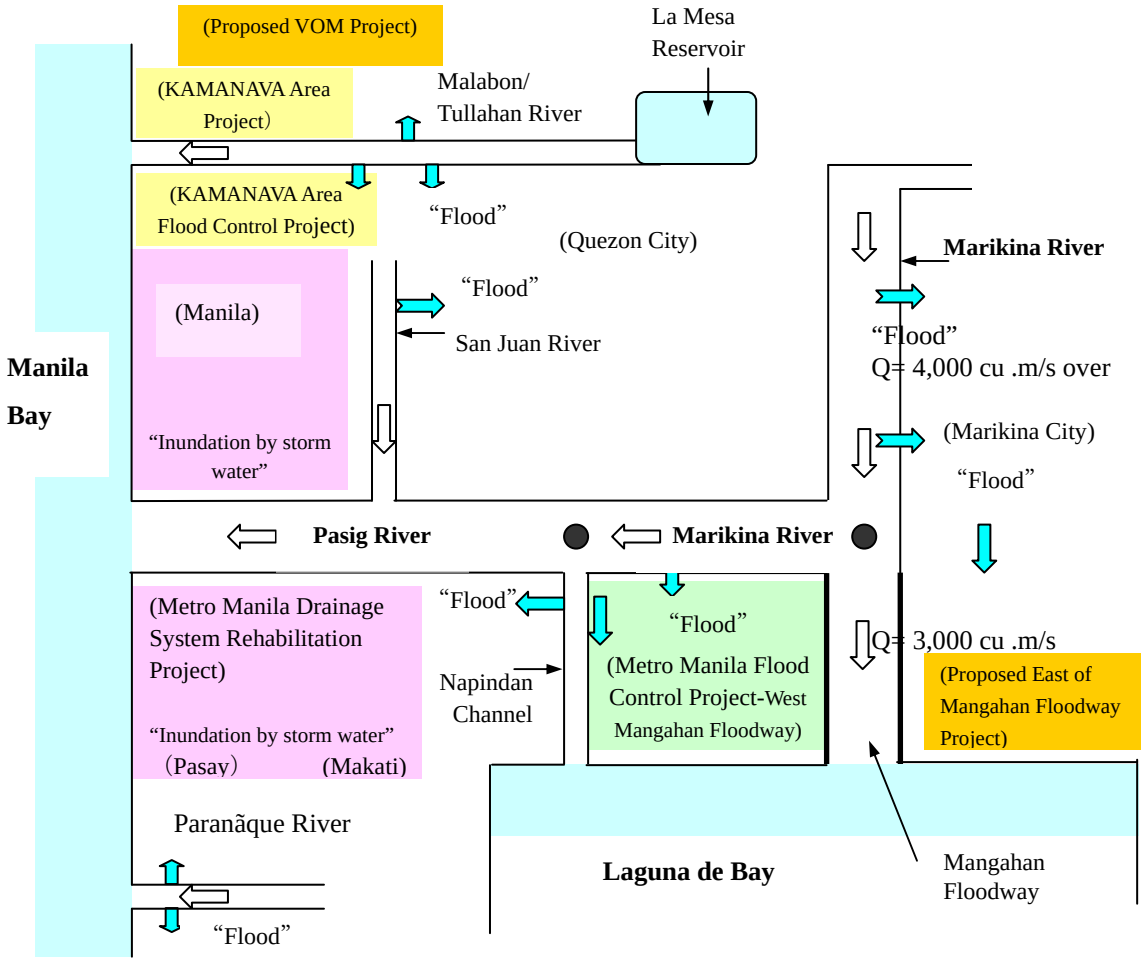
2) Discharge capacities of the existing channels of the Pasig-Marikina River are less than a half of the estimated flood discharge (over 4,000 m³/s), but the Pasig River was not over topped. The discharge capacities estimated in the JICA Study in 1990 are shown in the following box.

Bank full discharge capacities of Pasig-Marikina River Channels

River	Bank full Discharge capacity (Section)
Pasig River:	*700~800 m³/s （ from River mouth to San Juan River junction）*
Pasig River:	*500~600 m³/s （ from San Juan River to Napindan junction）*
Lower Marikina River:	*500~600 m³/s （from Napindan to Rosario Weir）*
Upper Marikina River:	*1,100~1,300 m³/s （from Rosario Weir to Sto. Niño）*
Upper Marikina ：	*1,500 ~1,800 m³/s （from Sto. Niño to Montalban）*

Source: *"the Study on Flood Control and Drainage Project in Metro Manila (March 1990 JICA)"*

A conceptual diagram of flood flows during Tropical Storm Ondoy is shown in **Figure 2.2.2**.



Notes: The peak flood discharges during Ondoy are estimated at 5,770 m³/s by NHRC-UP and at 4,150 m³/s by LLDA, respectively.

Figure 2.2.2 Conceptual Diagram of Flood Flow during TS Ondoy in Metro Manila

3) About 3,000 m³/s of the flood water of the Marikina River was estimated to flow in to Mangahan Floodway, of which design capacity is 2,400 m³/s, also about 150 m³/s of the rest of flood water flew backward Napindan channel and caused flooding in the west area of Mangahan Floodway.

4) The Pasig River was no over topping during Ondoy due to the effects of Mangahan Floodway and Napindan channel. However, the core area of Metro Manila was widely inundated by heavy storm waters and the drainage system partly took for about three days to drain the area. During Ondoy the operation of five pumping stations (Pandacan, Paco, Makati, Quiapo and Sta. Clara) were temporally stopped because of submerged by abnormal storm waters, but the other 10 pumping stations were operating. Also the San Juan, Tullahan and Parañaque Rivers, which are located surrounding of the core area of Metropolitan Manila were flooding.

5) During Ondoy the water level of Laguna Lake rose about 1.2 m in a short time to EL.13.84 and a wide area of the lake shore without shore dike was submerged. At the west area of Mangahan Floodway, of which the elevation of the lake shore dike is partly tentative level and partly not completed, was submerged. Three of the four pumping stations were stopped operation because of some of equipment submerged. Usually flood damages increase when the lake water level rises over 12.00 m. The lakeshore areas by elevation are shown as follows:

EL	Area of Marshland
10.50 ~ 11.50 m:	6,987.6 ha
11.50 ~ 12.00 m:	1,703.4 ha
12.00 ~ 13.00 m:	962.0 ha
13.00 ~ 14.03 m:	62.0 ha
14.03 ~ 14.60 m:	-
Minimum water level: 10.48 m	
Maximum water level: 14.60 m (in 1917)	

(5) Flood disasters by Pepeng

1) Pepeng took about six days (From October 3 to October 8) to pass Northern Luzon and brought heavy rains which caused floods and landslides in Northern and Central Luzon. Major rivers: the Aguno, Cagayan, Pampanga, Laoag and Bucao River Basins caused floods. Cities and municipalities affected by floods during Pepeng) are shown in **Figure 2.2.6**.

2) There were numerous landslides occurred in CAR, Region I and Region II, especially in

Baguio city and La Trinidad city in Benguet Province in CAR. According to the geo-hazard mapping and assessment of the Mines & Geosciences Bureau (MGB), the mountain slopes in the area are mostly assessed as susceptible to landslide due to the region's geographic and geologic setting. There are numerous landslides were occurred by the heavy rains during Pepeng. Cities and municipalities affected by landslides and sediment disasters during Pepeng are shown in **Figure 2.2.7**.

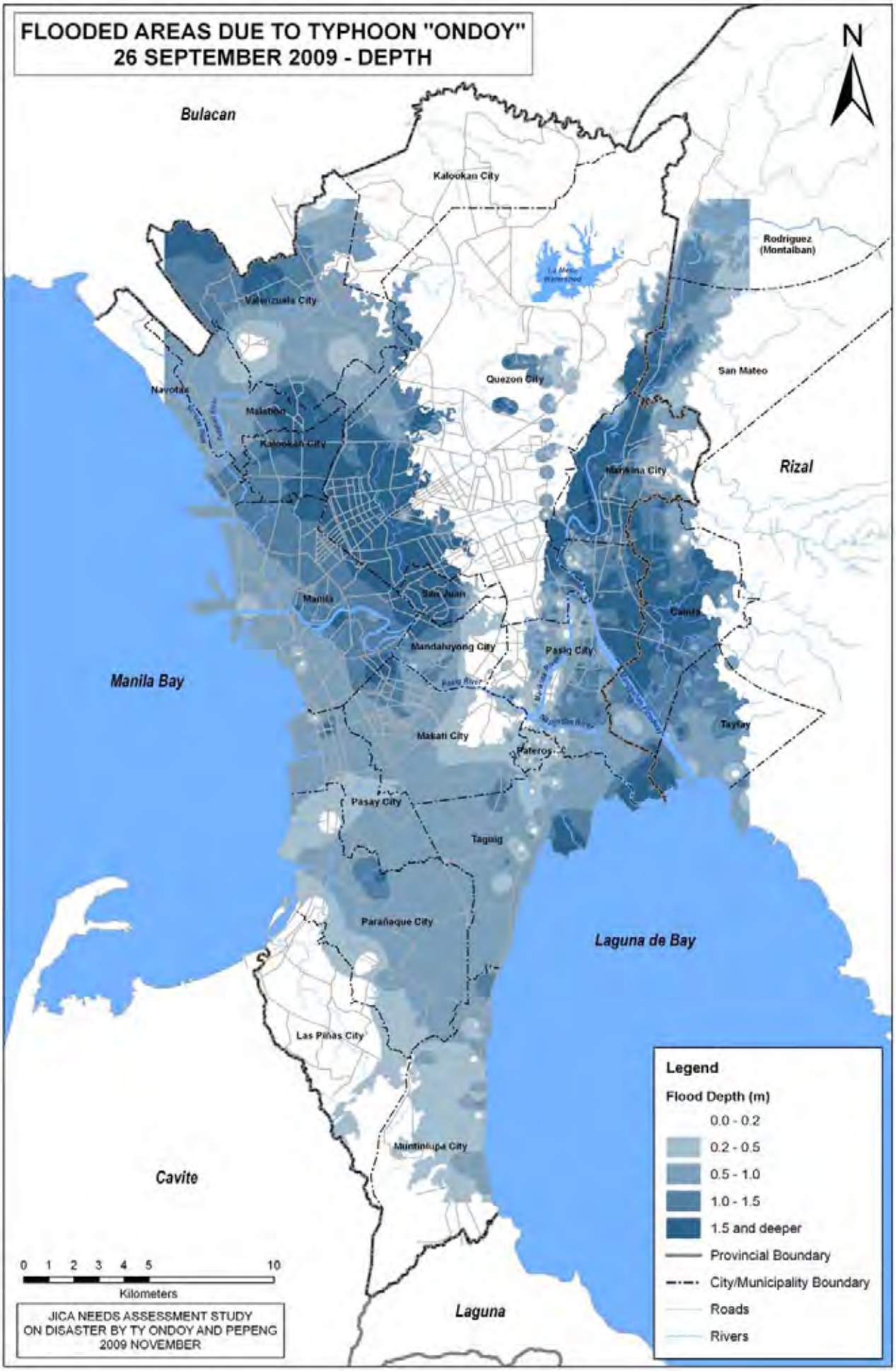


Figure 2.2.3 Flooded Area due to Typhoon "Ondoy" 26 Sep. 2009 - (Depth)

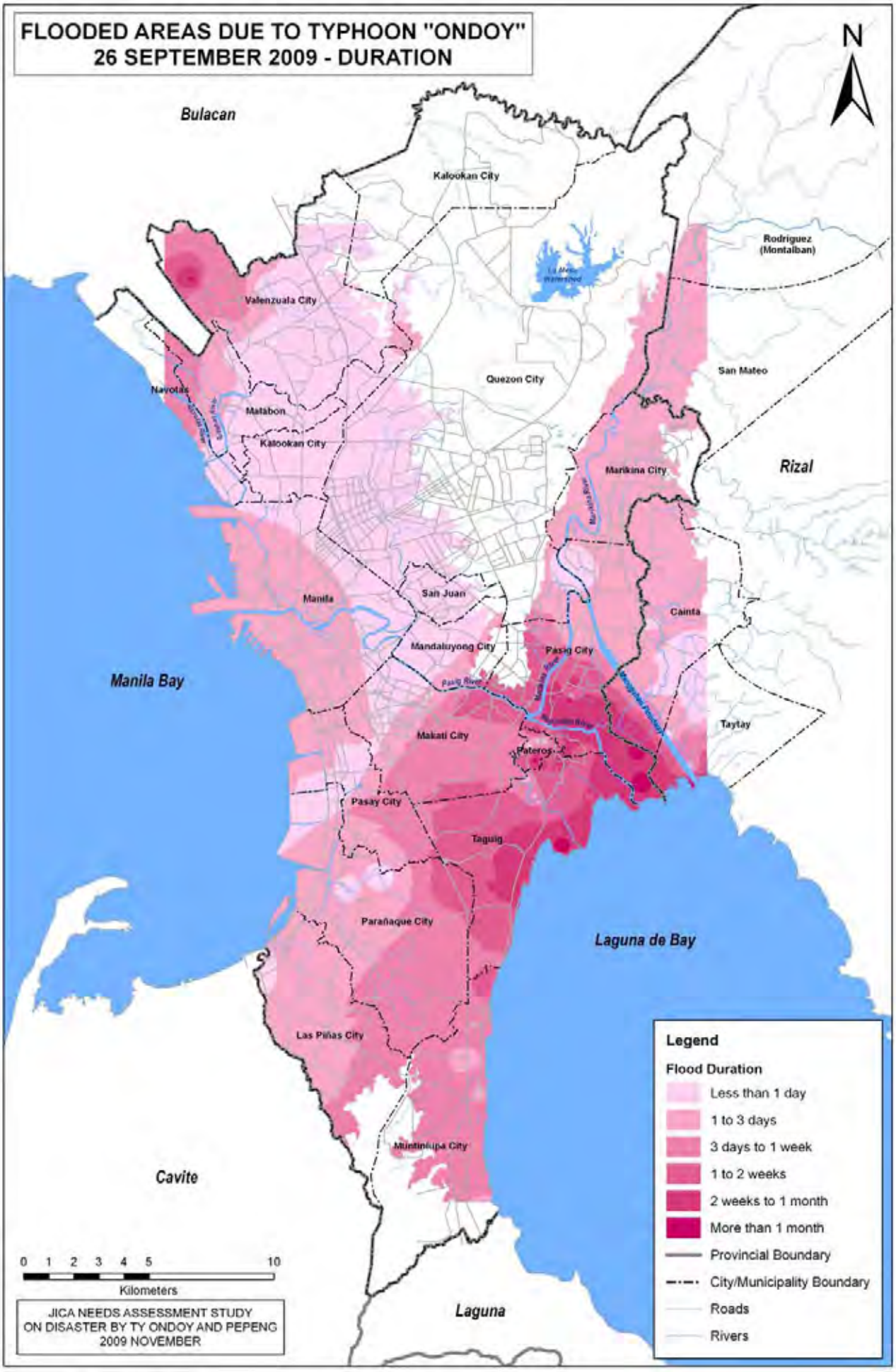


Figure 2.2.4 Flooded Area due to Typhoon "Ondoy" 26 Sep. 2009 - (Duration)

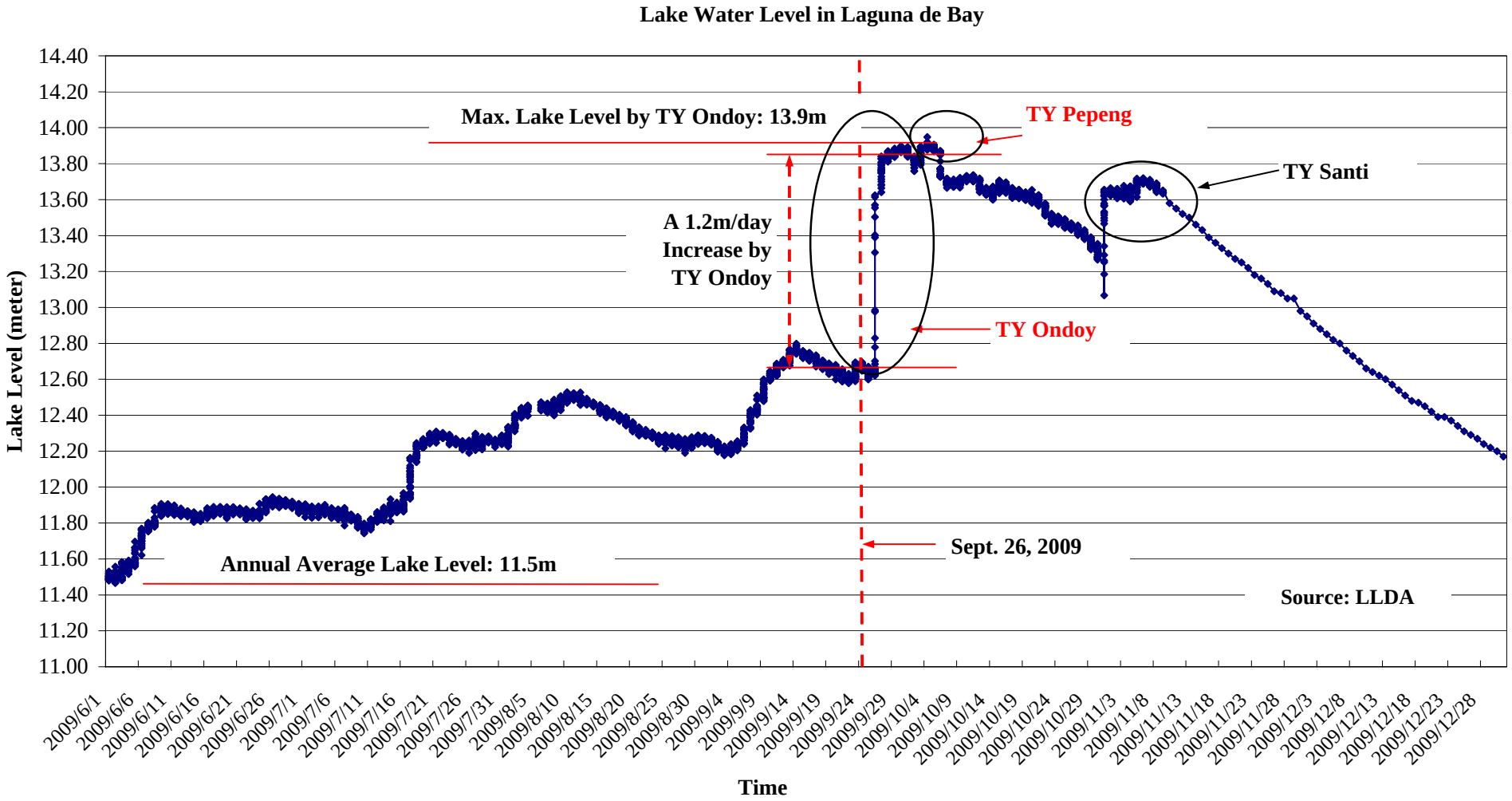


Figure 2.2.5 Records of Lake Water Level in Laguna de Bay (2009)

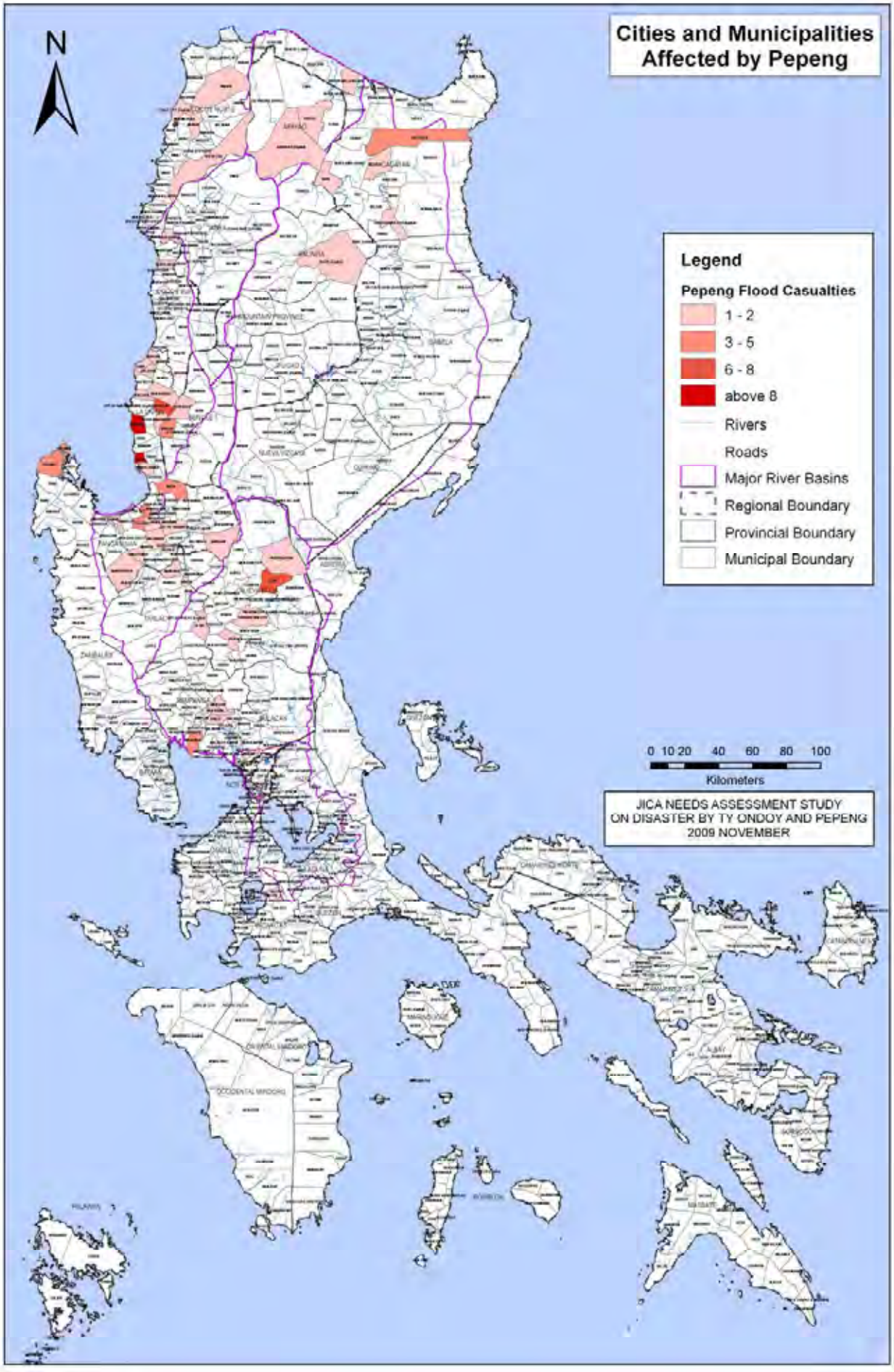


Figure 2.2.6 Cities and Municipalities affected by Typhoon Pepeng (Flood)

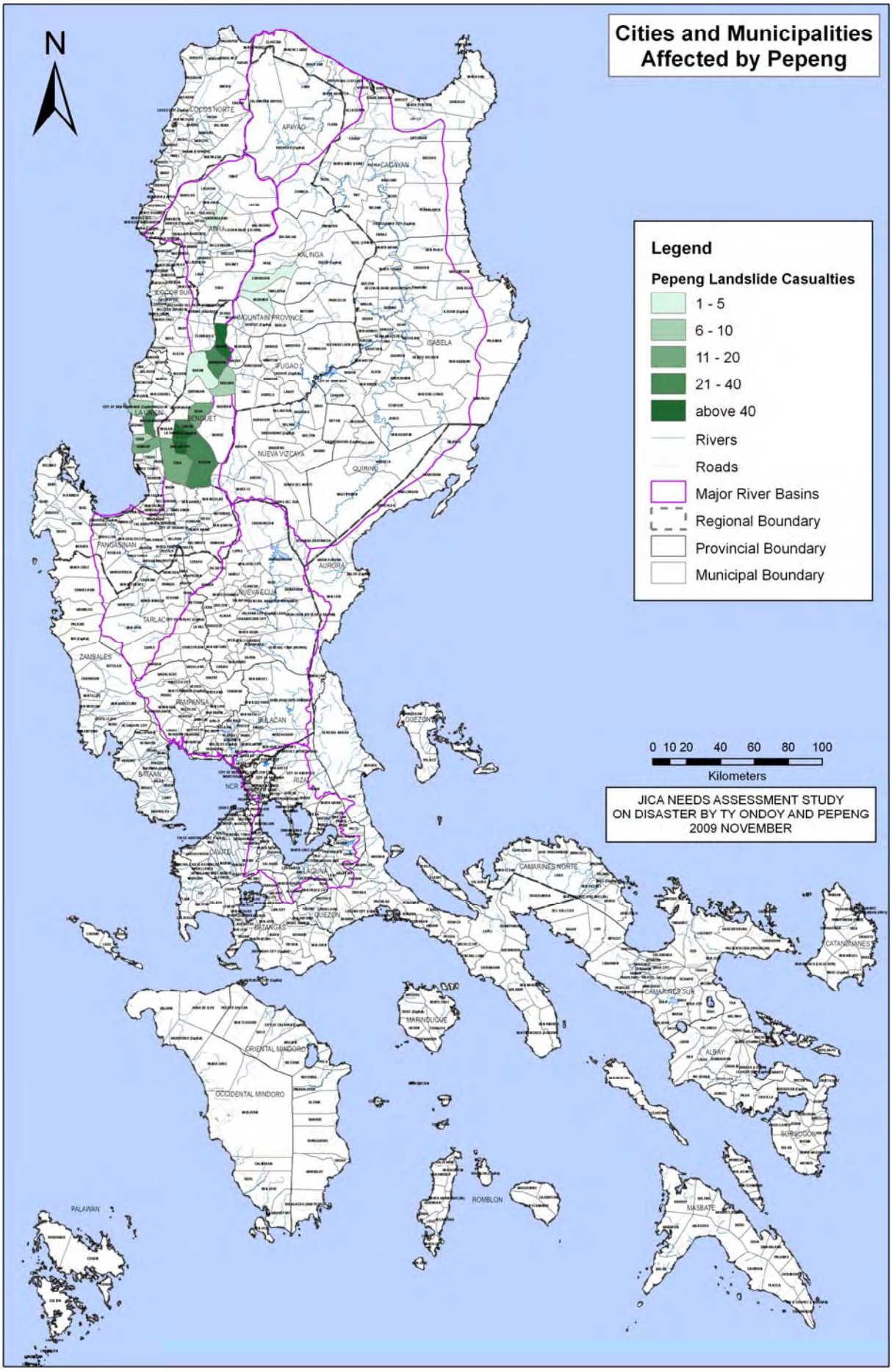


Figure 2.2.7 Cities and Municipalities affected by Typhoon Pepeng (Landslide)

2.3 Structural and Non-structural Measures for Existing Flood/Drainage Facilities

2.3.1 Effects of Exiting Flood/Drainage Facilities

(Metropolitan Manila and Surrounding)

In Metropolitan Manila flood control and drainage projects which have been planned and /or constructed and on going by JICA are shown in **Table 2.3.1** and **Figure 2.3.1**.

Table 2.3.1 Flood Control and Drainage Projects in Metropolitan Manila

Name of Project (ODA Scheme)	Catchment Area (km^2)	Facilities and Target Improvement Level (Design Return Period)	Implementation and Current Conditions
North			
KAMANAVA Area Flood Control and Drainage System Improvement Project (JBIC/JICA Loan)	19	River: 30-year Drainage:10-year	2002 - 2009 Continue the portion of Local Fund for completion ・Drainage pumping stations ・Ring dyke
Central			
Manila Drainage System Improvement Project –Drainage Improvement in the Core Area of Metropolitan Manila (JBIC Loan)	52	Drainage pump: 10-year	1974 - 1997 ・Drainage pumping stations (15 sites) ・Flood control gates ・Channel improvement
Pasig-Marikina River Channel Improvement Project (JBIC/JICA Loan)	651	River: 30-year	2009 – 2012: Now on going ・River improvement (17 km) ・Revetment and parapet wall
South			
Mangahan Floodway with Rosario Weir (OECF Loan)	-	River: 30-year	1984 – 1988 ・Floodway and control gates
Metro Manila Flood Control Project – West of Mangahan Floodway (JBIC/JICA Loan)	39	Drainage: 5-year Lake: 40-year	2000 – 2007 ・Lakeshore dike (9.4 km) ・Drainage pumping stations (4 sites) ・Flood control gates(4) ・Napindan river channel improvement/Parapet wall (4.3 km)
Pasig-Marikina River Basin			
Effective Flood Control and Operation System (EFCOS) (OECF Loan) & (JICA Grant Aid)	-	-	Completed in 1993 (OECF Loan) 2000 - 2002 (JICA Grant Aid)

The effectiveness of their flood control facilities and urgent tasks against the flood disasters are outlined as follow:

(1) Mangahan Floodway with Rosario Weir (1984-1988)：

After completion of the project in 1988 the operation and maintenance (O&M) for the control gates of Rosario Weir were conducted by DPWH. In 2002 the O&M activities for the control gates were transferred to MMDA, however, MMDA has not conducted the O&M activities for the control gates since 2006.

During Ondoy the flood discharge from the Upper Marikina River was estimated over 4,000 m^3/s, of which about 3,000 m^3/s was naturally diverted to Laguna Lake through Rosario Weir –Mangahan Floodway and furthermore through Napindan HCS-Napindan channel flowed backward about 150 m^3/s to Laguna Lake. As the result the Pasig River, which is the lower reach of the Marikina River, flowed through the core area of Metropolitan Manila without overtopping or flooding due to the reduction of flood water discharged into Laguna Lake through Mangahan Floodway and Napindan channel. Without Mangahan Floodway the Core Area of Metropolitan Manila should have been suffered from devastating flood damages from the Pasig River. The locations of the Pasig-Marikina River, Mangahan Floodway and Napindan HCS are shown in **Figure 2.3.1.**

The crest height of Rossario Weir was lowered in order to divert the design flood of 2,400 m^3/s from the Marikina River to the Mangahan floodway and installed gates to secure the design discharge of 900 m^3/s of the main stream of Marikina River. However, a control structure (MCGS) at the Marikina River should be examined because the discharge capacity of the Marikina River will increase by the completion of the on going Pasig-Marikina River Improvement Project. The result of hydraulic model experiment (NHRC-UP in 1981) shows the maximum diversion capacity of 2000 m^3/s by natural diversion without any control structure at the main stream of Marikina River and suggests the necessity of control structure for flood control of the Pasig Marikina River.

(2) Metro Manila Drainage System Rehabilitation (1976-1998):

The core area (73 km^2) of Metro Manila is mostly low lying. The flood control and drainage systems for 70% of the core area depend on mechanical (pumping) drainage system. The project provided the core area with 15 major drainage pumping stations (Total discharge capacity: 230.6 m^3/s) installed by Japanese ODA and the existing drainage networks which have mainly been constructed by the Philippines side and are composed of 74 km of estero/creeks, 35 km of drainage mains and about 400 km laterals. The flood control and drainage system is designed 10-year return period (269mm/day) for drainage pumps. During Ondoy the storm water was supposed to be by far larger than the design one and required 1-3 days to drain. According to the operation records of 15 pumping stations and the hours of operation (high operating rate group: 70~100%, low operating group: about 50%), most of

drainage channels are losing their discharge capacities due to sedimentation and deposition of solid wastes and the available capacities of pumps are not utilized fully. The existing flood control and drainage system should be effective, but maintenance of the existing facilities by dredging and removing deposits and solid wastes in drainage channels. The project and locations of facilities are shown in **Figure 2.3.2**.

(3) Metro Manila Flood Control Project-West Mangahan Floodway (2000-2007):

The West Area of Mangahan Floodway is low lying of flood prone areas and suffered from the floodwaters of the Marikina River and Laguna Lake. The project provided the area with lakeshore dike: 9.4 km, drainage pumping stations: 4 stations (Total discharge capacity: 36.0 m^3/s) and flood control gates: 8 sites. During Ondoy about 80% of residential areas were flooded from the Marikina River for one to three weeks and three pumping stations were submerged and stopped operation for four days at Taguig, three days at Hagonoy, 14 days at Tapayan） by abnormal increase of inland water level. In the past the people suffered from flooding for two to three months, but the project shows positive effects by reducing the duration of inundation period. However, the east part of lakeshore dike is still temporally one and need early completion. The project and locations of facilities are shown in **Figure 2.3.3.**

(4) KAMANAVA Area Flood Control and Drainage System Improvement Project (2002-2009)：

KAMANAVA (Kalookan, Malabon, Navotas and Valenzuela) area is low-lying coastal area. The project is composed of five major drainage pumping stations of Maypajo, Spine, Bankulasi, Catmon and North Navotas (Total discharge capacity: 44.1 m^3/s), gates and ring levee. During Ondoy Catomon pumping station was temporary stopped operation by abnormal increase of inland water levels caused flood from the Malabon-Tullahan River. The five pumping stations continued operation and had a good effect on reducing the flood disasters, and also the low tide level did much to the drainage system. The project and pumping stations, gates and dikes are shown in **Figure 2.3.4**.

(5) Effective Flood Control Operation and Warning System project (EFCOS) (2000-2002):

EFCOS was originally installed by DPWH in 1978, and new system was installed by OECF in 1992 and rehabilitated by JICA grant in 2001. Through this system, PAGASA issued flood bulletins. After the rehabilitation EFCOS was transferred from DPWH to MMDA in 2002. MMDA operated it until 2006, when MMDA shut down its operation due to budget constrain. During Ondoy the flood control operation and warning system was not utilized, and the observation equipment of Nangka gauging station and the cable of water gauge at Santo. Nino were damaged.

(6) Pasig-Marikina River Improvement (Phase I) (Commenced in December 2008)

The project has finished the preparatory stage and started driving steel sheet piles for bank protection works, which were procured in the preparatory stage for bank protection. The project is to conduct

river improvement of 17 km and to complete in 2012.

(7) Urgent Tasks

The rainfall amount in the Metropolitan Manila and surrounding during Ondoy was by far exceeding the design rainfall amount. By the heavy storm water some of the major pumping stations were submerged and temporarily stopped their operation, but there were no major damages to the flood control and drainage facilities except several spots of the drainage channels constructed by the local government in the past, which are shown in **Figure 4.1.1**. The major urgent tasks are summarized as follows:

1) Urgent rehabilitation of drainage pumping stations

The 15 major pumping stations in the core area of Metropolitan Manila have already been operating for 20~30 except a few stations and mostly need rehabilitation. Especially three pumping stations of Aviles, Quiapo and Tripa de Gallina need urgent rehabilitation.

2) Necessity of improvement of managing organizations for flood control and major drainage facilities

It is necessary for the Metropolitan Manila and surrounding area to have an unified responsible managing organization in order to effectively conduct planning, implementing and O&M of flood control and drainage facilities. DPWH should take initiative also in O&M activities for flood control and drainage facilities, which are now under MMDA, which stopped O&M activities for EFCOS and the control gates of Rosario weir since 2006.

3) Review of the design criteria for the flood control and drainage facilities

It is necessary to review the plans and their design criteria considering the flood disasters caused by the Ondoy and conduct remedial works.

4) Rehabilitation of the existing drainage networks and drainage facilities

The existing drainage channels and drainage facilities need rehabilitation. The conveyance capacities of existing drainage channels are mostly decreased by solid wastes and sediment accumulated at the drainage channels, which are also affecting the capacities of the drainage pumps.

5) Review of the JICA master plan in 1990

The projects proposed in the JICA master plan in 1990 should be reviewed and urgent tasks should be identified and conducted for the Metropolitan Manila and surrounding. Among proposed projects some projects have been implemented and the others are in the stage of pre-F/S and F/S are as follows:

(Construction Stage)

-1 Metropolitan Manila Flood Control Project-West of Mangahan Project: Completed in 2007

-2 KAMANAVA Area Flood Control and Drainage System Improvement Project: Completed in 2009

-3 Pasig-Marikina River Channel Improvement Project:

(a) Pasig－Marikina River Channel Improvement Project (Phase II, Delpan Bridge~NHCS)：under construction and complete in 2012

(b) Upper Marikina River Channel Improvement Project (Sto.Ninõ-Rodrigues): F/S in 2002

(c) San Juan River Flood Control Project: F/S in 2002

(Pre F/S or F/S stage)

-4 Metropolitan Manila Flood Control Project - East of Mangahan Floodway: F/S in 2008

-5 Valenzuela-Obando-Meycauyan (VOM) Area Drainage System Improvement Project: F/S in 2008

-6 Flood Control and Drainage Improvement Project for MIAA Compound and Paranãque-Las Pinãs River System: F/S in 2004

-7 Marikina Dam Project: Pre-F/S in 1989

(Northern and Central Luzon)

The flood control and drainage projects which have been implemented by OECF/JBIC Loan in the Northern and Central Luzon are shown in **Table 2.3.2**.

Table 2.3.2 Flood Control and Drainage Projects in Northern and Central Luzon

Name of Project (ODA Scheme)		Facility	Completion
1	Pampanga Delta Development Project, Flood Control Component(1) (OECF Loan)	Dredging: 14.2 km Embankment: 29 km Slice gate: 16 units	02/09/1990 (L/A) Completed in 2002
2	Agno and Allied Rivers Urgent Rehabilitation Project (OECF Loan)	Dredging of Lower Agno River including short cut: 28.3 km Bugallon Bridge Dike(left bank of Lower Agno):540 m	08/30/1995 (L/A) Completed in 2002
3	Mt. Pinatubo Hazard Urgent Mitigation Project (OECF Loan)	Dredging of Bamban River: 15.9 Channeling of Sacobia River: 5.4 km Channeling of Bamban River: 9.9 km Bamban Bridge and Mabalacat Bridge	03/29/1996 (L/A) Completed in 2001

4	Agno River Flood Control Project (II-A) (JBIC Loan)	Floodway: 11.6 km (low water channel excavation) Guide channel of Bamban: 1.97 km Hector Mendoza Bridge	09/10/1998 (L/A) Completed in 2009
5	Mt. Pinatubo Hazard Urgent Mitigation Project (II) (JBIC Loan)	Southern Mega Dike: 9.29 km Gugu Bridge Baluyot Channel Improvement:4.3 km Sand pocket dike: 9.64 km Guide dike: 2.6 km Channel dredging/excavation: 58 km Channeling/Dike: 6.22 km Mancatian Bridge	12/28/1999 (L/A) Completed in 2006
6	Laoag River Basin Flood Control and Sabo Project (JBIC Loan)	Laoag-Bongo and Alluvial Fan River Improvement works: River improvement: 14 km Sabo Dam and Alluvial Fan River Improvement Works: River improvement: 39 km (Cur/Labungaon, Solsona, Madongan and Papa Rivers) Sabo Dam: 5 (Cura No.1, Labungaon No.1, Solsona No.1, Madongan and Papa)	05/30/2001 (L/A) Completed in 2008

Flood control and drainage projects have been implemented at the Pampanga river, Aguno river, Mr. Pinatubo and Laoag river. During Pepeng at the Agno and Laoag rivers some part of the flood control dykes were breached and eroded, and severe flood disasters were caused. The effectiveness of their flood control facilities and urgent tasks are outlined as follow:

(1) Agno and Allied River Urgent Rehabilitation Project/Agno River Flood Control Project (-A)

The Agno river is the fifth largest in the Philippines and the third largest in the Luzon with a catchment area of 5,952 km² and a total length of 221 km, originated in the Cordillera mountains and flows through the plain of Pangasinan and discharges into the gulf of Lingayen. In the upper reach there are three multipurpose dams (Ambukulao Dam: constructed in 1956, Binga Dam: constructed in 1960 and San Roque Dam: constructed in 2003) which are belonged to NPC in the upper reach. The flood control project which aims to protect the Pangasinan plain, was commenced in 1995 from the lower reach of 54 km (Phase 1:1995-2002) and constructed flood dikes with revetments, groins and restoration of existing facilities, and completed the mid reach of 23 km (Phase : 1998-2009)

including retarding basins, dikes with revetments by 2009. Now the upper reach of 47 km (Phase) is proposed for implementation.

During Pepeng the flood water breached some parts of the old dyke, which were constructed in 1960s and 1990s) located at the mid and upper reaches, and caused severe floods affecting about one million families and 4.5 million persons in the Pangasinan plain. The flood waters not only breached flood dykes but also eroded dykes and revetments at several sites. The rehabilitation and restoration of damaged flood dykes and eroded revetments have been proposed.

In the Agno river basin the wide area of agricultural land and numerous peoples in the Pangasinan plain were suffered from the flood by breached old flood dykes at the mid and upper reach. The flood control facilities implemented by the project are protecting the areas along the lower reach of the Agno river and effective for flood disaster risk reduction.

And it is indicated that the flood disasters may be caused by the emergency discharge from San Roque Dam which discharged 5,354 m^3/s on October 9 that is by far larger than the design flow capacity (3,960 m^3/s.) of the upper reach of the Agno river.

(2) Laoag River Basin Flood Control and Sabo Project (2001-2008)

The Laoag river basin is located in the province of Ilocos Norte in Region I with a catchment of 1,353 km^2, originated in the Cordillera and flows through the Ilocos Norte and discharge into the South China Sea. The project is composed of river improvement works of 14 km for the Laoag-Bongo river and four alluvial fan river improvement works of 39 km in total and implemented from 2001 to 2008.

During Pepeng the flood water breached a part of the flood dykes of Madongan river and inundated, and also eroded parts of the flood dykes of Madongan, Papa and Cura rivers to critical condition. Rehabilitation and restoration of damaged flood dykes have been proposed.

By the flood from the Madongan river the agricultural areas in the upper and mid reaches may be affected, but the flood control facilities showed the effectiveness by protecting most of the flood prevention area.

(3) Urgent tasks

The major urgent tasks are summarized as follow:

1) It is necessary for the Paganini area to implement the Phase as early as possible in order to increase the safety level from the flood disaster risks

The flooding from the right bank of the Phase area shall affect a wide area of the Pangacinan plain as shown by the last flood and also by the existing landform. Early implementation of Phase will be very important from flood disaster risk management aspects.

2) Increase accuracy of flood forecast and improvement of dam operation rules for San Roque Dam

The inadequate operation of San Roque Dam during the Pepeng flood was indicated. They are the delay of operation of out flow for flood control and inappropriately large discharge of 5,354 m^3/s compared with the design flow capacity of 3,960 m^3/s in the down stream of the dam. The flood suggests (1) It is necessary for flood forecast services to issue quantitative flood forecast such as describing range of expected flood peaks by improving the present flood forecast system and (2) It is necessary to review and update the dam operation manuals for flood control and conduct reasonable operation for reduction of flood peaks and flood disaster risks at the down stream.

3) Flood control facilities shall require periodical O&M activities

Flood control facilities especially flood dykes and revetments shall require regular O&M activities and immediate rehabilitation shall be carried out if some defects were identified. Even small defect shall cause severe flood disasters.

Table 2.3.3 Existing Large-Scale Flood Control/Drainage Pumping Stations in Metro Manila

Pumping Station	Drainage Area (km2)	Present Discharge (m3/s)	Nos. of Unit	Capacity per Unit (m3/s)	Completion Year
KAMANAVA Area*1					
1 Maypajo	2.41	6.6	2	3.30	2008
2 Spine	1.73	13.0	4	3.25	2008
3 Bangkulasi	0.75	4.4	2	2.20	2008
4 Catmon	3.55	10.5	4	2.625	2008
5 North Navotas	9.63	9.6	3	3.20	2008
total	*18.07*	*44.1*			
Metropolitan Manila Core Area*2					
1 Aviles	3.28	15.6	4	3.90	1976
2 Balete	0.94	3.0	3	1.00	1988
3 Balut	0.49	2.0	2	1.00	1998
4 Binondo	2.69	11.6	4	2.90	1985
5 Escolta	0.30	1.5	3	0.50	1982
6 Libertad	7.48	42.0	6	7.00	1977
7 Makati	1.65	7.0	2	3.50	1982
8 Paco	1.74	7.6	3	2.53	1977
9 Pandacan	1.15	4.4	2	2.20	1976
10 Quiapo	2.29	10.8	4	2.70	1976
11 San Andres	3.23	19.0	4	4.75	1998
12 Sta. Clara	1.57	5.3	2	2.65	1977
13 Tripa De Gallina	17.05	57.0	8	7.13	1977
14 Valencia	2.37	11.8	4	2.95	1976
15 Vitas	5.56	32.0	5	6.40	1997
total	*51.79*	*230.6*			
West of Magahan Floodway Area*3					
1 Tapayan	13.49	9.0	3	3.0	2007
2 Labasan	6.01	9.0	3	3.0	2007
3 Taguig	14.23	12.0	4	3.0	2007
4 Hagonoy	5.28	6.0	2	3.0	2007
total	*39.01*	*36.0*			

Source: DPWH, MMDA

Notes: *1: KAMANAVA Area Flood Control and Drainage System Improvement Project (JBIC/JICA)
*2: Drainage Improvement in the Core Area of Metro Manila (OECF/, EXIM Bank for Binondo/ Libertad/Makati)
*3: Metro Manila Flood Control Project - West of Mangahan Floodway (JBIC)

Table 2.3.4 Pump Operation Records in Metro Manila during TS Ondoy
ONDOY (2009 SEP. 26 ~ SEP. 30)

Pump Station	Drainage Aera (km^2)	Present Discharge (m^3/s)	Capacity Unit (m^3/s)		Date 2009 Sep.25	Sep.26	Sep.27	Sep.28	Sep.29	Sep.30
Aviles	3.28	15.6	3.90	%	14.6	**78.1**	74.0	22.9	8.3	13.5
		1,347,840		m^3	196,560	1,053,000	996,840	308,880	112,320	182,520
Balete	0.94	3.0	1.00	%	18.1	**77.8**	50.0	37.5	4.2	12.5
		259,200		m^3	46,800	201,600	129,600	97,200	10,800	32,400
Balut	0.49	2.0	1.00	%	27.1	**87.5**	39.6	27.1	22.9	16.7
		172,800		m^3	46,800	151,200	68,400	46,800	39,600	28,800
Binondo	2.69	11.6	2.90	%	13.5	56.3	**96.9**	30.2	20.8	17.7
		1,002,240		m^3	135,720	563,760	970,920	302,760	208,800	177,480
Escolta	0.30	1.5	0.50	%	1.4	**26.4**	13.9	1.4	0.0	0.0
		129,600		m^3	1,800	34,200	18,000	1,800	0	0
Libertad	7.48	42.0	7.00	%	9.7	33.3	**36.8**	16.7	9.0	9.0
		3,628,800		m^3	352,800	1,209,600	1,335,600	604,800	327,600	327,600
Makati*	1.65	7.0	3.50	%	4.2	**16.7**	0.0	0.0	6.3	14.6
		604,800		m^3	25,200	100,800	0	0	37,800	88,200
Paco*	1.74	7.6	2.53	%	8.3	**30.5**	0.0	0.0	5.5	5.5
		656,640		m^3	54,648	200,376	0	0	36,432	36,432
Pandacan*	1.15	4.4	2.20	%	4.2	**39.6**	0.0	0.0	0.0	0.0
		380,160		m^3	15,840	150,480	0	0	0	0
Quiapo	2.29	10.8	2.70	%	14.6	**53.1**	21.9	25.0	14.6	7.3
		933,120		m^3	136,080	495,720	204,120	233,280	136,080	68,040
San Andres	3.23	19.0	4.75	%	5.2	**54.2**	10.4	7.3	4.2	4.2
		1,641,600		m^3	85,500	889,200	171,000	119,700	68,400	68,400
Sta. Clara*	1.57	5.3	2.65	%	8.3	**54.2**	0.0	0.0	25.0	27.1
		457,920		m^3	38,160	248,040	0	0	114,480	124,020
Tripa de Gallina	17.05	57.0	7.13	%	5.7	**45.3**	42.2	15.6	7.8	6.8
		4,924,800		m^3	282,348	2,233,116	2,079,108	770,040	385,020	333,684
Valencia	2.37	11.8	2.95	%	20.8	**83.3**	62.5	31.3	18.8	20.8
		1,019,520		m^3	212,400	849,600	637,200	318,600	191,160	212,400
Vitas	5.56	32.0	6.40	%	10.8	**32.5**	8.3	10.8	8.3	8.3
		2,764,800		m^3	299,520	898,560	230,400	299,520	230,400	230,400
Total	*51.79*	*230.60*								

Source: MMDA

Note: * shows the puming stations that stopped their operation during Ondoy due to submergence by flood.

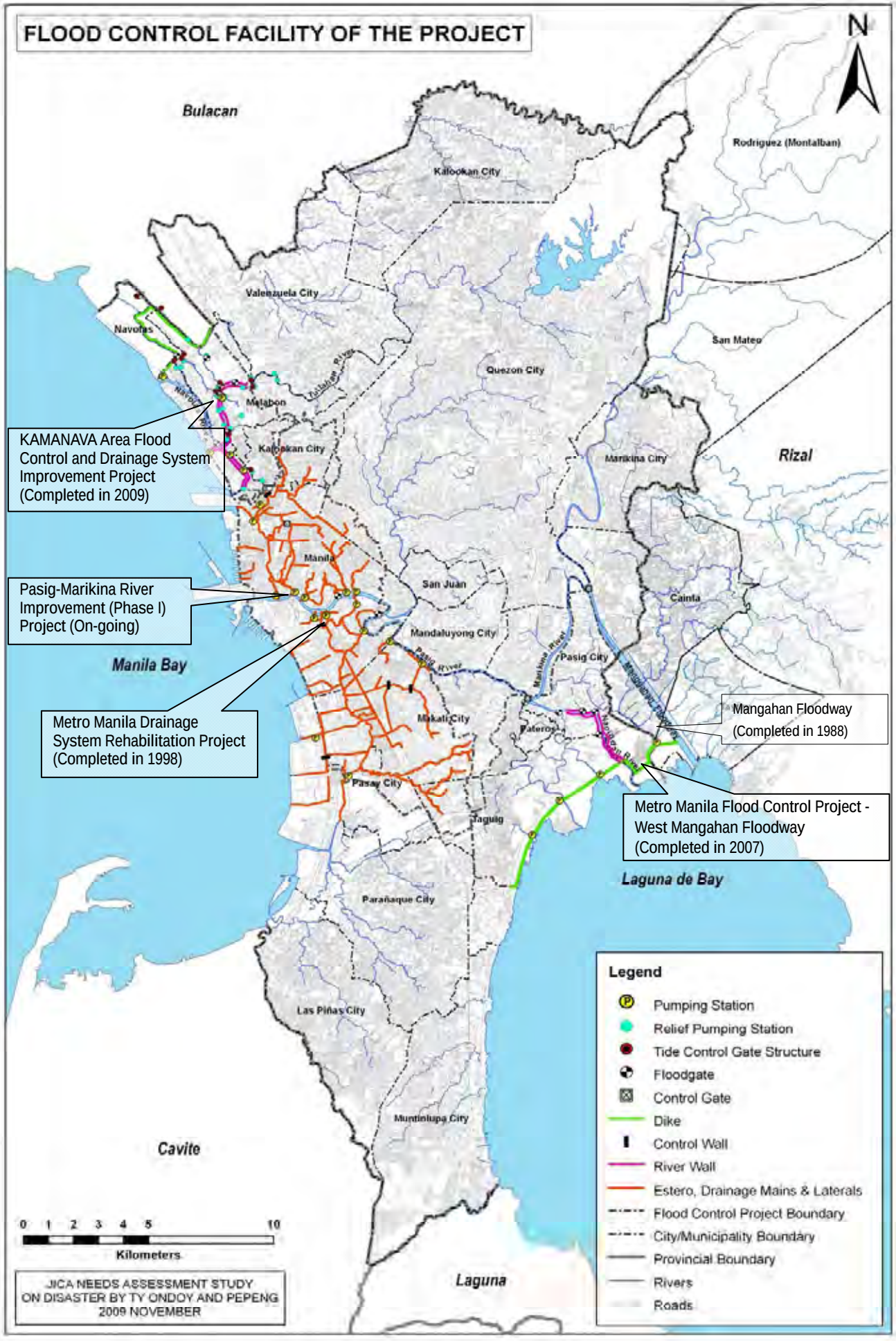


Figure 2.3.1 Flood Control Facility of the Project in Metro Manila

Figure 2.3.2 Drainage Improvement in the Core Area of Metro Manila

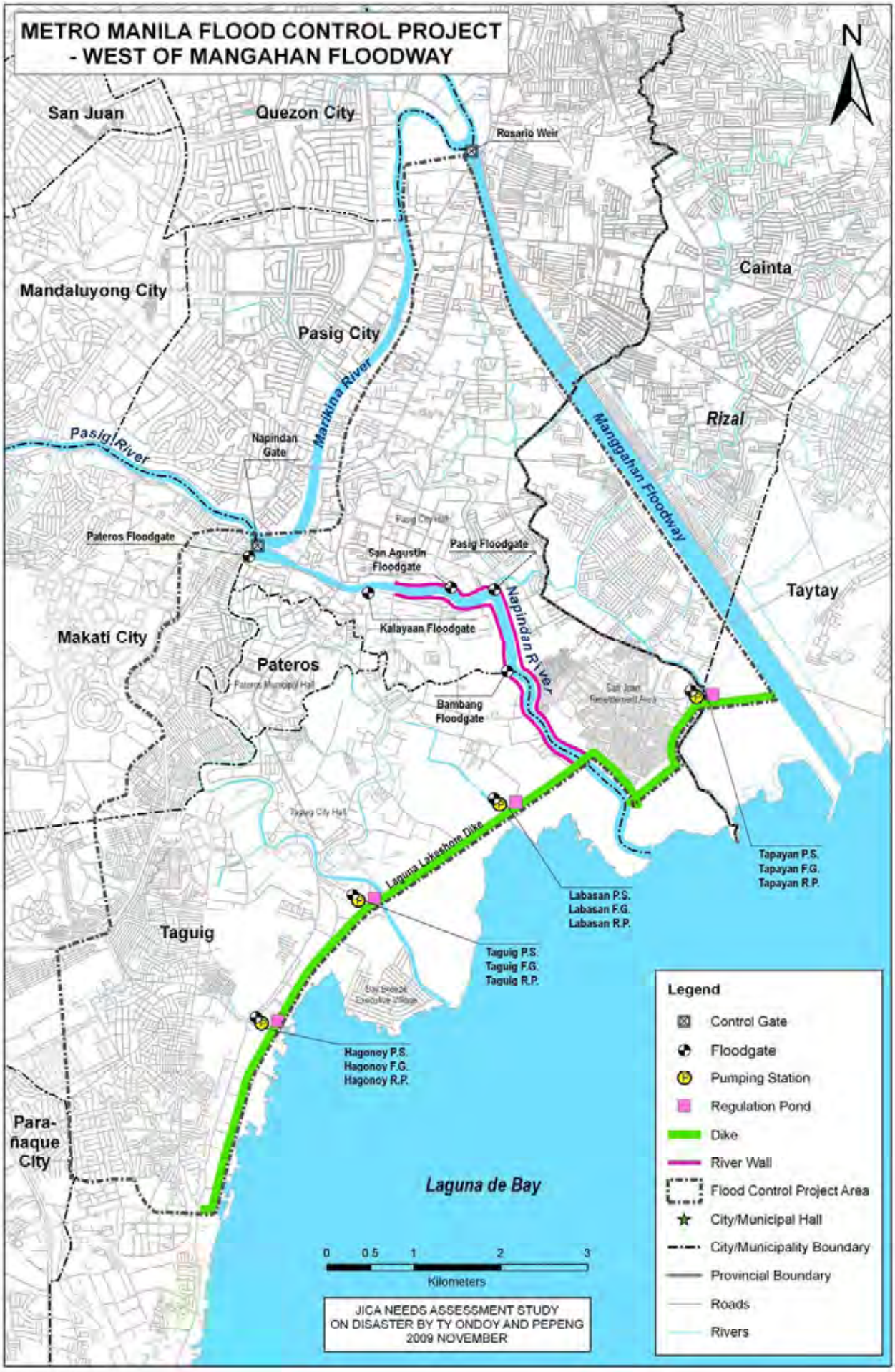


Figure 2.3.3 Metro Manila Flood Control Project - West of Mangahan Floodway -

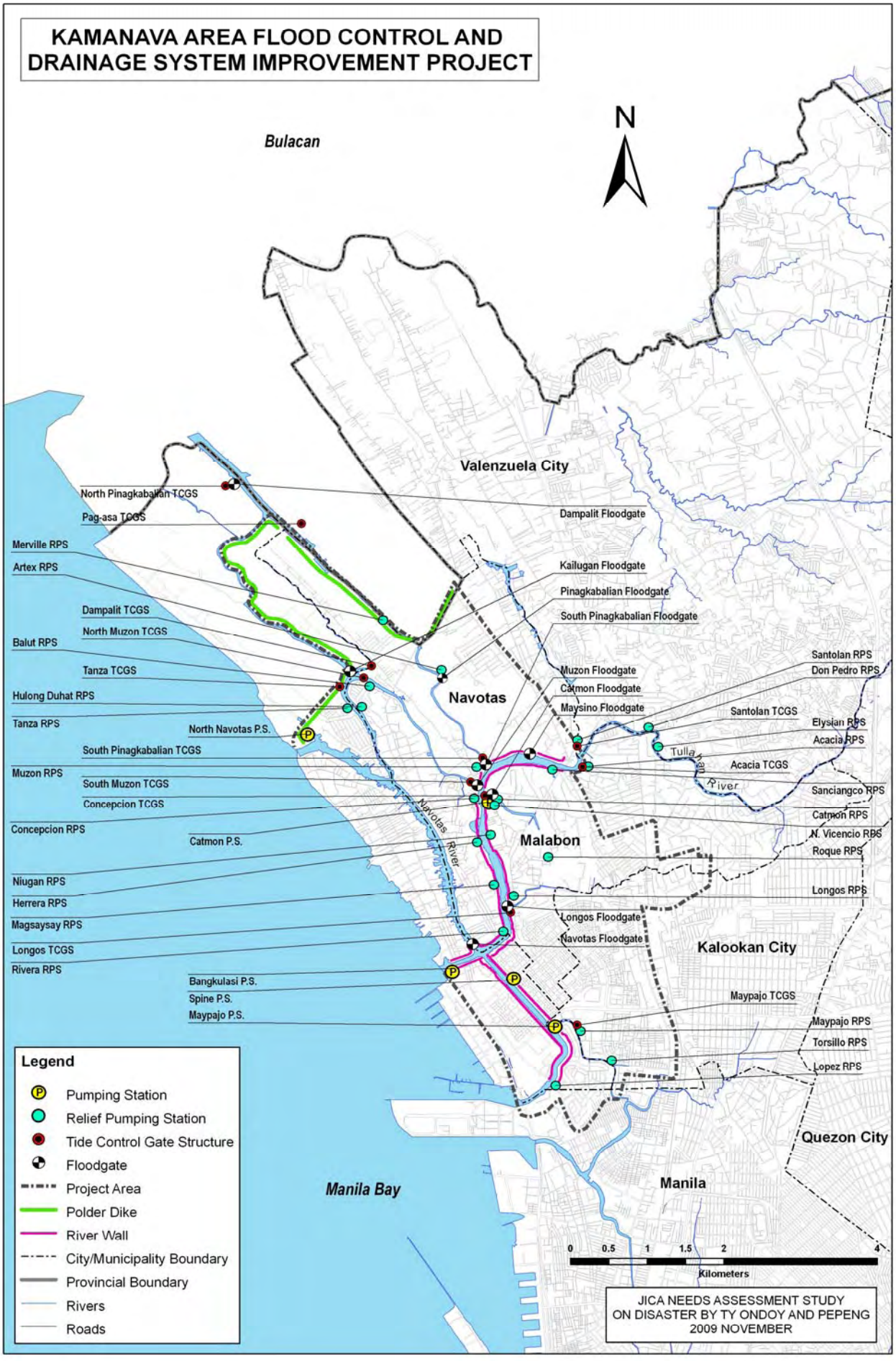


Figure 2.3.4 KAMANAVA Area Flood Control and Drainage System Improvement Project

2.3.2 Flood Forecasting and Warning System

(1) The Philippines Atmospheric, Geophysical and Astronomical Services Administration (PAGASA)

PAGASA, which is organized under the Department of Science and Technology (DOST), shall undertake operational activities in flood forecasting and warning, covering important river basins in the country, develop systems and facilities necessary to carry out these functions, improve the techniques and methods used, and coordinate with the Department of Public Works and Highway (DPWH), Department of Transportation and Communications (DOTC) and other agencies concerned with flood mitigation and control.

The Hydro-Meteorological Division (HMD) of PAGASA is in charge of analysis of pertinent catchment data (rainfall and water level) for flood forecasting and issuance of "Flood Warning" in the form of bulletin to specific target areas of telemeter river basins and "General Flood Advisories" to non-telemeter areas.

HMD issues and broadcasts: 1) Weather Forecast (5:00 am and 5:00 pm), 2) Severe Weather Bulletin and Tropical Cyclone Warning (5:00 am, 11:00 am, 5:00 pm and 11:00 pm), 3) Flood Bulletin, and 4) other information such as Status of major dams in Luzon. Target areas of basin Flood Bulletin are four river basins in Luzon, namely Pampanga, Agno, Bicol and Cagayan, where forecasting and warning system are installed, so-called Pampanga, Agno, Bicol and Cagayan Flood Forecasting and Warning System.

For Metro Manila, PAGASA has not issued Flood Bulletins since 2006.

(2) Effective Flood Control Operation System (EFCOS)

EFCOS was originally developed at DPWH in 1978, and a new system was installed in 1993 and rehabilitated in 2001. After the rehabilitation of EFCOS it was transferred from DPWH to MMDA in 2002. MMDA conducted it's O&M until 2006, but shut down its O&M due to the budget constrain.

The EFCOS project was implemented stepwise in two (2) phases, as stated below:

Phase I: the Project for EFCOS, completed in 1993
Phase II: the Project for Rehabilitation of the Flood Control Operation and Warning System in Metro-Manila, completed in 2001

The Phase I aimed to install rainfall and water level gauging stations in the Pasig-Marikina River basin and to transmit the observed data to the Rosario Master Control Center using a telemeter system. In the Phase II, the function of the system was enhanced by adding some new rain gauge and river stage

gauging stations, an emergency radio communication system, etc. The data transmitted to the Rosario Master Control Center are analyzed for the purpose of flood disaster risk reduction in the project area. The data can also be used for effective operation of the floodgates at the Rosario Weir.

The present configuration of the EFCOS system and its state are compiled in **Table 2.3.5.**

EFCOS has not functioned as follow:

1) Recently, the flood gates at Rosario Weir and Napindan HCS have been kept open, even in the rainy season. In addition, one of two emergency generators for operation of the flood gates is out of order.
2) The transmitter and circuit board at the Antipolo Relay Station is out of order and hence it is impossible to transmit the observed and processed data to any monitor station.
3) The three (3) amplifiers at the PAGASA Relay Station are out of order. Therefore, the emergency radio communication system for the pumping stations, LGU offices and district offices/related agencies, which are linked to the communication system, can not be operated and no communication with others.
4) During Ondoy, the rainfall/water level gauges at Nangka and the water level gauges at Sto. Niño were damaged, and the cable of water level gauges was damaged at Sot. Niño.
5) Before Ondoy, two gauging stations at Napindan weir and San Juan were out of order.
6) Although a computerized simulation model was developed for forecasting flood water level, but used only in 2002/2003.

Table 2.3.5 EFCOS Configuration

Description	Nos.	Station Name	Remarks
(1) Hydrological Observation Network System			
1. Telemeter Rain-gauge Stations	7	- Boso-Boso, - Mt. Oro, - Aries, - Mt.Campana, - PAGASA (Science Garden), - Nangka, - Napindan HCS	- operational - operational - operational - damaged - out of order (manual data collection) - damaged by Ondoy - out of order
2. Telemeter Water Level-gauge Stations	11	- Montalban, - Sto. Niño, - Pandakan, - Fort Santiago, - Angono, - Rosario Weir (2), - Napindan weir (2), - San Juan, - Nangka	- operational - damaged by Ondoy - operational - operational - operational - Junction side: operational - Lake side: out of order - out of order - out of order (manual data collection) - damaged by Ondoy
(2) Telecommunication Network System (Emergency Radio Communication Network System)			
3. Master Control Station	1	Rosario	- operational
4. Monitor Stations	4	- Napindan, - DPWH Central Office, - NCR Head Office (DPWH), - PAGASA (DIC)	- operational - operational - operational - operational
5. Relay Stations	2	PAGASA (Science Garden), Antipolo	Out of order
6. Warning Post Stations	9	Warning Posts-1 to -9	- operational
7. Pumping Stations	15	Aviles, Balete, Binondo, Escolta, Makati, Paco, Pandacan, Quiapo, San Andres, Sta. Clare, Valencia, Tapayan, Labasan, Taguig, Hagonoy	Can not communicate, base station (PAGASA) not available
8. LGUs	14	Rodrigues (Montalban), San Mateo, Marikina, Pasig, Taguig, Pateros, Cainta, Taytay, Angono, Mandaluyong, Makati City, Quezon City, San Juan, City of Manila	Emergency radio equipment and UPS are pull-out./ Can not communicate, base station (PAGASA) not available
9. Engineering District Offices of DPWH-NCR	7	North Manila Engineering District, South Manila Engineering District, 1st Metro Manila Engineering District, 2nd Metro Manila Engineering District, 3rd Metro Manila Engineering District, Quezon City Engineering District, Quezon City Sub-Office Engineering District	Emergency radio equipment and UPS are pull-out. Can not communicate, base station (PAGASA) not available

2.3.3 Transmission of Flood Information

(1) NDCC

The National Disaster Coordination Council (NDCC) was established under Presidential Decree No. 1566, issued in 1978, on the premise that the country shall mobilize all its available institutions to protect lives and property and ensure collective survival in the face of natural disasters.

The NDCC is the highest policy-making and coordinating body for disaster management at the national level, supported by the Office of Civil Defense (OCD) which serves as its Executive Officer and Secretariat to the NDCC. The NDCC directs all disaster preparedness planning, as well as disaster response operations and rehabilitation, in the public and private sectors. The Secretary of National Defense serves as the Chairman of the NDCC. The members of the NDCC are composed of the heads of fifteen (15) national agencies, Director General, Philippine Information Agency, the Chief of Staff of the Armed Forces of the Philippines, the Secretary-General of Philippines National Red Cross, and the Administrator, OCD.

In each of the administrative levels of the country, there exist the disaster coordinating councils (DCCs) : Regional DCCs, Provincial DCCs, City/Municipal DCCs and Barangay DCCs. These local DCCs have the function to execute the actual disaster management works required at the local level through close cooperation with civic and non-government organizations (NGOs).

The NDCC receives such flood information as weather advisory, typhoon bulletin, flood advisory, food bulletin, gate openings and dam status from PAGASA and transmits them to RDCCs and the other agencies concerned:

During Ondoy there is no flood warning from PAGASA because of no functioning of EFCOS. In Metropolitan Manila rehabilitation of the flood warning system is urgent and establishment of community based flood warning and evacuation system is important. In general LGUs and Barangays should conduct flood disaster risk management and emergency activities under the support of NDCC-OCD, DILG and DSWD, but most of LGUs and Barangays are lack of experience for preparation and operation of flood disaster risk management and emergency response plans, and need assistance.

2.3.4 Evacuation

(1) Evacuation activities in Metro Manila during and after Ondoy

In Metro Manila, the LGUs are in charge of actual operations and managements of the activities according to *the Inclement Weather Emergency Preparedness and Response Plan* prepared by MMDA DCC. **Table 2.3.6** compiles the status of evacuation centers in NCR on 18 November 2009. The Table shows 418 centers were activated, and 80, 423 families (about 400,000 persons) were evacuated.

Out of 17 cities in NCR, the three cities: Pasig, Marikina and Quezon Cities, located in the Marikina River and the Sun Juan River basins, evacuated as many refugees as about 265,000 persons, which are 66% of the total.

Table 2.3.6 Status of Evacuation Centers in NCR (as of 18 November 2009)

Type of Disaster: Typhoon Ondoy

Date of Occurrence: 26 September 2009

Places of ECs	**Nos. of ECs Activated**		**Numbers Served**			
			Families		**Persons**	
	(a)	(b)	(a)	(b)	(a)	(b)
Mandaluyong	16	0	2,185 (3%)	0	10,160 (3%)	0
Pasig	34	0	15,126 (19%)	0	75,630 (19%)	0
Makati	13	0	679 (1%)	0	3,395 (1%)	0
Pateros	26	0	1,687 (2%)	0	9,820 (2%)	0
Caloocan	42	0	4,157 (5%)	0	20,785 (5%)	0
Navotas	2	0	38 (0%)	0	194 (0%)	0
Marikina	21	0	15,789 (20%)	0	78,985 (20%)	0
Pasay	5	0	2,182 (3%)	0	8,537 (2%)	0
Quezon City	83	0	21,965 (27%)	0	109,855 (27%)	0
Muntinlupa	25	16	4,527 (6%)	2,603	22,550 (6%)	9,754
Manila	14	0	1,158 (1%)	0	5,790 (1%)	0
Taguig	62	0	5,616 (7%)	0	28,175 (7%)	0
San Juan	1	0	520 (1%)	0	2,234 (1%)	0
Las Piñas	13	0	1,365 (2%)	0	6,825 (2%)	0
Valenzuela	43	1	1,598 (2%)	11	8,106 (2%)	63
Malabon	15	0	1,381 (2%)	0	8,736 (2%)	0
Paraňaque	3	0	450 (1%)	0	2,250 (1%)	0
Total	**418**	**17**	**80,423 (100%)**	**2,614**	**402,027 (100%)**	**9,817**

Source: DSWD-NCR

Notes: EC = Evacuation Center, (a) = cumulative, (b) = as of 18 November 2009, 8:00 PM

With regard to the evacuation activities at Marikina City during Ondoy, the following are found in this study:

1) The Marikina City prepared “Disaster Management Handbook” two years ago and established an automatic alarm system along the Marikina River. The system has been designed to automatically sound sirens for preparation and commencement of flood evacuation activities when

the river stage of the Marikina River reaches El.15 m and EL.16 m at the Marikina Bridge river gauge. The alarm system was designed based on several past experiences of flood evacuation activities in the City. Usually, it took 12 to 16 hours for the Marikina river stage to rise from EL.15 m to EL.16 m at the Marikina bridge river gauge. During the Ondoy, however, the alarm system was not helpful for the evacuation because of the following reasons:

- Ondoy caused a flash flood in the Marikina River, resulting in sudden flood inundation with a rapid rise of flood water in the City. In some areas, the inundation water rose by about one meter in as short as 10 minutes immediately after the overtopping of the flash flood from the Marikina River.
- In the City, no evacuation drill had been carried out for the floods with a rapid and high rise of flood water like the Ondoy case. (EL.22.16 m)
- Based on the experience of Ondoy flood disaster risk management plan is to be required.

2) The capacity of evacuation centers to accommodate evacuees was insufficient because several centers were submerged. Therefore, the evacuees were compelled to stay in the centers under a very compressed condition, and .clean water for drinking, cooking and washing was not sufficiently secured in the centers. The flood disaster emergency response plan requires to be based on the flood hazard map.

3) According to the Local Government Code, the implementation of evacuation activities, including management of evacuation centers, shall be handled by the LGUs themselves. DSWD is not a direct service provider during disaster and mandated to provide the LGUs with such technical assistance as training, consultation and orientation for relief to victims. Enhancement of public awareness for flood disaster risk reduction is to be required.

4) Rescue of victims and transfer to evacuation centers is the task of NDCC. The response of the task was rather late in the case of the Ondoy. It took long time to find available evacuation centers, because several candidates of the centers were submerged and the location maps of evacuation centers were unavailable also because of submergence. Furthermore, smooth evacuation activities were hampered due to mudflow brought about by the flash flood of the Ondoy. For smooth evacuation GIS based hazard map is necessary to be prepared.

5) As several emergency communication facilities were in malfunction during the Ondoy, the cellular phone networks were relied on for communication in the evacuation activities. However, the networks went down due to sudden concentration of access to the networks during a certain period of time, and also battery charge of cellular phones was seriously limited due to break in power supply.

6) For people to conduct emergency response activities it is necessary to establish community based flood risk management.

3. Assistance Programs of the GOP and the Other Donors

3.1 Assistance Programs of the Central and Local Governments

(1) According to PD 1566 of 1978, the NDCC is the highest policy-making and coordinating body for disaster risk management. The OCD serves as the Secretariat of the NDCC, and implements policies and programs on disaster risk management. The NDCC is chaired by the Secretary of the DND and has 19 member government departments and agencies, which are to be given specific roles and responsibilities in disaster risk management. The NDCC has the National Disaster Management Center (NDMC), which serves as a disaster operation center open 24 hours a day, seven days a week. When the NDMC received information from its member agencies responsible for the early warning system (e.g. PAGASA or PHIVOLCS) of an important natural event and its potential disastrous impacts, it raises alert warning to the concerned Regional Disaster Coordinating Councils (RDCCs) and during disasters gives information to them as "NDCC UPDATE" based on the information from member agencies.

(2) Disasters are handled by several layers of Disaster Coordinating Councils (DCCs) in the Philippines. The DCC is composed of, 1) the NDCC; 2) 17 Regional DCCs; 3) 81 Provincial DCCs; 4) 117 City DCCs; 5)1,496 Municipal DCCs; 6) 41, 945 Barangay DCCs. The DCCs are to provide services in three phase of disaster management: namely the pre-disaster, disaster and post-disaster phases. Every DCC should have disaster risk management plans, but mostly are not ready for disaster risk management except emergency responses in disaster.

(3) The NDCC has reformed its disaster management policy and strategy from reactive and emergency management to a pro-active one toward disaster risk reduction and a more integrated approach to disaster risk management (DRM) on natural disasters since 2004. The NDCC developed the Strategic National Action Plan (SNAP) for 2009-2019 (Consultation Version 5.2) in December 2008 for the pursuit of disaster risk reduction objectives aligned with the HFA.

It is necessary for the NDCC to review and update the functions and responsibilities to make them pro-active and attain the objectives of DRM, and to strengthen the current NDCC system in capacity, human resources, technology needs, financial resources and institutional.

(4) UNDP and AusAid have been supporting NDCC-OCD to conduct the READY Projects (2006-2011), which NDCC-OCD is to prepare hazards maps for effective community based DRM at the 27 high risk provinces with collaboration with MGB, NAMRIA, PAGASA and PHIVOLCS.

3.2 National and Local Calamity Funds

As for National and Local Calamity Fund there are National Calamity Fund (NCF), Local Calamity Fund (LCF) and Local Development Fund (LDF). The National Calamity Fund is included in the

budget based on General Appropriation Act: GAA and approved as the budget, and used in calamity areas for aid, relief, rehabilitation, reconstruction and other work, and services necessary to deal with disasters. The National Calamity Fund includes Quick Response Fund, which is provided to the Central Government Agencies to utilize in emergency needs in the Calamity Areas. The National Calamity Fund is utilized more in rehabilitation/restoration than in emergency responses.

All LGUs are mandated due to the Republic Act No. 8185 to set aside annually about 5% of their Internal Revenue Allotment (IRA) as their Local Calamity Fund (LCF). The LCFs are usually released within 24 hours of the declaration of a disaster, and utilized in the calamity areas for aid, relief, rehabilitation and reconstruction necessary to deal with disasters. The LGUs are also possible to include about 20% of annual budget as their Local Development Funds, which are utilized for rehabilitation or improvement of infrastructure like irrigation and road facilities. It is possible for cities and municipalities to utilize the calamity fund for undertaking disaster preparedness activities and measures, but their annual budgets are insufficient in order to conduct their obligation for flood risk management.

3.3 Assistance Program of the Other Donors

The government requested international assistance on September 28, 2009. The Department of Finance requested development partners to undertake a Post-Disaster Needs Assessment (PDNA) jointly with the Government. The Post-Disaster Needs Assessment (PDNA) is a joint initiative of the Government of the Republic of the Philippines, representatives of the private sector and civil society organizations, multilateral development partners: ADB, EC, UN、WB and bilateral development partners including AusAID, CIDA, GTZ, JICA, Royal Netherlands Government (RNG) and USAID.

The PDNA covers 13 sectors, as well as 4 cross-sectoral areas. The assessed sectors are: 1) Productive sectors, which consist of agriculture and enterprises (industry, commerce, and tourism), 2) Social sectors, consisting of housing, education, cultural heritage, and health, 3) Infrastructure, consisting of power, water and sanitation, flood control, drainage and dam management, transport, and telecommunications, and 4) Cross-sectoral areas of local government, social protection, financial sector, and disaster risk management and reduction.

As for assistance programs from donor agencies and countries, NEDA suggested that they are expecting some assistance programs to be committed from multilateral development partners and bilateral development partners after the meeting on the PDNA held by WB on December 2, 2009.

4. Needs Assistance for Post-disaster Rehabilitation and Restoration

4.1 Needs and Countermeasures

The flood disaster areas by the Tropical Storm Ondoy are the Marikina River, Laguna Lake and Metropolitan Manila and surrounding, and the flood disaster areas by the Typhoon Pepeng are major rivers in the Northern and Central Luzon. The major cause of disasters and required measures are listed as follows:

(1) Marikina River (Including East and west areas of Mangahan Floodway)

Cause of flood	Required Countermeasures
Floods from the Marikina River and its tributaries	Flood control measures against designed flood and excess floods: ・ Control of flood peaks (Construction of dam and retarding basin) ・ Increase the conveyance capacity of the Marikina River (River improvement) ・ Improvement of tributaries (Cainta River , Taytay River and others) ・ Drainage improvement Flood disaster risk reduction by non-structural measures: ・ River and flood plain management and land use control ・ Establishment of community based flood early warning system ・ Promotion of IEC campaign ・ River basin and watershed management (Recovery of forest area and reforestation)

(2) Laguna Lake Area

Cause of flood	Required Countermeasures
Rising of lake water level	Flood control measures against designed flood and excess floods: ・ Flood control facilities (Construction of Lakeshore dike) Flood disaster risk reduction by non-structural measures:

	・ Lakeshore floodplain management ・ Establishment of community based flood early warning ・ Promotion of IEC campaign

(3) Metropolitan Manila Core Area and Surrounding

Cause of flood	Required Countermeasures
Floods caused by storm water and flashflood	Flood control measures against designed flood and excess floods ・ Rehabilitation of drainage pumping stations and drainage facilities in the core area of Metropolitan Manila ・ Rehabilitation of EFCOS ・ Drainage improvement of VOM area ・ Improvement of small rivers: the San Juan, Tollahan and Paranaque rivers Flood disaster risk reduction by non-structural measures ・ Establishment of community based flood early warning ・ Promotion of IEC campaign

(4) North and Central Luzon

Cause of flood	Required Countermeasures
Floods caused by heavy rain	Flood control measures against designed flood and excess floods: ・ Strengthening river embankments for major rivers ・ Regular O&M activities for flood control facilities

Needs and countermeasures for the flood areas through lesson from the disasters are summarized as follows:

(1) Pasig-Marikina River

Marikina River

1) The Pasig-Marikina River Improvement Project was commenced in December 2008 and planned to be complete in August 2013. Now the project is in construction stage-1. The project is composed of three construction stages and planned to conduct the river channel improvement from the Pasig River Mouth up to Marikina Bridge, which is located at 6.1 km upstream from Rosario Weir. In order to increase their flood discharge capacities and level up their safety level of the Metropolitan Manila the project shall be completed as early as possible. The project does not include the improvement of the upper reach of Marikina Bridge, where were suffered from severe flood by Ondoy.

2) In order to protect people in the flood risk area along the Marikina River some flood control facilities such as reservoirs and retarding basins will be required to reduce flood peaks in the upper reach of the Marikina River.

3) Also non-structural measures like flood plain management and community based flood warning system will be required to reduce flood disaster risks.

Laguna Lake:

4) During Ondoy the water level of Laguna Lake rose about 1.20 m to over EL.13.80 (the design water level of the lakeshore dyke) and caused flooding at the lakeshore area. It is necessary for the lakeshore area to develop flood control measures like lakeshore dikes to protect people from a rising water level of Laguna Lake and introduce non-structure measures such as flood plain management and community based flood warning to reduce flood disaster risks.

Core Area of Metroplitan Manila and surrounding

5) During Ondoy the core area of Metro Manila was not suffered from the flood from the Pasig River, but early completion of Pasig-Marikina River Channel Improvement Project;

6) The core area of Metropolitan Manila suffered from a heavy storm water and inundated for one to three days. The core area of Metro Manila is low lying and 70% (52 sq. km) of the area depends on the mechanical drainage system and it is very important for the core area to maintain the function of the existing storm water drainage system. The drainage system is composed of 15 major pumping stations, 74 km of estero and creek, 35 km of drainage main. However, 12 of the major pumping stations have already been superannuated and need rehabilitation, and drainage channels need dredging as proposed in the JICA Study in 2005.

The rehabilitation of major pumping stations is divided three groups in the following box.

Proposed 12 Pumping Stations for rehabilitation:

- **Group 1**: Very old and serious conditions
  Aviles (Discharge capacity: 18.6 cu. m/s, Construction year: 1976),
  Quiapo (10.8 cu. m/s, 1976), **Valencia** (10.8 cu. m/s, 1976),
  Tripa de Gallina (57.0 cu. m/s, 1977)
- **Group 2**: Old and marginal service life
  Pandacan (4.4 cu. m/s, 1976), **Paco** (7.6 cu. m/s, 1977), **Sta. Clara** (5.3 cu. m/s,1977),
  Libertad (42.0 cu. m/s, 1977), **Makati** (7.0 cu. m/s, 1984), **Binondo** (11.6 cu. m/s, 1985)
- **Group 3**: Submergible pumps of outdoor type
  Escolta (1.5 cu. m/s, 1982) and **Balete** (3.0 cu. m/s, 1988)

Source: The Study on Drainage Improvement in the Core Area of Metropolitan Manila (JICA, 2005)

During torrential rainstorm, there are small scale inundation in the road, local depression area and low-lying area. For urgent drainage emergency mobile pumps are considered at Manila City and several other cities.

7) The San Juan, Tullahan and Parañaque Rivers Para in the vicinity of core area of Metro Manila were flooding and need rehabilitation of their channels to increase their flood discharge capacities and also Valenzuela-Oband-Meycauyan (VOM) area, which is adjacent of KAMANAVA needs flood control and drainage improvement.

In General

8) According to the interviews with people in the flood disaster areas there was no flood warning during Ondoy. It is necessary for Metropolitan Manila to rehabilitate EFCOS as a basic flood warning system and utilize its function effectively;

9) For Metropolitan Manila it is very important to utilize EFCOS and also establish reliable organization for proper O&M of EFCOS instead of MMDA which has stopped O&M since 2006;

10) It is essential for LGUs of Metropolitan Manila to develop community-based flood warning and evacuation systems based on the actual flood hazard area by Ondoy. It is necessary for LGUs to develop flood hazard maps. The LGUs need to develop practical flood hazard maps. Metro Manila has a base map of the scale (1:5,000), and the LGUs in the surrounding should have a topographic map of scale (1: 5,000 or 1:10,000) for developing practical flood hazard maps;

11) The master plan of the 1990 needs to be updated. The study is to develop an integrated flood control and drainage program for the Pasig-Marikina- Laguna Lake area and cover the following:
    - Development of basic policy, objectives and measures for the area
    - Required development program and institutional plan
    - Implementation plan
    - F/S on priority measures

    The rainfall amount during Ondoy is by far larger than the design rainfall for the 1990 master plan and the study should consider required adaptation measures for the area. The projects proposed in the master plan are now in various stages: maintenance, construction, waiting after F/S and Pre F/S, and need an optimum implementation program. The measures to be studied are proposed as follows:

    a) Flood control measures for the Marikina River:
    - F/S on flood control reservoirs and retarding basins in the upper reach of the Marikina River
    - Introduction of flood plain management and land use management for the flood plain of the Marikina River

    b) Flood control facilities for Laguna Lake:
    - F/S on lakeshore dikes around Laguna Lake for protection of people along the lakeshore
    - Introduction of lakeshore and land use management.

12) For management of Pasig-Marikina-Laguna Lake area there are many concerned organizations at central and local levels, but it is necessary for the area to improve and establish one optimum managing organization responsible for river management and flood risk management and also necessary to improve coordination among the concerned organizations

13) It is necessary to promote IEC campaign to enhance public awareness for flood disaster risk management;

(Northern and Central Luzon)

14) In the Northern Luzon Pepeng caused destruction and damaged flood embankments especially along the Agno, Laoag, Cagayan, and Bucao Rivers. These rivers need to reconstruct damaged embankment sections based on the concept of “building better” in order to protect people and assets in municipalities and communities in the flood disaster areas. The main implementing agency for the project will be DPWH, with cooperation from LGU, as needed;

15) Also it caused severe landslide disasters in CAR, Region I and Region II. The Mines & Geosciences Bureau (MGB) has surveyed landslide sites along roads in Bagio City, Itogon, Tubao, Tublay and La Trinidad in Benguet and recommended (1) stabilization of slopes at risk, and (2) relocation of people living in the vicinities of land slides;

16) MGB is reporting that on-going debris flows caused the damming of a portion of the Bued River at Sitio Caipilan, Camp 3, Tuba, Benguet and that MGB gave a warning to the residents of the area including those living downstream for the possible occurrence of flashflood;

17) Instable and susceptible slopes to landslide are widely distributed in the Benguet area and numerous landslides were caused by the extreme heavy rainfalls of Pepeng. It suggests that those rivers, which have their stream heads in Benguet area have possibilities of increasing sediment related disasters like flashfloods and mudflows, and that further investigation will be required.

4.2 Needs for Post-disaster Rehabilitation and Restoration Plans

(1) Post-disaster reconstruction

The Tropical Storm Ondoy caused flood disasters in Metropolitan Manila/National Capital Region and the Typhoon Pepeng did flood disasters in the Northern, Central Luzon and others, and landslide disasters in the Northern Luzon. Post-disaster reconstruction needs are selected from the flood control and drainage facilities damaged by Ondoy and Pepeng in NCR and Luzon based on the data from DPWH and MMDA, and estimated at Php716.8 million and regions/priority projects/cost are shown in **Table 4.1.1**. The reconstruction works are scheduled to be implemented in 2010 as proposed by the PDNA.

(2) Medium-Term (2010 ~ 2012)

Medium-Term needs are also planned to be conducted for three years (2010～2012) as proposed by the PDNA. The proposed projects are selected based on the information from DPWH (implementing agency of flood control measures) and MMDA (O&M agency for flood control facilities) to implement in the next Medium Term Philippine Development Plan (MTPDP). The projects proposed for NCR and Luzon are composed of structural and non-structural measures necessary for flood risk reduction and estimated to be Php8.05 Billion and shown in **Table 4.1.2**.

1) Proposed Flood Management and Control Projects in Metro Manila

A) Existing key flood management and drainage systems

(a) Valenzuela-Obando-Meycauayan (VOM) Area Drainage Improvement and Related Work

Projects (Phase 1/2): F/S was completed by DPWH in 2008

(b) Metro Manila Flood Control Projects, East of Mangahan Floodway (Phase 1/2): F/S was completed by DPWH in 2007

(c) Tullahan River Improvement Project (Phase 1/2)

(d) Paranaque River Improvement Project ((Phase 1/2): F/S was completed by JETRO (Japan External Trade Organization)

(e) Drainage improvement & Pump Rehabilitation in Core Area of Metro Manila (Phase 1/2): F/S was completed by JICA in 2005

B) Improvement of flood risk management

(a) Making of fund and emergency maintenance equipment available for regular maintenance

(b) Establishment of system-specific operation and maintenance (O&M) needs

(c) Re-establishment and development of the management information system and appropriate flood forecasting and warning systems

(d) Establishment of optimum water and river management agency responsible for flood management and drainage in the Pasig-Marikina and Laguna Lake basin.

(e) Conduct of a risk assessment study for the entire basin area and update the master plan of the 1990 to come up with a comprehensive development program

2) Proposed Flood Management and Control Projects in Luzon (Central & Northern Luzon)

A) Cagayan River Flood Control Project, (Part 1/2) Phase I-Urgent Bank Protection Work (Lower Cagayan River)

B) Agno & Allied Rivers Urgent Rehabilitation Projects, Phase III (Part 1/2)

C) Flood Control Measures in the Pinatubo Devastated Areas and Rehabilitation of School Buildings (Part 1/2)

D) Tarlac River Overall Improvement Project (Part 1/)

(3) Long-Term (2013 ~ 2016 Beyond)

Long-Term needs are planed to be conducted for 2013～2016 beyond considering the next MTPDP. Projects are to be continued from the Medium-Term as Phase 2 or Part 2. Lakeshore Dike Project for Laguna Lake and Marikina Flood Control Dam Project for Marikina River are proposed. The Projects proposed for NCR and Luzon are Php44.85 Billion and shown in **Table 4.1.3**.

1) Proposed Flood Management and Control Projects in NCR and Surroundings

A) Existing key flood management and drainage systems

a) Valenzuela-Obando-Meycauayan (VOM) Area Drainage System Improvement and Related Works Projects (Phase 2/2)
b) Metro Manila Flood Control Project (Phase 2/2) -East of Mangahan Floodway
c) Tullahan River Improvement Project (Phase 2/2)
d) Parañaque River Improvement Project (Phase 2/2)
e) Drainage Improvement & Pump Rehabilitation in Core Area of Metro Manila (Phase 2/2)
f) Lower Marikina River (Napindan HCS to Mangahan Gates)
g) Upper Marikina River (Mangahan Gates to Marikina Bridge)
h) Upper Marikina River (Marikina Bridge to San Mateo Bridge)
i) Upper Marikina River (San Mateo Bridge to Rodriguez Bridge)
j) San Juan River Improvement Project

B) Existing key flood management and drainage systems in Metro Manila, Rizal & Laguna

a) Laguna Lakeshore Dykes and Pumping Stations (Metro Manila, Rizal & Laguna)
b) Flood Control Dam Project (Rizal)

(2) Proposed Flood Management and Control Projects in Luzon (Central & Northern Luzon)

a) Cagayan River Flood Control Project, (Part 2) Phase I-Urgent Bank Protection Work (Lower Cagayan River)
b) Agno & Allied Rivers Urgent Rehabilitation Projects, Phase III (Part 2/2)
c) Flood Control Measures in the Pinatubo Devastated Areas and Rehabilitation of School Buildings (Part 2/2)
d) Tarlac River Overall Improvement Project (Part 2/2)
e) Project for Storage of Construction Materials for Agno and Pampanga River Flood Mitigation Project
f) Detailed Design Study of the Proposed Agus River Flood Control in Infanta, Quezon
g) Yaya/Basud/Quirangay (Legazpi City) River Flood Control and Drainage Project
h) Agos River Flood Control and Drainage Project
i) Amburayan Flood Control and Drainage Project

Figure 4.1.1 Flood Control Facilities Damaged by Typhoon Ondoy in Metro Manila

Table 4.1.1 Flood Control Projects in Emergency Public Investment Program

- Metro Manila and Luzon -

Region	**Priority Projects** (Year 2010)		**Total Cost** (million Pesos)	**Flood/River Control Damage As Validated** (thousand Pesos)	
CAR		I	0.00	Php	-
		II	19.08	Php	19,076
		III	0.00	Php	-
		Sub-total	**19.08**	Php	19,076
Region I		I	232.00	Php	231,997
		II	0.00	Php	-
		III	0.00	Php	-
		Sub-total	**232.00**	Php	231,997
Region II		I	58.84	Php	58,842
		II	16.14	Php	16,141
		III	0.00	Php	-
		Sub-total	**74.98**	Php	74,984
Region III		I	107.41	Php	107,413
		II	4.46	Php	4,461
		III	0.00	Php	-
		Sub-total	**111.87**	Php	111,874
NCR	Pasig-Marikina River		90.20	Php	90,200
	East of Mangahan Floodway		85.57	Php	85,570
	West of Mangahan Floodway		37.50	Php	37,500
	Metro Manila		25.25	Php	25,250
		Sub-total	**238.52**	Php	238,520
Region IV-A		I	4.26	Php	4,255
		II	0.00	Php	-
		III	0.00	Php	-
		Sub-total	**4.26**	Php	4,255
Region IV-B		I	0.00	Php	-
		II	0.00	Php	-
		III	0.00	Php	-
		Sub-total	**0.00**	Php	-
Region V		I	0.00	Php	-
		II	36.10	Php	36,098
		III	0.00	Php	-
		Sub-total	**36.10**	Php	36,098
Total		I	**641.03**	Php	641,027
		II	**75.78**	Php	75,776
		III	**0.00**	Php	-
		Total	**716.80**	**Php**	**716,804**

Source: JICA, WB, DPWH

Table 4.1.2 Future Flood Control Projects in Medium-Term (2010-2012) Public Investment Program

Investiment Program (Region NCR, Northern and Central Luzon)

List of Projects	Region	Total Cost		Proposed Annual Allocation (in thousand Pesos)		
		(Billion Pesos)	(Thousand Pesos)	2010	2011	2012
I. Proposed Flood Management and Control Projects in Metro Manila	NCR	**5.55**	5,549,099			
1 Existing key flood management and drainage systems		3.75				
(1) Valenzuela-Obando-Meycauayan (VOM) Area Drainage System Improvement and Related Works Projects (Phase 1 out of 2 Phases)		1.06	1,064,296	200,000	580,000	284,296
(2) Metro Manila Flood Control Project (Phase 1 of 2 Phases) East of Mangahan Floodway		0.86	857,150	200,000	400,000	257,150
(3) Tullahan River Improvement Project (Phase 1 out of 2 Phases)		0.77	767,600	40,000	400,000	327,600
(4) Paranaque River Improvement Project (Phase 1 out of 2 Phases)		0.36	360,053	14,000	200,000	146,053
(5) Drainage Improvement & Pump Rehabilitation in Core Area of Metro Manila (Phase 1 out of 2 Phases)		0.70	700,000	250,000	250,000	200,000
2 Making of funds and emergency maintenance equipment available for regular maintenance		1.10	1,100,000	363,000	363,000	374,000
3 Establishment of system-specific operation and maintenance (O&M) needs		0.075	75,000	75,000		
4 Re-establishment and development of the management information system and appropriate flood forecasting systems		0.25	250,000	250,000		
5 Establishment of a single water management agency responsible for flood management and drainage in the entire catchment agency		0.125	125,000	43,750	50,000	31,250
6 Conduct of a risk assessment study for the entire basin area and update the master plan of the 1990 to come up with a comprehensive development program		0.25	250,000	250,000		
II. Proposed Flood Management and Control Projects in Luzon		**2.50**	2,495,944			
River Bank Strengthening along Rivers in Central and Northern Luzon						
(1) Cagayan River Flood Control Project, (Part 1 out of 2 Parts) Phase I-Urgent Bank Protection Work (Lower Cagayan River)	II	0.63	627,380	207,035	207,035	213,309
(2) Agno & Allied Rivers Urgent Rehabilitation Projects, Phase III (Part 1 out of 2 Parts)	I	0.76	757,964	207,035	207,035	343,893
(3) Flood Control Measures in the Pinatubo Devastated Areas and Rehabilitation of School Buildings (Part 1 out of 2 Parts)	III	0.44	440,000	207,035	207,035	25,929
(4) Tarlac River Overall Improvement Project (Part 1 out of 2 Parts)	III	0.67	670,600	207,035	207,035	256,529
Total		**8.05**	8,045,043	2,513,892	3,071,142	2,460,010

Source: DPWH, MMDA

Total construction cost excluding ROW acquisition cost
"Phase I" & "Part 1" mean successive construction works to fully operation condition of the Project due to constrains of cost allocated and to be continuously implemented during a long-term program.

Table 4.1.3 Future Flood Control Projects in Long-Term (2013-2016 Beyond) Public Investment Program

Investiment Program (Region NCR, Northern and Central Luzon)

List of Projects	Region	Total Cost		Proposed Annual Allocation (in thousand Pesos)				
		(Billion Pesos)	(Thousand Pesos)	2013	2014	2015	2016	2016 Beyond
I. Proposed Flood Management and Control Projects in NCR & Surroundings		**32.32**						
1 Existing key flood management and drainage systems		16.44						
(1) Valenzuela-Obando-Meycauayan (VOM) Area Drainage System Improvement and Related Works Projects (Phase 2)	NCR	2.01	2,011,704	905,267	804,682	301,756		
(2) Metro Manila Flood Control Project, East of Mangahan Floodway (Phase 2)	NCR	1.59	1,591,850	318,000	850,000	423,850		
(3) Tullahan River Improvement Project (Phase 2)	NCR	1.25	1,252,000	600,000	652,000			
(4) Paranaque River Improvement Project (Phase 2)	NCR	0.37	368,947	250,000	118,947			
(5) Drainage Improvement & Pump Rehabilitation in Core Area of Metro Manila (Phase 2)	NCR	1.40	1,400,000	980,000	420,000			
(6) Lower Marikina River (Napindan HCS to Mangahan Gates)	NCR	1.45	1,452,000	254,100	544,500	508,200	145,200	
(7) Upper Marikina River (Mangahan Gates to Marikina Bridge)	NCR	1.39	1,388,000	242,900	520,500	485,800	138,800	
(8) Upper Marikina River (Marikina Bridge to San Mateo Bridge)	NCR, IV-A	1.30	1,301,680		73,680	429,800	491,200	307,000
(9) Upper Marikina River (San Mateo Bridge to Rodriguez Bridge)	NCR, IV-A	1.67	1,670,560		94,560	551,600	630,400	394,000
(10) San Juan River Improvement Project	NCR	4.00	4,000,000		73,460	220,380	1,285,550	2,420,610
2 Existing key flood management and drainage systems in Metro Manila, Rizal & Laguna		15.88						
(11) Laguna Lake, Dykes and Pumping Station (Metro Manila, Rizal, Laguna)	NCR, IV-A	11.50	11,500,000	210,000	630,000	2,100,000	2,100,000	6,460,000
(12) Flood Control Dam Project (Rizal)	IV-A	4.38	4,380,000	90,000	270,000	1,533,000	1,752,000	735,000
II. Proposed Flood Management and Control Projects in Luzon River Bank Strengthening along Rivers in Central and Northern Luzon		**11.53**						
(1) Cagayan River Flood Control Project, Phase I-Urgent Bank Protection Work (Lower Cagayan River) (Part 2)	II	2.51	2,509,520	1,003,808	878,332	627,380		
(2) Agno & Allied Rivers Urgent Rehabilitation Projects, Phase III (Part 2)	I	2.72	2,718,936	951,628	1,087,574	679,734		
(3) Flood Control Measures in the Pinatubo Devastated Areas and Rehabilitation of School Buildings (Phase 2)	III	1.76	1,760,000	704,000	792,000	264,000		
(4) Tarlac River Overall Improvement Project (Phase 2)	III	2.68	2,682,400	938,840	1,072,960	670,600		
(5) Project for Storage of Construction Materials for Agno and Pampanga River Flood Mitigation Program*1	I, III	0.02	20,000	10,000	10,000			
(6) Detailed Design Study of the Proposed Agus River Flood Control in Infanta, Quezon*1	IV-A	0.01	10,000	5,000	5,000			
(7) Yaya/Basud/Quirangay (Legazpi City) Rivers Flood Control and Drainage Project*1	V	0.48	475,000	9,500	14,250	14,250	87,400	349,600
(8) Agos River Flood Control and Drainage Project *1	IV-B	0.68	680,000	20,400	20,400	127,840	95,880	415,480
(9) Amburayan Flood Control and Drainage Project*1	I, CAR	0.68	676,000	13,520	20,280	20,280	124,384	497,536
Total		**43.85**						

Source: DPWH, MMDA

Project Cost*1: Consulting services and civil works excluding ROW acquisition cost.

5. Lesson from the Disaster and Recommendation on Disaster Sector Loan and JICA Project

5.1 Lesson from the Flood Disaster

The flood control and drainage improvement projects conducted by the Japanese ODA in NCR have a big effect to protect NCR from the flood disasters and to reduce the flood disaster risk caused by Ondoy. If the Mangahan Floodway were not constructed, by an extraordinary flood from the Pasig River Metropolitan Manila had had a devastating damage, and without the flood control and drainage projects for the core area of Metropolitan Manila, KAMANAVA area and West of Mangahan the areas had inundated for a long time. The structural measures by the Japanese ODA have protected NCR from severe flood disaster, but it is revealed that flood protection measures have been delayed for the mid and upper Marikina River and there are high needs for implementation of structural measures and non-structural measures for excessive floods. As the lesson from the flood disasters it is necessary for the disaster sector loan and also for the implemented and new JICA projects to consider the following factors.

(1) Promotion of flood control and drainage improvement measures

The core area of Metropolitan Manila has luckily escaped severe flood disasters, but the area along the Marikina River has widely suffered from the severe flood disasters and the delay in flood control measures at the mid and upper Marikina River becomes clear. If the excessive flood and the climate change in future are considered, flood control reservoirs and flood retarding basins as flood control measures in the upper reach of Marikina River and flood plain management along the Marikina River, lake shore dykes and flood plain management as flood control measures at Laguna Lake area will be required. Normally structural measures will take a long time before their completion, therefore community based flood disaster risk reduction measures as non-structural measures will be urgently promoted.

(2) Maintenance of the function of the existing flood control and drainage facilities

In the core area of Metropolitan Manila the flood control and drainage systems based on the 15 major drainage pumping stations been developed since 1970s, but many of the pumping facilities of the drainage systems have been superannuated and need rehabilitation. The drainage channels have mostly decreased their conveyance capacities because of sedimentation and accumulation of solid wastes. The function of the existing drainage facilities are very important for the core area of Metropolitan Manila and should be maintained by periodical rehabilitation.

(3) Introduction of river management and flood plain management, and centralization of river and flood management

In NCR there are numerous agencies like DPWH, MMDA, LLDA, DENR and LGUs concerned for flood management and the agencies are to act on the basis of their proper authorities. It is suggested that it is necessary for the Pasig-Marikina-Laguna lake area to conduct proper management based on the river basin and that it is necessary to select one responsible agency to carry out planning, implementing and conducting O&M for flood control in order to conduct proper flood risk management in NCR. At the same time it will be necessary to introduce river and flood plain management.

(4) Early assistance for non-structural measures for flood disaster risk reduction

It is necessary to assist LGUs to develop an effective flood disaster risk management plan. It is suggested that there are needs to assist LGUs, which have a high risk against flood disasters, in developing flood hazard maps based on the last flood and also in preparing flood disaster risk management plan (flood prevention, flood warning and evacuation system) and IEC campaign.

(5) Improvement of flood risk management for NCR

To enhance the effectiveness of the flood disaster risk reduction in NCR it is necessary to select pilot LGUs from the flood hazard area and conduct a pilot project. Though LGU has an obligation to develop a disaster prevention plan including flood disasters, it is necessary for LGU to have technical and financial assistance for formulating effective flood disaster risk management plan. Pilot LGUs should be selected from the flood hazard areas of the Marikina River, West Mangahan Area and the core area of Metropolitan Manila. To enhance the effectiveness of the flood disaster risk reduction in NCR it is necessary to select pilot LGUs from the flood hazard area and conduct a pilot project. Though LGU has an obligation to develop a disaster prevention plan including flood disasters, it is necessary for LGU to have technical and financial assistance for formulating effective flood disaster risk management plan. Pilot LGUs should be selected from the flood hazard areas of the Marikina River, West Mangahan Area and the core area of Metropolitan Manila.

5.2 Recommendation for JICA Project

JICA project required structural and non-structural measures for the flood disaster risk reduction in NCR, Northern and Central Luzon are recommended as follows:

(1) Implementation of reconstruction, rehabilitation and projects

1) Early completion of Pasig-Marikina River Channel Improvement Project
   - Upper Marikina River: Construction stage 2 (from immediate vicinity of Napindan HCS to Mangahan Floodway), and

- Upper Marikina River: Construction stage 3 (from Mangahan Floodway to Marikina Bridge)

2) Implementation of key flood management and drainage systems in Metropolitan Manila
3) Implementation of proposed flood management and control projects in the Northern and Central Luzon
4) Rehabilitation of EFCOS for flood warning system of Metropolitan Manila

(2) Assistance for preparatory study

1) Flood control projects for the upper Marikina River and Laguna Lake area

(3) Assistance for pilot non-structural measures in NCR

1) Improvement of managing organization for river management and flood disaster risk management in NCR or Metropolitan Manila and surrounding;
2) Preparation of flood risk management plan for pilot LGUs and establishment of community based flood warning and evacuation systems;
3) Promotion of IEC campaign for enhancement of public awareness for flood risk management.